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ORIGINAL ARTICLE

Is there a link between cardiovascular mortality and economic fluctuations?

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Abstract

Background: Unemployment might affect several risk factors of cardiovascular disease (CVD), which is the leading cause of death globally. The characterisation of the relation between these two phenomena is thus of great significance from a public-health perspective. The main aim of this study was to estimate the association between the unemployment rate and mortality from CVD and from coronary heart disease (CHD). Additional aims were (a) to assess whether the associations are modified by the degree of unemployment protection; (b) to determine the impact of GDP on heart-disease mortality; and (c) to assess the impact of the Great Recession in this context. *Methods:* We used time-series data for 32 countries spanning the period 1960–2015. We applied two alternative modelling strategies: (a) error correction modelling, provided that the data were co-integrated; and (b) first-difference modelling in the absence of co-integration. Separate models were estimated for each of five welfare state regimes with different levels of unemployment protection. We also performed country-specific ARIMA-analyses. *Results:* Because the data did not prove to be co-integrated, we applied first-difference modelling. The estimated effect of unemployment and GDP on CVD as well as CHD was statistically insignificant across age and sex groups and across the various welfare state regimes. An interaction term capturing the possible excess effect of unemployment during the Great Recession was also statistically insignificant. ***Conclusions:* Our findings, based on data from predominantly affluent countries, suggest that heart-disease mortality does not respond to economic fluctuations.**

Keywords: *Heart-disease mortality, unemployment, GDP, Great Recession, time series*

Introduction

In 2017, about 17.7 million people died from cardiovascular diseases (CVD), which makes CVD the largest cause of death globally. It is thus a priority to gain a better understanding of the driving forces behind changes in CVD mortality. Using cross-sectional time-series data for 32 countries, this work studied the potential role of macro-economic fluctuations as indicated by changes in the unemployment rate and GDP.

Unemployment, or the fear of losing one's job, potentially affects several risk factors linked to CVD such as stress, anxiety, depression, high blood pressure and serum cholesterol [1]. The hypothesis that unemployment is associated with increased CVD risk thus seems plausible and is supported by the findings from large-scale longitudinal census-based studies carried out in Denmark [2], Finland [3] and the UK [4] indicating elevated rates of CVD mortality among the unemployed. However, at least part of this excess risk might be due to health selection; that is, that those with poor health are more likely to become unemployed. This notion is supported by specific analyses in one of these studies [2]. One approach to avoiding the problem of health selection is to apply a quasi-experimental approach by exploring the effect on mortality risk of plant closures or downsizing. Although earlier work in this tradition, typically relying on case studies, has been criticised as methodologically weak, there are a couple of recent Nordic studies that are methodologically more

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satisfactory in that they rely on large administrative data sets covering the whole population. Thus, a Danish study [5] reports statistically significant effects of job loss due to plant closure on mortality in the broader category of circulatory diseases, as well as in the more specific outcomes of myocardial infarction and stroke. The results from a Swedish study [6] point in the same direction, although the estimates are less precise, and statistically insignificant, possibly due to the smaller data set.

Analyses of aggregate time-series data provide another way of gaining insights into the relation between unemployment and health. The early work in this tradition by Brenner et al. found that increases in the unemployment rate were linked to increases in CVD mortality in a large number of countries, including the USA [7], the UK [8] and Sweden [9]. However, closer examinations of Brenner's work [10] revealed serious methodological flaws, such as correlating trending time series and arbitrary specifications of lagged effects. The investigation by Ruhm [11] was one of the first well-designed studies in the field, and this study suggested that recessions are in fact associated with improved population health. Applying fixed-effects modelling of US state data for the period 1972–1991, he found that an increase in the state unemployment rate of one percentage point was associated with an approximately 0.5% decrease in total mortality. More detailed analyses revealed that mortality from 8/10 causes of death, including CVD mortality, decreased during bad times. The finding that CVD mortality is pro-cyclical (i.e. it decreases in economic downturns) has been replicated in a subsequent and more detailed analyses of US data [12] and in similarly designed analyses of data for Germany [13] and the OECD countries [14]. However, in analyses of Spanish panel data [15], the association between unemployment and CVD mortality was statistically insignificant. Further, a study based on Swedish panel data [16] found a statistically significant counter-cyclical effect (i.e. CVD increases in economic downturns).

Although the pattern of findings from the literature reviewed above is far from clear-cut, most individual-level analyses find adverse effects of unemployment on CVD outcomes, while the aggregate population-level studies tend to reveal a pro-cyclical effect, implying that economic upturns are associated with increased CVD. However, these opposing findings need not be incompatible. Although a downturn in the economy in all probability has a detrimental health effect on those who lose or fear losing their jobs, this negative effect might be more or less offset by a cardio-protective effect on the remaining, and much larger, part of the population. A slowdown in the economy is thus potentially associated with reduced exposure to a number of risk factors for CVD, including overtime and work-related stress, less exposure to air pollutants and reduced intake of alcohol and tobacco [12]. Thus, positive and negative effects of a downturn in the economy are possibly present simultaneously. Which of the two are the stronger might therefore depend on a number of factors, for example specific characteristics of the country and time period under study, as well as which age group and specific CVD outcomes are in focus. These sources of heterogeneity might explain the somewhat inconsistent pattern of aggregate findings.

Another issue concerns the choice of macroeconomic indicator. It is noteworthy that the emphasis in the existing population-level studies is on the role of unemployment. However, during the last half-century, CVD mortality has decreased dramatically (at least in the developed countries; see Figure 1), and a large part of this decrease seems to be attributable to advances in prevention and treatment (for a review, see Mensah [17]). A plausible hypothesis in this context is that the necessary resources for these advances are provided by economic growth, as indicated by GDP/capita.

Does the link between unemployment and CVD vary across time and space?

Welfare state regimes

In her review of the literature, Bartley [18] singles out poverty and financial anxiety as especially important mechanisms linking unemployment to stressful life events that might deteriorate health, including cardiovascular health. This suggests that the adverse effect of job loss may be mitigated by a generous welfare system. This hypothesis receives support from the few studies that have addressed this topic. Thus, two studies [19,20], both based on time-series data for close to 30 countries, found a gradient in the unemployment effect on suicide, being weaker in countries with more generous labour-market security. Further, in their analyses of time-series data for 23 OECD countries, Gerdtham and Ruhm [14] found a weaker pro-cyclical variation in several causes of death (including CVD) in countries with strong social welfare systems (proxied by public social expenditure). A possible mechanism underlying this pattern is that employees in these countries due to their tighter social safety nets have less incentive and pressure to work harder than what is healthy when the economy is booming.

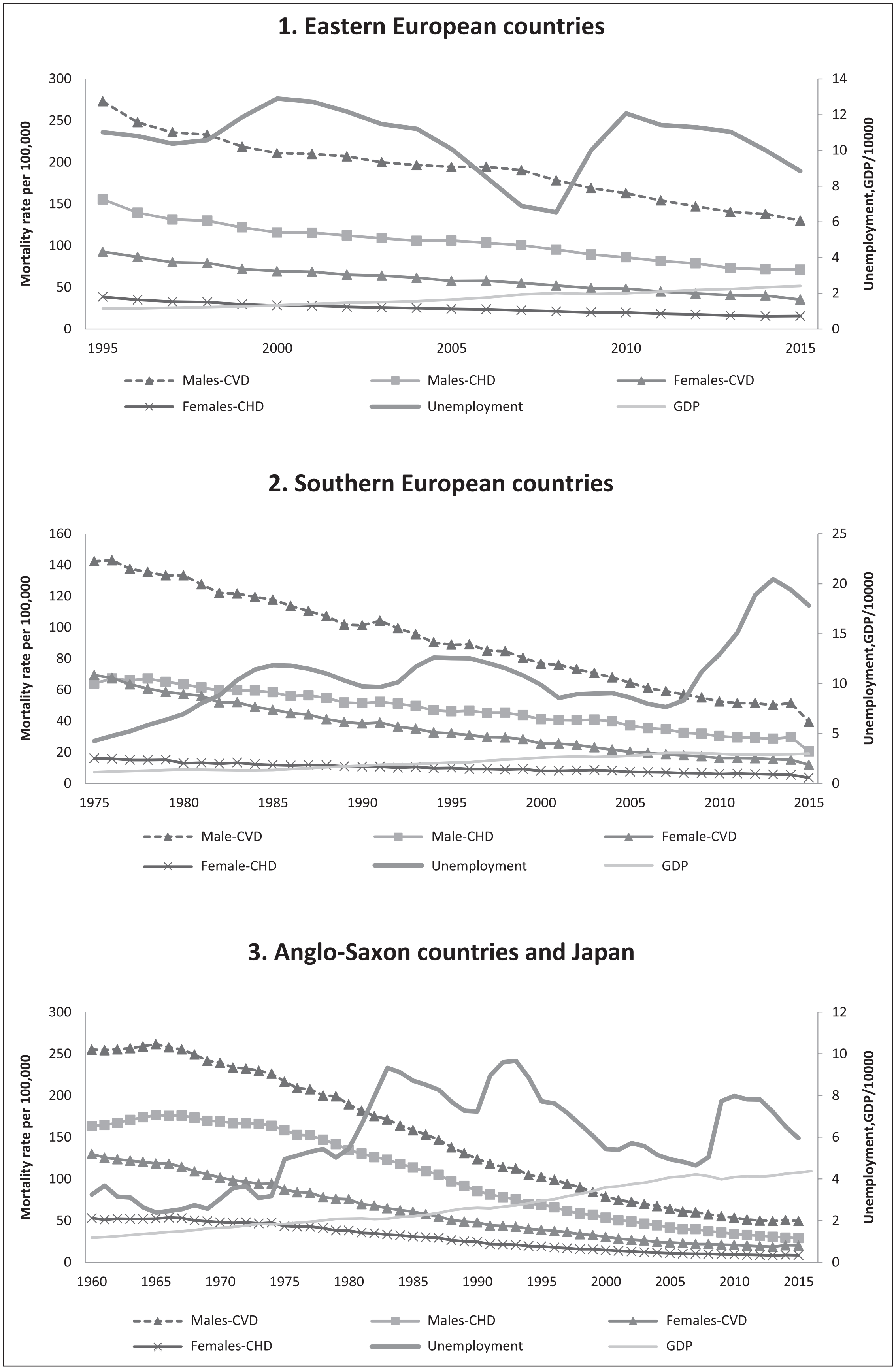

Figure 1. *(Continued)*

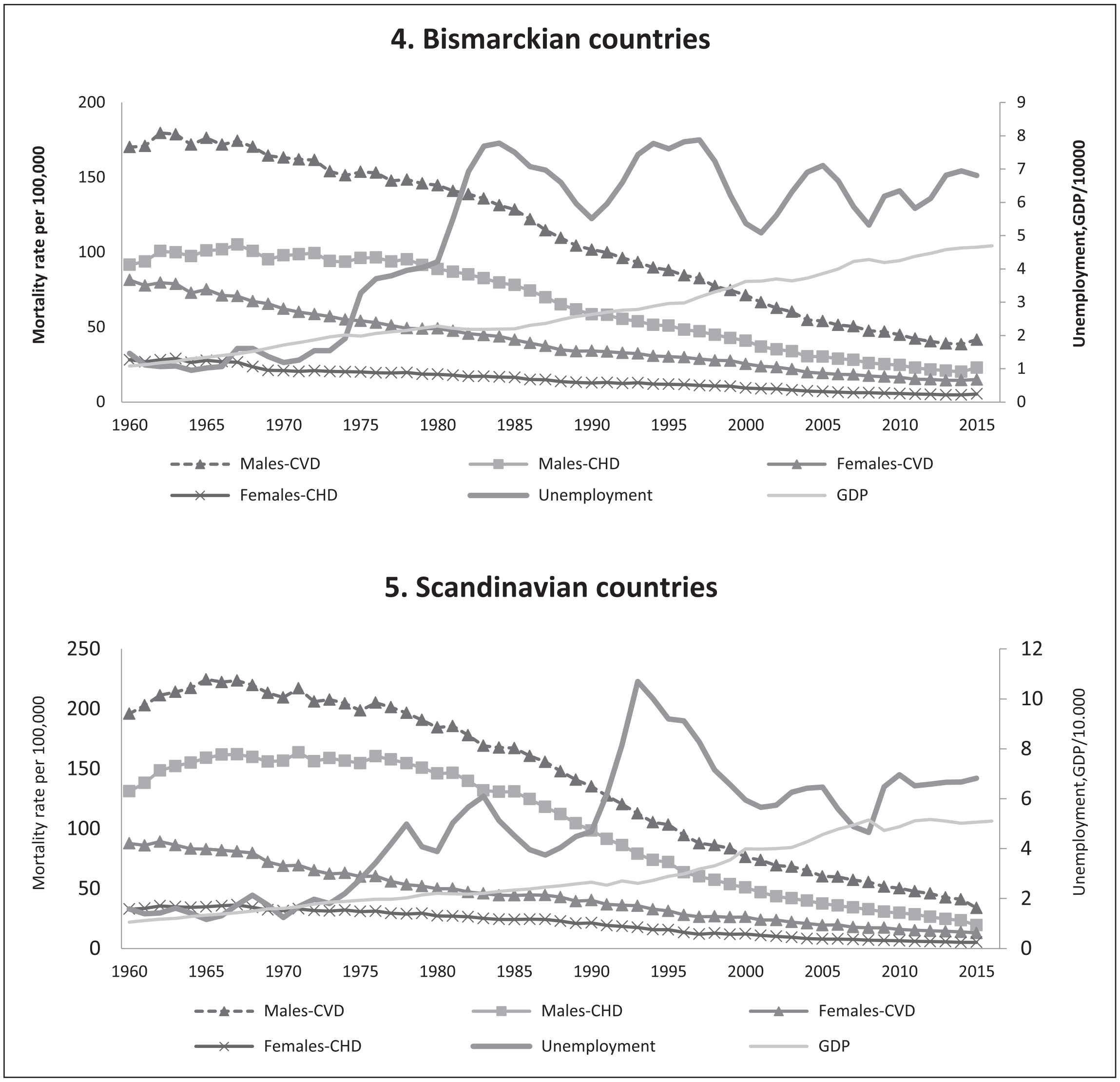

Figure 1. Trends in GDP/capita (US$10,000), unemployment rate, and cardiovascular disease (CVD) and coronary heart disease (CHD) deaths per 100,000 in the age group 20–64 years.

In the present study, we applied a design that has been developed within comparative population health research [21], and which was used in one of the studies mentioned above on the association between unemployment and suicide [20]. In this scheme, the countries are classified into five welfare state regimes, ranked from low (1) to high (5) levels of social and financial protection during unemployment: (1) Eastern European countries, (2) Southern European countries, (3) Anglo-Saxon countries and Japan, (4) Bismarckian countries, and (5) Scandinavian countries (see Table I). The ranking is based on the generosity of the unemployment protection system as indicated by four indicators, the most important being the replacement rate [22]. The highest levels of unemployment protection are thus found in the Scandinavian and Bismarckian countries, and the lowest levels are found in the Eastern and Southern European countries, with the Anglo-Saxon countries in between.

Has the Great Recession amplified the unemployment effect?

Another issue that we address is whether the detrimental health effect of the Great Recession might differ from the effects of previous economic downturns. The Great Recession, which started in the fall of 2007, is considered to be the deepest global economic recession during the post–World War II period. One hypothesis is that losing one's job during such a grave crisis is particularly harmful due to

Table I. Descriptive statistics (period averages) for unemployment replacement rate, unemployment, GDP, male CVD and CHD rate per 100 000 (20–64 years), and female CVD and CHD rate per 100,000 (20–64 years).

	Observation period	Unemployment replacement rate* (%)	Unemployment	GDP	Mortality rate per 100,000 (20–64 years)			
					CVD		CHD	
					Females	Males	Females	Males
Eastern European countries								
Bulgaria	1990–2014		11.41	10,541.33	103.35	226.26	25.37	89.07
Croatia	1991–2015		13.41	13,961.28	56.33	155.17	17.65	75.29
Czech Republic	1993–2015		6.30	20,256.62	70.23	186.60	28.64	117.18
Estonia	1990–2015		8.62	14,004.61	75.89	261.80	34.10	162.96
Hungary	1992–2015		8.36	12,431.19	95.30	228.43	41.09	132.07
Latvia	1992–2015		11.50	13,674.42	100.73	330.67	47.00	207.04
Lithuania	1994–2015		12.38	13,893.47	74.82	256.47	36.90	171.89
Poland	1992–2015		12.54	10,591.84	71.09	187.73	20.09	89.48
Romania	1990–2015		7.33	7,858.81	108.66	205.38	30.22	86.61
Slovakia	1994–2014		14.08	17,119.09	52.38	163.77	28.10	106.58
Slovenia	1996–2015		7.10	18,206.95	33.98	107.04	10.26	52.02
Period average		56.10	10.28	13,867.24	76.62	209.94	29.04	117.29
Southern European countries								
Greece	1974–2014		9.82	16,394.77	43.75	104.37	13.21	58.94
Italy	1960–2014		8.57	23,134.82	47.59	107.51	14.07	56.80
Portugal	1974–2014		7.25	14,578.37	57.91	114.17	13.99	45.22
Spain	1972–2015		15.07	18,225.28	44.45	95.11	9.13	40.34
Period average		55.11	10.18	18,083.31	48.43	105.29	12.60	50.32
Anglo-Saxon countries and Japan								
Australia	1960–2013		7.50	29,031.37	50.04	139.86	27.69	108.81
Canada	1960–2015		6.07	35,778.07	73.88	178.54	37.95	124.74
Ireland	1960–2015		2.80	23,573.09	49.93	98.01	8.49	22.07
Japan	1960–2013		9.24	24,390.53	72.59	165.44	35.69	119.87
New Zealand	1960–2015		5.80	24,781.49	61.11	159.16	29.88	118.95
United Kingdom	1960–2015		5.48	28,739.63	60.53	150.24	31.82	111.71
United States of America	1960–2013		3.93	21,173.58	68.63	164.38	35.78	124.48
Period average		61.32	5.83	26,781.11	62.39	150.80	29.61	104.38
Bismarckian countries								
Austria	1960–2016		3.25	25,010.63	49.06	130.33	18.41	77.24
Belgium	1960–2014		7.46	24,613.77	48.61	123.35	16.71	69.38
France	1960–2014		6.76	24,671.89	31.04	84.79	7.02	36.82
Germany	1960–2015		5.26	26,702.30	46.97	128.37	19.01	79.02
Netherlands	1960–2015		4.94	28,360.63	39.60	110.72	17.43	76.46
Switzerland	1960–2013		1.86	35,111.07	33.37	93.95	12.78	56.57
Period average		71.00	4.92	27,411.72	41.44	111.92	15.23	65.91
Scandinavian countries								
Denmark	1960–2015		5.46	27,251.88	43.48	118.11	21.64	83.88
Finland	1960–2014		6.42	23,759.95	61.64	215.93	27.07	156.60
Norway	1960–2015		2.90	37,390.58	37.24	119.42	17.89	89.41
Sweden	1960–2015		4.55	26,918.96	37.70	106.60	18.03	76.79
Period average		72.10	4.83	28,830.34	45.01	140.01	21.16	101.67

CVD: cardiovascular disease; CHD: coronary heart disease.

the poor prospects of finding a new job and the decreased access to social services and medical treatment following the austerities implemented in several countries due to the recession [23]. Alternatively, it can be hypothesised that job loss is felt as less stigmatising when this situation is shared by many others in society. A pertinent finding in this context, based on US individual-level data, indicated that job loss increases the risk of CVD only if it occurs under recessionary conditions [24].

Aims of the study

The present study expands on previous aggregate-level research by (a) including a fairly large number of countries that represent various welfare state regimes that might potentially modify the association between unemployment and CVD, (b) using time-series data that are long enough to enable the assessment of the possible impact of the Great Recession on CVD mortality, and (c) including GDP/capita in addition to unemployment as an explanatory variable in order to test whether GDP has any long-term effect on CVD.

Methods

The study comprised 32 countries, and the longest observation period was 1960–2015, though it was appreciably shorter for some countries (see Table I). Data on unemployment (% unemployed in the workforce) were obtained from Eurostat. Age-specific mortality data for females and males were sourced from the World Health Organization Mortality Database. Data on GDP/capita, expressed in purchasing power parity and converted into US dollars of 1990 value, were obtained from the Maddison Project. Sex-specific and age-standardised mortality rates (numbers of deaths per 100,000 population) were constructed (following the WHO World Standard population) for the working-age population (20–64) and for the age groups 20–34, 35–49, 50–64 and ⩾65 years. In addition to total CVD mortality, we analysed mortality from coronary heart disease (CHD), which is considered to be especially affected by modifiable health behaviours and therefore particularly sensitive to macroeconomic fluctuations [12]. Supplemental Table SI shows which ICD codes were included.

We included an interaction term to capture the possible excess effect of unemployment during the years of the financial crisis. The interaction term was constructed as follows:

$$Uncrisis_{it} = Unemployment_{it} * Crisis_{it}$$

where *Unemployment* is the unemployment rate (%) and *Crisis* is a country-specific variable that takes the value 0 in years with no recession, 0.25 in years with a one-quarter recession, 0.5 in years with a two-quarter recession, 0.75 in years with a three-quarter recession and 1 in years with four quarters of recession. We used the common definition of recession, that is, that a recession occurred when GDP had contracted for least two consecutive quarters. Data were obtained from Eurostat and OECD. Different ICD classifications were used during the study period, from ICD-7 to ICD-10, and possible influences of revisions of ICD classification were captured by dummy variables.

Depending on the structure of the data, we opted for one of two alternative modelling strategies to estimate how mortality responds to macro-economic changes: (a) error correction modelling (ECM; provided that the data are co-integrated), and (b) first-difference modelling (in the absence of co-integration). ECM is useful when short- and long-term dynamics are investigated, and it was used in a study with a design similar to the present one that estimated short- and long-term effects of GDP on traffic fatalities [25].

To test the hypothesis that the unemployment effect might differ across welfare state regimes, the countries were sorted into five country groups ranging from low to high levels of unemployment protection, as described above and detailed in Table I. Although the grouping of countries into welfare regimes increases the power of the analyses, it comes at the cost of concealing possible country differences. Thus, we performed country-specific analyses as well. This was in the form of time-series analyses applying the technique developed by Box and Jenkins [26], often referred to as autoregressive integrated moving average (ARIMA) modelling. A simple differencing was sufficient to remove trends to achieve the stationarity required for ARIMA modelling.

Following standard specifications [27], our error correction model was as follows in its most basic form (like most previous studies, e.g. [11–13], we applied a semi-log specification, i.e., with logged mortality):

$$\Delta LnMortality_{it} = \alpha + \beta_1 LnMortality_{it-1} + \beta_2 GDP_{it-1} + \beta_3 \Delta Unemployment_{it} + \beta_4 \Delta GDP_{it} + \varepsilon_{it}$$

In this equation, β_3 and β_4 indicate the instantaneous, short-term effect on mortality of a change in unemployment and GDP, respectively, while β_1 estimates the speed at which the long-term effect of GDP operates. If such an effect does exist, the estimate of β_1 should be negative and statistically significant. The total long-term effect of GDP was calculated as $\beta_2/(-1\times\beta_1)$, and we used *F*-tests to assess whether the estimated unemployment effects differed across the five country groups.

A complication with pooled time-series cross-sectional data is the likely presence of serial and spatial (cross-country) dependence of the errors, which yields a downward bias of the ordinary least squares estimates of the standard errors. We thus chose a modelling technique that accounts for spatial dependence of the errors by applying the more conservative panel-corrected standard errors suggested by Beck and Katz [28] and that accounts for serial dependence by including panel-specific autoregressive parameters for estimation of residual autocorrelation.

Prior to performing error-correction modelling, it is necessary to carry out some key tests. First, we tested for unit root using the Fisher-type ADF panel unit root test [29]. If the independent and dependent variables prove to be integrated of the order $I(1)$, the next step is to test whether they are co-integrated. Two variables X and Y are co-integrated if there exists a linear combination of X and Y that is stationary around which the two series fluctuate; put simply, if X drifts off, Y is bound to follow suit, and in the long run, the series will not drift far apart. The theory of co-integration originates from Engle and Granger [30], and empirical examples include the relation between GDP and traffic fatalities (25). We used the panel co-integration test developed by Westerlund [31]. Simulation results [31] indicate that the tests have better small-sample properties and power than other commonly used panel co-integration tests. Provided the test indicates co-integration, it is appropriate to proceed to error correction modelling; if not, the first two variables in the model [2] are dropped, and we are left with a first-difference model. Note that the EC model as well as the first-difference model only exploit within-country variation, thus avoiding the potential bias due to country differences that are linked to the dependent as well as the independent variables.

All statistical analyses were performed with Stata v15 (StataCorp, College Station, TX).

Results

Descriptive statistics are shown in Table I. There was a steady and marked decrease in CVD mortality in all country groups during the study period, although the decline did not start until the 1970s in the Scandinavian country group (Figure 1). After 2007, unemployment rose in all country groups except the Bismarckian, and the increase was especially marked in the Eastern and Southern European country groups. (Inspection of the country-specific trends reveals that unemployment increased in every single country after 2007 except for Germany, where it decreased somewhat.) The graphs in Figure 1 make it obvious that unemployment has a limited explanatory power with respect to the trajectories in CVD mortality. For instance, the approximately halving of male CVD mortality observed in most of the country groups is obviously due to factors other than unemployment. Likewise, none of the marked spikes and troughs in the unemployment rate left any traces in the mortality trends. Although changes in the unemployment rate might still have some effect on mortality, we should not expect this effect to be very large. GDP seems to have more potential for having an impact on CVD mortality, but diverging trends is a precarious basis for causal inferences.

The unit-root testing (Supplemental Table SII) suggested that all series were non-stationary and integrated of the order $I(1)$. However, the outcome of the co-integration tests (Supplemental Table SIII) indicated that GDP was not co-integrated with any of the two outcomes in any country group in any demographic group. This means that the necessary condition for EC modelling was not fulfilled, and we thus proceeded to estimate the first-difference models. As can be seen in Tables II and III, the estimated effects of unemployment and GDP on CVD mortality and CHD mortality were clearly insignificant in all country groups for males as well as females. The interaction term (Uncrisis) that estimates the possible excess effect of unemployment during the years of the financial crisis was clearly insignificant in all model estimations (estimates not shown). The outcome from the country-specific time-series analyses is displayed in Supplemental Table SIV. Most of the estimates were statistically insignificant. However, for two countries (Germany and the USA), the estimates suggested that an increase in GDP was associated with lowered CVD mortality, while increased unemployment was linked to decreased mortality in the USA.

Discussion

CVD is the leading cause of death globally, and stress is one of its well-established risk factors. Stress, in turn, might be induced by economic downturns not only for those who become unemployed, but also for those who fear losing their jobs. On the other hand, it has also been hypothesised that economic downturns might have a cardio-protective effect, for example due to less overtime and work-related stress and less exposure to air pollution. It is therefore of interest to investigate how the prevalence of CVD is related to economic fluctuations.

Most previous aggregate-level studies on this topic have focused on a single country and typically rely on data from before the year 2000. The findings from these studies cover the whole spectrum from significantly positive associations (that CVD increases in economic upturns), as found for the USA for example [12], over insignificant (Spain [15]), to significantly negative (Sweden [16]). In the present study, we adopted a more encompassing approach by including a large set of countries and using data that cover more recent time periods. This design made it possible to assess whether the relation between unemployment and CVD is modified by the generosity of the unemployment protection system or by the Great Recession, and we also tested

Table II. Estimated effects of unemployment and GDP on CHD and CVD mortality rates according to age and country group. Males.

			CVD							CHD					
			GDP			Unemployment				GDP			Unemployment		
	Country group	N	Est	SE	P	Est	SE	P	N	Est	SE	P	Est	SE	P
20–64	1. Eastern European countries	249	0.003	0.008	0.666	0.001	0.002	0.676	249	0.002	0.009	0.828	0.000	0.003	0.867
	2. Southern European countries	177	0.000	0.007	0.968	−0.001	0.004	0.818	177	0.003	0.008	0.676	−0.007	0.004	0.080
	3. Anglo-Saxon countries and Japan	379	0.003	0.004	0.495	0.001	0.005	0.844	379	0.005	0.005	0.317	0.003	0.005	0.553
	4. Bismarckian countries	327	−0.002	0.005	0.709	0.007	0.007	0.298	327	−0.001	0.006	0.866	0.008	0.007	0.262
	5. Scandinavian countries	219	0.000	0.002	0.981	0.004	0.005	0.324	219	0.000	0.002	0.879	0.002	0.005	0.702
	F-test for heterogeneity		*0.163*		*0.957*	*0.467*		*0.760*		*0.142*		*0.967*	*1.192*		*0.312*
	All countries	1351	0.000	0.002	0.915	0.001	0.002	0.790	1351	0.000	0.003	0.868	0.000	0.002	0.973
20–34	1. Eastern European countries	249	−0.047	0.024	0.049	0.010	0.006	0.101	248	−0.072	0.033	0.030	0.012	0.010	0.224
	2. Southern European countries	177	−0.020	0.017	0.255	−0.010	0.010	0.312	177	−0.051	0.025	0.044	0.010	0.014	0.467
	3. Anglo-Saxon countries and Japan	379	−0.006	0.010	0.522	−0.003	0.010	0.775	379	0.001	0.016	0.934	0.018	0.017	0.275
	4. Bismarckian countries	327	−0.025	0.012	0.033	−0.015	0.015	0.317	327	−0.024	0.018	0.180	0.003	0.025	0.909
	5. Scandinavian countries	219	0.008	0.010	0.419	0.005	0.020	0.810	219	0.012	0.019	0.518	0.027	0.034	0.432
	F-test for heterogeneity		*1.793*		*0.128*	*0.602*		*0.661*		*2.295*		*0.057*	*0.175*		*0.952*
	All countries	1351	−0.003	0.008	0.671	0.005	0.005	0.355	1350	−0.004	0.015	0.779	0.013	0.008	0.123
35–49	1. Eastern European countries	249	0.002	0.012	0.860	0.000	0.004	0.905	249	0.007	0.015	0.666	0.000	0.004	0.967
	2. Southern European countries	177	0.004	0.008	0.660	0.000	0.004	0.948	177	0.006	0.010	0.530	0.002	0.005	0.739
	3. Anglo-Saxon countries and Japan	379	0.005	0.005	0.330	0.008	0.006	0.153	379	0.004	0.006	0.547	0.008	0.006	0.214
	4. Bismarckian countries	327	0.001	0.005	0.918	0.010	0.007	0.160	327	−0.001	0.007	0.875	0.013	0.009	0.118
	5. Scandinavian countries	219	0.000	0.003	0.913	0.012	0.007	0.096	219	0.000	0.003	0.916	0.010	0.008	0.224
	F-test for heterogeneity		*0.091*		*0.985*	*1.029*		*0.391*		*0.153*		*0.962*	*0.707*		*0.587*
	All countries	1351	0.000	0.003	0.935	0.002	0.003	0.556	1351	0.000	0.003	0.968	0.002	0.003	0.615
50–64	1. Eastern European countries	249	0.004	0.008	0.609	0.001	0.002	0.695	249	0.001	0.008	0.872	0.000	0.002	0.978
	2. Southern European countries	177	0.000	0.007	0.973	−0.001	0.004	0.883	177	0.001	0.008	0.905	−0.005	0.004	0.246
	3. Anglo-Saxon countries and Japan	379	0.003	0.005	0.548	−0.001	0.005	0.908	379	0.005	0.005	0.269	0.002	0.005	0.748
	4. Bismarckian countries	327	−0.002	0.005	0.738	0.007	0.007	0.305	327	−0.001	0.006	0.912	0.007	0.007	0.343
	5. Scandinavian countries	219	0.000	0.002	0.881	0.002	0.005	0.595	219	−0.001	0.002	0.709	0.000	0.005	0.997
	F-test for heterogeneity		*0.176*		*0.951*	*0.454*		*0.769*		*0.159*		*0.959*	*0.702*		*0.590*
	All countries	1351	0.000	0.002	0.959	0.000	0.002	0.949	1351	0.000	0.003	0.917	−0.001	0.002	0.827
65+	1. Eastern European countries	249	0.000	0.007	0.980	0.002	0.002	0.264	249	0.000	0.008	0.989	0.001	0.002	0.597
	2. Southern European countries	177	0.007	0.006	0.271	0.005	0.004	0.225	177	0.008	0.007	0.270	0.001	0.004	0.815
	3. Anglo-Saxon countries and Japan	371	0.000	0.003	0.894	−0.002	0.004	0.497	371	−0.001	0.004	0.702	−0.003	0.004	0.472
	4. Bismarckian countries	327	−0.003	0.004	0.536	0.008	0.006	0.150	327	−0.002	0.005	0.692	0.010	0.006	0.126
	5. Scandinavian countries	219	0.000	0.001	0.989	0.005	0.004	0.201	219	0.000	0.002	0.788	0.006	0.004	0.145
	F-test for heterogeneity		*0.532*		*0.712*	*1.015*		*0.399*		*0.474*		*0.755*	*1.256*		*0.286*
	All countries	1343	0.000	0.002	0.900	0.002	0.002	0.343	1343	0.000	0.002	0.912	0.001	0.002	0.694

Table III. Estimated effects of unemployment and GDP on CHD and CVD mortality rates according to age and country group. Females.

		CVD							CHD						
			GDP			Unemployment				GDP			Unemployment		
	Country group	N	Est	SE	P	Est	SE	P	N	Est	SE	P	Est	SE	P
20–64	1. Eastern European countries	249	−0.002	0.012	0.859	0.003	0.003	0.334	249	−0.006	0.013	0.632	0.003	0.004	0.491
	2. Southern European countries	177	0.006	0.009	0.537	0.006	0.006	0.333	177	0.005	0.010	0.639	0.003	0.005	0.615
	3. Anglo-Saxon countries and Japan	379	0.003	0.005	0.565	−0.002	0.006	0.703	379	0.007	0.006	0.250	−0.004	0.006	0.535
	4. Bismarckian countries	327	−0.002	0.006	0.716	0.005	0.008	0.556	327	−0.003	0.007	0.661	0.015	0.009	0.114
	5. Scandinavian countries	219	0.001	0.002	0.637	0.006	0.006	0.272	219	0.000	0.003	0.935	0.005	0.007	0.483
	F-test for heterogeneity		*0.197*		*0.940*	*0.333*		*0.856*		*0.408*		*0.803*	*1.032*		*0.390*
	All countries	1351	0.001	0.003	0.639	0.001	0.003	0.576	1351	0.001	0.003	0.851	0.001	0.003	0.723
20–34	1. Eastern European countries	248	−0.116	0.041	0.005	−0.008	0.011	0.455	215	−0.050	0.054	0.357	0.020	0.022	0.344
	2. Southern European countries	177	0.009	0.021	0.662	−0.007	0.011	0.540	177	−0.045	0.042	0.281	0.018	0.023	0.445
	3. Anglo-Saxon countries and Japan	379	0.000	0.018	0.983	0.012	0.019	0.512	371	−0.016	0.028	0.561	0.027	0.027	0.327
	4. Bismarckian countries	327	0.001	0.015	0.930	0.013	0.019	0.478	322	−0.049	0.037	0.193	−0.044	0.044	0.314
	5. Scandinavian countries	219	−0.006	0.013	0.640	−0.011	0.025	0.667	195	−0.032	0.023	0.175	−0.016	0.051	0.754
	F-test for heterogeneity		*4.847*		*0.001*	*0.443*		*0.777*		*0.139*		*0.968*	*0.723*		*0.567*
	All countries	1350	−0.007	0.012	0.562	0.005	0.008	0.510	1280	−0.030	0.014	0.035	0.013	0.013	0.309
35–49	1. Eastern European countries	249	0.023	0.019	0.227	0.009	0.005	0.039	249	0.013	0.026	0.617	0.014	0.008	0.082
	2. Southern European countries	177	−0.003	0.011	0.803	−0.003	0.007	0.634	177	0.009	0.018	0.628	0.008	0.011	0.451
	3. Anglo-Saxon countries and Japan	379	−0.001	0.008	0.900	−0.003	0.008	0.699	379	0.005	0.010	0.622	−0.005	0.010	0.599
	4. Bismarckian countries	327	−0.008	0.007	0.293	0.006	0.009	0.551	327	0.001	0.012	0.919	0.034	0.016	0.030
	5. Scandinavian countries	219	−0.002	0.005	0.618	0.019	0.010	0.065	219	−0.008	0.008	0.366	−0.001	0.019	0.945
	F-test for heterogeneity		*1.184*		*0.316*	*1.321*		*0.260*		*0.231*		*0.921*	*1.350*		*0.249*
	All countries	1351	−0.001	0.004	0.749	0.004	0.004	0.236	1351	−0.001	0.008	0.871	0.009	0.006	0.162
50–64	1. Eastern European countries	249	−0.007	0.012	0.573	0.002	0.003	0.545	249	−0.010	0.014	0.485	0.000	0.004	0.945
	2. Southern European countries	177	0.008	0.010	0.382	0.008	0.006	0.202	177	0.006	0.011	0.592	0.006	0.006	0.329
	3. Anglo-Saxon countries and Japan	379	0.004	0.006	0.443	−0.003	0.006	0.637	379	0.008	0.006	0.172	−0.004	0.006	0.512
	4. Bismarckian countries	327	−0.001	0.007	0.879	0.004	0.009	0.675	327	−0.005	0.008	0.494	0.010	0.009	0.309
	5. Scandinavian countries	219	0.002	0.002	0.323	0.003	0.006	0.594	219	0.003	0.003	0.357	0.005	0.008	0.472
	F-test for heterogeneity		*0.510*		*0.728*	*0.358*		*0.838*		*0.701*		*0.591*	*0.605*		*0.659*
	All countries	1351	0.002	0.003	0.415	0.001	0.003	0.762	1351	0.002	0.003	0.534	0.000	0.003	0.890
65+	1. Eastern European countries	249	0.000	0.008	0.993	0.002	0.002	0.408	249	0.000	0.009	0.997	0.001	0.002	0.725
	2. Southern European countries	177	0.002	0.007	0.722	0.004	0.004	0.353	177	0.010	0.008	0.247	0.002	0.005	0.722
	3. Anglo-Saxon countries and Japan	371	−0.001	0.004	0.820	−0.002	0.004	0.666	371	−0.002	0.004	0.705	−0.002	0.004	0.639
	4. Bismarckian countries	327	−0.003	0.005	0.481	0.009	0.006	0.170	327	−0.004	0.007	0.559	0.012	0.008	0.120
	5. Scandinavian countries	219	−0.001	0.002	0.705	0.003	0.004	0.470	219	−0.001	0.002	0.656	0.005	0.005	0.294
	F-test for heterogeneity		*0.149*		*0.963*	*0.733*		*0.570*		*0.641*		*0.633*	*1.093*		*0.358*
	All countries	1343	−0.001	0.002	0.657	0.001	0.002	0.382	1343	−0.001	0.002	0.621	0.001	0.002	0.650

whether GDP has any short- or long-term effects on CVD mortality. In addition to pooled time-series cross-sectional modelling, we performed country-specific analyses. The latter uncovered statistically significant associations for a few countries, although the estimates were clearly insignificant for the vast majority of nations. It cannot be excluded that the statistically significant estimates are due to as yet unknown country characteristics. Alternatively, they might be the false positives that likely occur when a large number of models are being estimated. The analysis of the pooled data, which yields a more global outcome, suggests that there were no statistically significant associations between the prevalence of CVD and changes in the economy, whether these are proxied by GDP or unemployment. This pattern held true across five different country groups with various levels of unemployment protection, as well as across different age groups and outcomes (CVD vs. CHD).

The question now is how to interpret our findings. As noted above, a downturn in the economy, as proxied by increased unemployment, might increase the CVD risk for those who lose or fear losing their jobs. At the same time, a downturn might have beneficial effects, for example by reducing overtime and giving more time for health-promoting activities. The absence of any association between unemployment and CVD that we observed might thus be an amalgam of these countervailing effects.

Before concluding, some limitations of our study should be pointed out. A potential reason for our null result might be a lack of power due to insufficient numbers of observations, measurement errors, inefficient estimation techniques and so on. However, this notion is contradicted by the fact that when basically the same research design was applied in a study addressing the association between unemployment and suicide [20], significant unemployment effects were obtained that were also in accordance with the expected gradient in effects sizes (the stronger the unemployment protection, the weaker the unemployment effect). Another limitation comes with the ecological character of our data that only makes it possible to assess the net effect of unemployment; that is, we cannot disentangle between deleterious effects of job loss and potentially beneficiary effects through other pathways, for example less overtime. Further, we do not have any data to test the alleged mechanisms between unemployment and CVD, for example stress. Another limitation is that our data include predominantly affluent countries during a fairly prosperous historical epoch, which limits the generalisability of our findings.

With these caveats in mind, we conclude that our findings suggest that heart-disease mortality in Europe does not respond to changes in unemployment or GDP.

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Supplemental material

Supplemental material for this article is available online.

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