Centre d'Estudis Demogràfics

SOCIOECONOMIC AND OTHER DETERMINANTS OF MORTALITY DIFFERENCES IN EUROPE: A POOLED, CROSS-COUNTRY, TIME SERIES ANALYSIS*

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SOCIOECONOMIC AND OTHER DETERMINANTS OF MORTALITY DIFFERENCES IN EUROPE: A POOLED, CROSS-COUNTRY, TIME-SERIES ANALYSIS[1]

1.- Introduction

During the last 30 years, both the level of mortality and the level of socioeconomic development have improved in Western Europe, albeit not uniform across countries. Previous studies, though, have shown that there is, at best, only a weak *direct* link between living standards and total mortality among wealthy nations at the international level (e.g. Mackenbach and Looman, 1994; Wilkinson, 1992). As an explanation for this Mackenbach and Looman (1994) suggested that *"the mortality increasing effects of urbanisation and industrialisation obscured the mortality lowering effects of high living standards"* as well as that country-specific factors such as dietary habits acted as confounders. A different explanation for mortality differences between wealthy nations came from Wilkinson (1992), who argued that *"among the developed countries, it is not the richest societies that have the best health, but those that have the smallest income differences between rich and poor"*. The results presented in this paper provides strong evidence for both, the absolute and relative income, hypotheses and differences with results from previous studies are likely to be subject to several essential factors which, to the author's knowledge, were often neglected in the absolute-relative income debate. This includes the selection of countries, the time frame of the study and methodological aspects. The potential aspect of confounding factors should also be taken into account, including other macroeconomic factors as well as behavioural/cultural, psychosocial, health care and ecological factors. It was again Wilkinson (1997) who refuted the role of cultural factors when he stated that *"a strong international relation* [between absolute income and mortality] *is unlikely to be masked by cultural factors: not only are the international comparisons confined to OECD countries, but the picture is supported by comparisons among the 50 states of the United*

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[1] An earlier version of this paper was presented at the XV World Congress of Sociology, Brisbane, Australia, July 7-13, 2002. This working paper will be one of the chapters of the PhD thesis of the author, which will be defended at the University of Groningen, the Netherlands, in 2004, entitled "Socioeconomic determinants of mortality differentials in Europe".

States, where cultural differences are smaller". Wilkinson´s conclusions may hold for all-cause mortality, but when we consider international differences in cause-specific mortality this judgement seems too complacent. This is because some of the main (proximate) determinants of specific diseases like lung cancer and circulatory system diseases, such as the consumption of tobacco, alcohol and dietary factors, are culturally embedded in society such as through ethnicity and religion. As international differences in consumption patterns are still very much present (*Table 1*) the possibility that the association between absolute income and mortality is confounded by such factors should not be ignored. The importance of incorporating more than just economic factors when studying mortality is exemplified with the following three examples:

i. It was suggested that the rise of ischaemic heart disease (IHD) was much more pronounced in western[2] and northern Europe than in the Mediterranean (i.e. southern) countries because of the regular consumption of red wine, non-animal fat and fruit and vegetables (Ulbrecht and Southgate, 1991; Renaud and de Lorgezil, 1992). This occurred even though economically the Mediterranean countries are both less well off *and* generally show larger income inequalities than other countries of Western Europe.

ii. In the study by Mackenbach and Looman (1994), Greece and Portugal both only managed a low level of GDP, but Greece had a low and Portugal a high mortality rate. This apparent anomaly was in part explained by the omission of urbanisation and industrialisation that obscured the mortality lowering effect of high living standards, as well as country-specific factors like those mentioned earlier. These country-specific factors were captured in a control variable called 'country' to allow for different mortality levels in different countries, because not all developed countries had experienced the epidemiological transition from infections to 'western' diseases such as IHD in the same way. As regards to Italy, this 'cultural' factor also helped to explain the difference in a mortality pattern between the north and the south, as the association between living standards and mortality at the regional level did not hold. Whereas infant mortality and mortality from infectious diseases were slightly higher in the south, mortality from western diseases was much higher in the north.

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[2] 'western' Europe without a capital letter excludes the countries of northern and southern Europe. Similarly, 'eastern' Europe, as opposed to 'Eastern' Europe does not include the former USSR successor states. In this study, these four parts of Europe are also referred to as 'macro-regions'.

iii. In a sex-specific cross-section analysis (1992) by Or (2000) a similar dummy variable was used to capture the impact of unobservable country-specific factors on premature (0-70 years) all-cause mortality differences between Japan, the country with the lowest all-cause mortality, and 20 other OECD countries. Results showed that while Japan's lower mortality was mainly caused by GDP, non-manual workers and health expenditure (pollution, tobacco and alcohol consumption and several dietary factors explained little), mortality would actually have been lower in Spain, Greece, Portugal and Ireland if the level of each explanatory variable was equal. It is possible that factors representing this dummy variable are non-socioeconomic, because during the course of the last 20 years levels of income inequality, education and unemployment – variables absent from the analysis – were generally more favourable in Japan (WIDER, 2000; Barro and Lee, 2000; Gartner, 1999). More plausible are psychosocial factors, as for instance divorce was higher in Japan (Council of Europe, 2001; IPSS[3]).

The main interest of this study is to *simultaneously* consider at the aggregate level the influence of living standards (absolute and relative) on mortality differences between European countries and over time, taking into account potential confounding factors. The results are placed within the framework of the life course, because mortality differences, whether socioeconomic, geographic, according to gender or otherwise, do not occur overnight but are the result of the accumulation of exposures of different risk factors that have been accrued from the period before birth to well into adulthood (Davey Smith *et al.*, 1997).

As it is an ecological study the study design only allows reference to be made to the way in which contextual factors influences mortality, but much more is not required for the purpose of the project and some of the life course concepts may still be applicable. For instance, when a sudden change in conditions at the societal level is associated with changes in mortality, it may be suggestive of a critical period. One important application of ecological studies is that the importance of disease determinants at an individual level may be different from those at the population level. This is because the variation in an exposure may be far less within than between populations (Elford and Ben-Shlomo, 1997), like air pollution. At an individual level the relationship between exposure and outcome may also

[3] For Japan, divorce data can be found on the National Institute of Population and Social Security Research

be weaker due to the multifactorial nature of disease causation, in which these other factors may be more homogeneous between groups and hence the relative importance of a key variable may be accentuated (*ibid.*). One should be aware that although proxies for disease determinants were used in the analysis, such as national average tobacco consumption, the failure to replicate an individual-based study at an ecological level does not negate the causal importance of that variable. Instead it suggests that other variables are more important in explaining ecological variations.

Table 1.- Tobacco, alcohol and fruit & vegetable consumption1 in different parts of Europe, 1961, 1971, 1981, 19912 and 1998

	Alcohol [3]					Tobacco [4]			Fruit & vegetables [4]				
	North [5]	West [6]	South [7]	East [8]	USSR [9]	North	West	South	North	West	South	East	USSR
1961	4.33	11.76	12.86	7.00	9.31	2693	3633	2916	-	-	-	-	-
1971	6.90	14.38	14.02	10.87	11.35	2714	3790	3611	110	180	310	-	-
1981	7.90	14.06	13.76	13.41	12.94	2457	3509	4097	129	184	340	-	-
1991	8.00	12.72	10.66	12.00	12.29	2064	2818	3735	153	209	373	119	123
1998	7.84	11.73	9.66	11.28	14.75	1676	2429	3247	170	204	362	151	131

[1] For data issues and estimations for the selected countries, see Spijker (2002). The data sources are found in Table 3
[2] 1993 for Eastern Europe and the former USSR.
[3] In litres of pure alcohol per capita per year.
[4] In kilograms per capita per year.
[5] Northern Europe consists of: Denmark, Finland, Norway and Sweden.
[6] Western Europe consists of: Austria, Belgium, France, Switzerland, the United Kingdom and West Germany.
[7] Southern Europe consists of: Greece and Italy.
[8] Eastern Europe consists of: Bulgaria, Czech Republic, East Germany, Hungary, Romania, Slovak Republic.
[9] Former USSR consists of: Belarus, Estonia, Latvia, Moldova, Russia and the Ukraine.

The analytical method employed was pooled cross-section (i.e. country) and time-series analysis. The time series data were collected for almost all European countries. In Sections 2 and 3 a brief summary of the most important mortality determinants is given from which a number of hypotheses have been formulated. Section 4 provides the data sources and the analytical method employed. Given the different economic and political backgrounds of Eastern and Western Europe and the (consequent) incomparability of certain socioeconomic variables, particularly education and unemployment, the analysis was split into two. To better understand mortality differences, mortality is analysed by cause of death. The cause-of-death selection was generally based on their prevalence and the existence of socioeconomic health differences, as has been explicated elsewhere (see

site (http://www.ipss.go.jp/English/S_D_I/Indip.html#t_5).

Spijker, 1999). Before the results are presented in Section 6 a brief overview is given of cause-specific mortality trends in Europe between 1971 and the late 1990s. The main emphasis of the study relates to male mortality, because of the assumption that changes in economic and other factors affect the health of men more than that of women. A good example is the deterioration of health in Eastern Europe in the early 1990s as a consequence of the political and economic transition. Nevertheless, for complementary purposes a brief comparative summary is given at the end of the results' section. This paper concludes with a summary and discussion of the results.

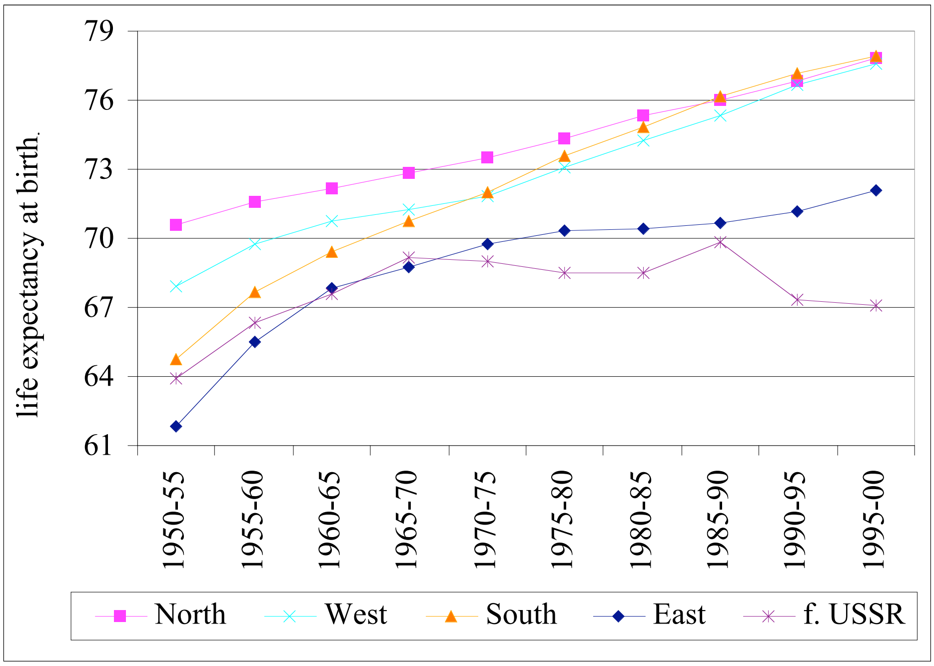
2.- Economic determinants of mortality differences: absolute or relative income?

Perhaps the most common indicator of living standards of a country is per capita gross domestic product (GDP), which is used as a measurement of the average income of a person in a population (at a sub-national one refers to gross regional product (GRP). It would be reasonable to assume that there is a positive relation between income level and health, as high income increases the consumption of commodities that have a direct impact on the quality of life, such as housing, dietary and health care factors. Consequently, a changing state of the economy will also affect the health of a population. However, the association between living standards and mortality is not simply negative and linear. It is suggested that among rich countries the relation between income and mortality may be characterised by diminishing returns to scale (Wilkinson, 1992), or that confounding factors exist which negate the association between income and health. For instance, lifestyle factors, industrialisation and urbanisation partly confounded the income-mortality association in Western Europe (Mackenbach and Looman, 1994). Another example where economic development did not explain all differences in mortality was when several countries with different political systems but similar national incomes were compared. From the 1960s to the 1980s, Spain and Portugal (the two least developed countries in Western Europe) made great strides in life expectancy, while countries in Eastern Europe showed little progress (Guo, 1993). One reason for this development was that in the former Eastern bloc, the communist party controlled all political and economic activity including the health system. In order to compete with the West these countries concentrated most of their energies into heavy industry and often ignored the non-economic sectors. Neither did the state-controlled media cover the popular health movement in the West that prevented the middle aged in Eastern Europe from adapting beneficial behavioural changes, as the effectiveness in the prevention and treatment of cardiovascular diseases was largely responsible for the increased years of life expectancy and the difference in mortality between adults in Western Europe and those in Eastern Europe (*ibid.*). However, the role of economic factors in causing the East-West mortality divide should not be dismissed. While the West progressed in terms of economic development, much of Eastern Europe lagged behind, even though in the early 1960s, levels of GDP did not differ much between the two parts of Europe. After communism collapsed, the economic transition occurred very rapidly, which led to large declines in economic productivity and sudden changes in the employment structure. This was mainly due to job losses in the industrial sector, as many industries were forced to lay off a large number of workers in order to fulfil the necessary changes to compete in a market economy. In Russia, this resulted in a large labour turnover (sum of job gains and losses as a percentage of average employment), but with more job losses than gains the economic transformation prompted the emergence of unemployment, something that the population had not experienced before. This caused enormous stress for the Russians, not only because jobs were no longer guaranteed, but many aspects of the social welfare system also collapsed (Leon and Shkolnikov, 1998). The repercussions on the health of the population were devastating: between 1990 and 1994 life expectancy for men decreased 6 years to 57.7 years and for women decreased 3 years to 71.2 years – an unprecedented pace of deterioration in a country not at war.

Contrary to the current East-West mortality differences, differences within Western Europe are much smaller. During the course of the last 40 years mortality rates have been converging as the southern countries (except Portugal) have caught up or even surpassed most of the other countries of Western Europe (*Figure 1*). However, in terms of economic development, absolute differences have been remarkably consistent throughout the same period, even though the four largest Mediterranean countries have all joined the European Union (Italy in 1950, Greece in 1981, Spain and Portugal in 1986). Incidentally, western and northern Europe virtually had identical levels of GDP throughout this period (see *Figure 2*).

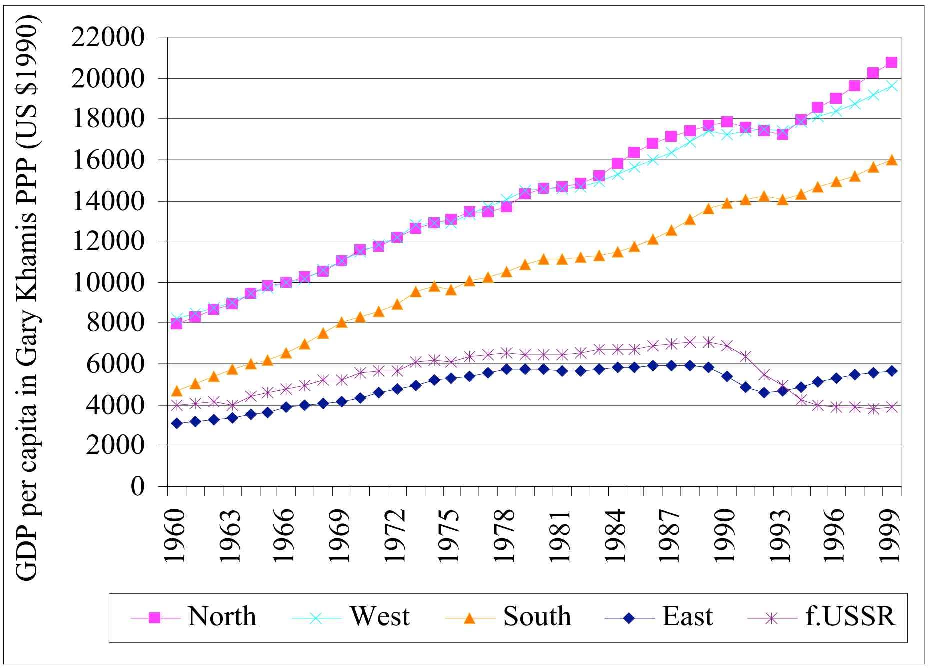
Although at a country-specific level, both life expectancy and economic development in Western Europe increased almost incessantly during the last 40 years, the life expectancy of wealthy countries such as the Netherlands and Germany have been surpassed by less wealthy countries like Greece and Spain (c.f. Table 1.1).

Figure 1.- Life expectancy at birth in European macro regions, 1950-2000



Data source: United Nations (2001), *World Population Prospects: The 2000 Revision*. UN Department of Economic and Social Affairs, New York; countries are grouped according to Table 5, last column.

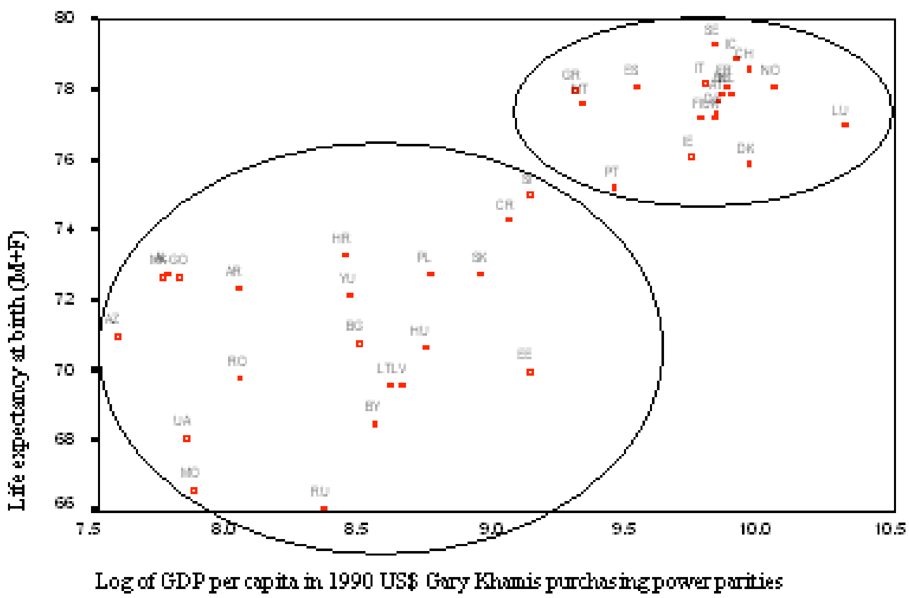
Figure 2.- GDP per capita for the European macro regions, 1960-1999



To explain differences between countries within Western Europe, we therefore need to look elsewhere. It is possible that "what matters within societies is not so much the direct health effects of absolute material living standards so much as the effects of social relativities", as Wilkinson (1996) writes. If that were the case, differences in the *distribution* of income becomes an important determinant of health differences between countries. When just considering these four countries previously mentioned, there appears to be no direct association as the Netherlands and Germany have been more egalitarian throughout the period than Greece and Spain (WIDER, 2000).

In other words, how strong are the absolute or relative income hypotheses, anyway? From *Figure 3*, it is possible to distinguish two groups of countries, i.e. those of Eastern and Western Europe. The former countries are characterised by low life expectancy and economic development and the latter with the opposite features. In fact, all Western European countries had both higher life expectancies *and* higher levels of GDP than all Eastern European countries. Within each group there was no association between living standards and standardised mortality in 1995 (correlation coefficients were, respectively -0.21 and -0.12 for Western and Eastern Europe).

Figure 3.- Association between the log of GDP per capita and life expectancy at birth for all European countries with a population greater than 250,000, 1995-2000 (pooled)



Note: The data for GDP pertain to the period 1995-99.
Data sources: Life expectancy from the UN Population Division (2001); GDP, see Table 4; for abbreviations of countries, see Table 5.

This result is consistent with similar studies such as the one conducted by Kaplan *et al.* (1996) of the 50 relatively homogenous United States of America, in which the correlation coefficient between standardised mortality and median state income was -0.28. However, even though there was no within-group association between income and mortality, when both groups of countries are considered at once, there appears to be a clear association (the correlation coefficient equalled -0.73, p<0.001). Furthermore, for the whole time period (1977-99) the correlation coefficient also equalled –0.73 (p<0.001)[4], but when we again consider Western and Eastern Europe separately, an association was only established in the Western and not in the Eastern European data (correlation coefficients were, respectively –0.45 (p<0.001) and -0.07 (not significant). In other words, both the selection of countries and the time dimension (i.e. one time point vs. longitudinal) become crucial factors in the results.

The question now remains what pattern we obtain with a measure of income inequality. Between 1970 and 1999, the trend over time in the average level of income inequality among the same aggregated macro-regions differed from the trend of absolute material development. Although levels declined steadily in the 1970s, southern Europe showed the highest levels until about 1990. Under communism, income inequality in the East was low, but by the late 1970s levels in northern Europe had declined to similar levels. At that time, levels of income inequality were more profound in western Europe. From about 1990 (in western Europe in the early 1980s), levels began to rise almost everywhere, although by far the most extreme in the countries of the former Soviet Union (*Figure 4*).

By the late 1990s, there was a clear association between income inequality and life expectancy at birth (*Figure 5*), but although the correlation coefficient between SDR's and the Gini coefficient was significant (+0.40 at p<0.01), the strength of the association was lower than for GDP. Contrary to absolute levels of welfare, the delineation point between the East and the West is less apparent. Although the two countries with the best and worst health also had the lowest and highest Gini coefficient (Sweden and the Russian Federation), several Eastern European countries like the Slovak Republic and Hungary had lower levels of income inequality than most of the healthier Western European countries. When considering the Western and Eastern European countries separately, their respective correlation coefficients equalled -0.22 (n/s) and -0.58 (p<0.01).

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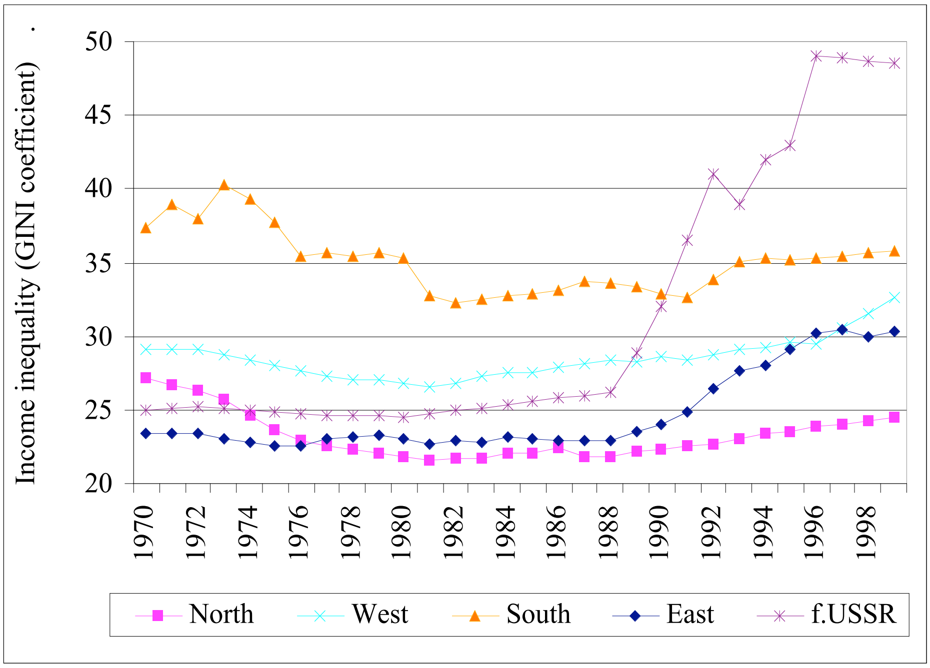
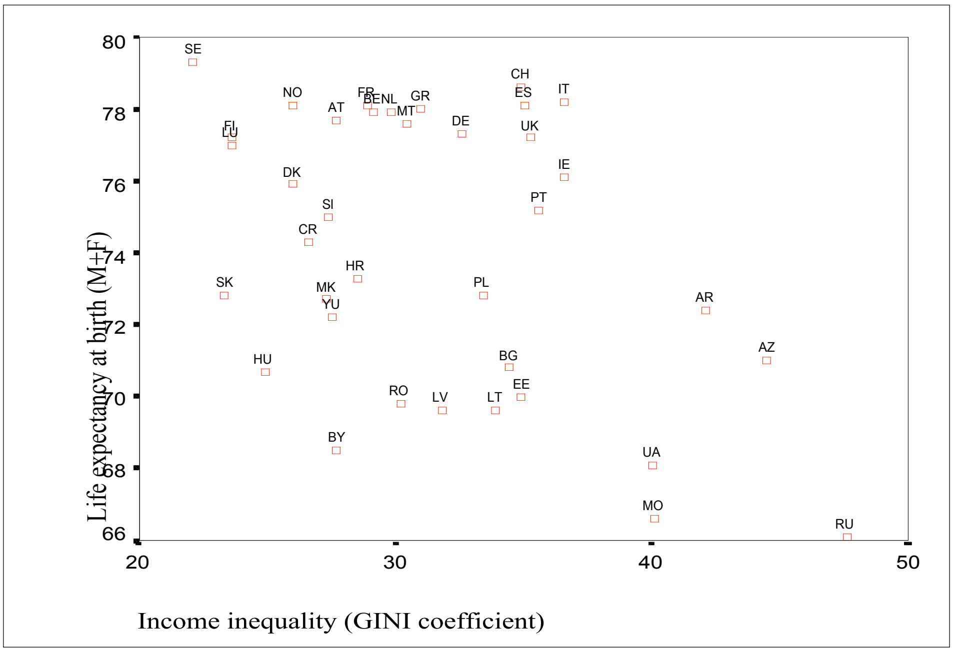
[4] Although a scatter plot gave a loglinear appearance, when a log was taken of GDP, the correlation coefficient was virtually identical.

Figure 4.- Income inequality in the European macro regions, 1960-1999



Data source: see Table

Figure 5.- Association between income inequality and life expectancy at birth for all European countries with a population greater than 250,000, 1995-2000 (pooled)



Note: The income inequality data pertain to the period 1995–99. Countries for which no data were available are Albania, Georgia and Iceland.

Data sources: Life expectancy, see Figure 1; GINI coefficients, see Table 4; for abbreviations of countries, see Table 5.

In other words, in the late 1990s there was a clear association between income inequality in Eastern, but not in Western Europe. The same pattern is apparent when the entire study period between 1977 and 1999 is considered: the correlation coefficient for Western Europe equalled -0.02 (n/s) and for Eastern Europe 0.18 ($p<0.001$), but although this last figure is significant, it only explains roughly 3% of mortality. When both Europe's are considered together, the correlation coefficient equals just -0.04, in which GDP did not confound the association (after controlling for GDP, the association was actually negative: -0.25, $p<0.001$). Why does this last result differ from the cross-sectional one that pertained to the late 1990s? The most likely explanation is that for most of the period, income inequality was low in the countries of Eastern Europe, while mortality was higher than in the West. This is an important observation, because it would suggest that at least before the transition, East and West mortality differences had little to do with differences in income inequality (but as Wilkinson (1996) said more with "the deterioration of the social fabric of society", i.e. the general breakdown of interactions that hold communities together). Indeed, in 1995, well into the transition, the same association was larger between Eastern than Western European countries.

When considering a longer period of time and all European countries at once, the absolute living standards argument appears to be more convincing. The correlation coefficients with mortality were also more robust, equalling -0.63 in 1981, -0.72 in 1988 and -0.73 in 1995 (all $p<0.001$) versus -0.36, -0.28 and +0.40 (all $p<0.1$) for the Gini coefficients. In other words, also differences between the European countries at one point in time are for about 50% explained by differences in absolute welfare. Within the two Europe's though, the situation is different. For Western Europe, the absolute income hypothesis seemed to hold best and for Eastern Europe the relative income hypothesis. The results were not very robust: from the three years tested, GDP was significant in Western Europe in 1988 and the Gini coefficient in Eastern Europe in 1995, explaining just respectively 10% and 25% of the differences between the countries (*Table 2*). Regarding Eastern Europe, the lack of association is not surprising because while economic changes have been relatively recent, life expectancy has stagnated for many years. Within Western Europe, absolute income differences at one point in time are generally not large enough to explain mortality, but the continual growth in the economy is. The question now remains how absolute or relative income is associated with mortality when several factors are simultaneously included in a pooled regression model.

Table 2.-Correlation coefficients between GDP, Gini and SDR's

		GDP	n	p value	GINI	n	p value
West	1981	-0.16	18	0.267	0.01	17	0.486
	1988	-0.33	19	0.081	-0.01	17	0.484
	1995	-0.21	19	0.189	0.18	17	0.240
	1977-99	-0.45	394	0.000	-0.02	356	0.337
East	1981	0.12	17	0.317	-0.14	17	0.299
	1988	0.00	19	0.498	-0.07	18	0.387
	1995	-0.12	19	0.305	0.51	18	0.015
	1981-99	-0.07	373	0.089	0.18	361	0.000
West+East	1981	-0.63	35	0.000	-0.36	34	0.017
	1988	-0.72	38	0.000	-0.28	35	0.053
	1995	-0.73	38	0.000	0.40	35	0.009
	1977-99	-0.73	767	0.000	-0.04	717	0.128

3.- The hypotheses

The effect of absolute income, measured as GDP, on mortality is the first hypothesis to be tested. We have special interest for variables that may confound the association between GDP and mortality (i.e. to what degree they influence the coefficient of GDP). The effect of income inequality is also tested independently. Due to the distinct political and economic history Western and of Eastern Europe are analysed separately. Besides total mortality, the causes of death, as selected in Spijker (1999) are also modelled.

H1. Differences in mortality in Europe can partly be explained by differences in absolute income.

H2. Differences in mortality in Europe can partly be explained by differences in relative income

Although living standards affect mortality, there are other macroeconomic factors that could confound the relationship between living standards and mortality, such as urbanisation, agricultural and industrial employment, which are all associated with the level of economic development of a region but each have an independent effect on mortality (Mackenbach and Looman, 1994)[5]. The compliment of agricultural and industrial

[5] In the study of 133 European Community regions Mackenbach and Looman (1994) used population density in terms of inhabitants per km^2 as the indicator for urbanisation. However, as the level of aggregation was larger in the present study, the percentage of the population resident in urban areas was

employment is service sector employment and the proportion of people employed in this sector has increased dramatically over the last thirty years. Levels in northern and western Europe are now around 70% of the total workforce, in southern Europe about 60% and in the East about 50% (for sources, see footnotes of Table 2). In Western Europe, the main contributing factor to this increase was the decline in the importance of the industrial sector, but in the southern countries the agricultural sector also shrunk substantially to about a third of its level in 1970, although its level is still higher than the Western average. In eastern Europe, the agricultural sector declined and both other sectors increased in the 1970s and 1980s. In the 1990s, a sharp decline in industrial workers was the main driving force behind a proportionally larger service sector. This was more the result of the economic transition that led to large-scale unemployment than the creation of new employment in the service sector, because the proportion of agricultural sector workers also increased. In the former Soviet Union marked changes in the employment structure have only been observed since the 1990s and are similar to those mentioned for eastern Europe.

How does this relate to changing levels in mortality? Due to different factors that act across the life course, mortality is highest among manual workers and lowest among white-collar workers with farmers generally somewhere in the middle (Valkonen *et al.*, 1993; Kunst, 1997). It is therefore superfluous to say that a change in the composition of the employment structure, as well as changes in the level of unemployment, would be expected to indirectly affect the level of mortality in a country. In an aggregate-level health study of 21 OECD countries in which an attempt was made to ascertain the contribution of a number of health determinants to the reduction in premature mortality between 1970 and 1992, the rise in the employment share of white-collar workers played the greatest role (Or, 2000). Even in countries such as Portugal and Greece, where economic growth over this period was more rapid than the OECD average, the improvement in health due to the rise in 'work status' was more than double the contribution from the rise in per capita income. Occupational mortality differences have also been established in former socialist countries (Kunst, 1997). Part of the reason for the established mortality differences over time and between countries may be due to compositional changes and differences in the workforce, rather than or as well as improvements or international differences in welfare. No specific

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used. There are several examples of urbanised and economically developed countries with vast areas of uninhabited land, which would make population density an inaccurate reflection of urbanisation (e.g. Finland).

hypothesis was formulated for primary sector employment because of inconsistent results in the literature, but the variable was included in the analysis in order to accommodate by deduction for the effect of tertiary sector employment. Unemployment was only tested in the models for Western Europe, as it still is a recent phenomenon in Eastern Europe and therefore too few data points remained when its latency period was also considered.

H3. The share of secondary sector employment in total employment is positively associated with mortality.

H4. Unemployment is positively associated with mortality.

Although education correlates with both absolute and relative income, as it improves one's personal position on the labour market and simultaneously increasing the supply of skilled workers and reducing wage differentials, it is also known for its independent effect on mortality due to its association with the acquisition of knowledge regarding health-damaging behaviours.

Educational differences in mortality between countries may be attributed to a combination of large differences between high and low social positions in the number of years of education (large educational inequalities), and different effects of one extra year of extra education on mortality (Kunst, 1997). In his internationally comparative study, Kunst established that mortality differences by educational level among men aged 35-44 years were relatively small in the Netherlands, Sweden, Denmark and Norway and about twice as large in the United States, France and Italy, while England and Wales and Finland occupied intermediate positions. Ironically, despite the fact that equity was a proclaimed and pursued political goal, in the 1980s educational differences in mortality in former communist countries were the same or larger than in Western Europe (*ibid.*).

As a result of the unequivocally rise in the level of average education in all European countries during the last forty years, as well as the fact that large educational differences still exist between countries (e.g. in 2000 between Portugal and Norway almost 7 years in favour of the latter) (Barro and Lee, 2000) and the earlier stated influence of education on health, education is likely to be an important explanatory factor. The following hypothesis has been formulated:

H5. Education is negatively associated with mortality.

Highly correlated with industrial production is pollution, which is an environmental outcome with negative consequences for health and disease. However, from certain industrial emitters, air pollution has been on the decrease in the course of the twentieth century. Recently, in Eastern Europe, the economic transformation has caused the forced closure of factories, which has inadvertently resulted in the alleviation of emissions. In other parts of Europe, the growing concern for global warming, acid rain and public health has led to the drawing and implementation of international standards regarding air pollution from industries and motor vehicles and other environmental laws. One consequence has been the introduction of new technologies, such as flue gas desulphurisation and catalytic converters that have contributed to the reduction in pollutant emissions. Not only a decline in industrial pollution has occurred, but also a reduction in the number of persons employed in heavy industry, particularly mining. This has meant that fewer people are exposed to the type of occupational hazards that may lead to mortality, particularly related to the respiratory system. Yet, there are still large international differences in industrial production and pollution. Unfortunately was this hypothesis not tested for Eastern Europe because there was no data for several countries. The following hypothesis has been formulated:

H6. Air pollution is positively associated with total mortality, lung cancer, remaining circulatory system diseases and respiratory system diseases.

Besides economic and environmental factors, there are also characteristics of the social environment that may influence differential mortality. One factor that has often been researched is the effect of divorce. While it is perhaps rather obvious that married persons live longer than unmarried persons, mortality differentials between married and divorced persons tend to be less in countries where divorce is more common (Hu and Goldman, 1990). If we therefore consider that divorce rate differs greatly in both time and between countries, it becomes evident that including divorce in a study of determinants of mortality differences is a pertinent thing to do. To give an example of the relative importance of divorce in excess mortality, results of a study of 12 European countries showed that excess mortality among the non-married was largest among men aged 45 to 54 in the 1990s, which was almost double compared to 1980 (Valkonen, 2001). It contributed statistically approximately 25% of deaths in this age group, although this percentage varied widely between countries. In Finland it was 44% in 1998 because both the relative excess mortality of not married men was high (228%) and their share of all men in the age group was also high (34%). In 1981, only 7% of deaths among men aged 45 to 54 in Greece was attributable to excess mortality among the non-married, as both the excess mortality and the proportion of non-married men was below average. Among women the relative population-attributable risk was smaller than among men of the same age, because of the smaller relative excess mortality of non-married women. The following hypothesis has been formulated:

H7. Divorce is positively associated with mortality.

Behavioural factors may also confound the association between economic factors and mortality, particularly when investigating causes of death. The prevalence of these direct determinants are partly caused by the preponderance of different life course events known to evoke health-damaging behaviour such as unemployment and divorce, as well as factors that can stimulate health-promoting behaviour like education, but by controlling for such distal factors, the independent effect of behavioural factors (at the macro level) can be ascertained. Data for three behavioural factors were obtained: smoking and the consumption of alcohol and fruit and vegetables. Considering the dominant aetiology of several of the causes of death investigated, the following hypotheses have been formulated:

H8. Smoking is positively associated with mortality from all-cause mortality and the natural causes taken into account in this study, except LDC[6].

H9. Alcohol is negatively associated with total mortality and mortality from remaining circulatory system diseases.

H10. Alcohol is positively associated with mortality from cancer, CRB, LDC and external causes of death.

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[6] In the well-known articles by Peto *et al.* (1992) and Nizard and Muñoz-Perez (1994) mortality from tobacco consumption was estimated with the assumption that smoking had no causal relationship with LDC. This assumption is also made here. The author is aware of articles that demonstrate statistically significant associations between smoking and LDC (e.g. Doll *et al.*, 1994), but raises the same concern as Doll and colleagues that it is likely to be spurious due to the confounding effect of its main risk factor alcohol consumption.

H11. Fruit and vegetable consumption is negatively associated with mortality from natural causes.

The last hypothesis deals with the contribution of health care to differences and changes in mortality, as there is a growing body of evidence that health care has a demonstrable effect on health at a population level, because many formerly fatal conditions are now susceptible to treatment. Although previous research has shown a negligible contribution of government health care expenditure to the decline in premature total mortality in industrialised countries (Or, 2000) this indirect and easy to obtain health care indicator (for Western European countries only) was considered to reduce mortality from specific causes:

H12. Government health care expenditure is negatively associated with mortality.

The variable urbanisation was also included in each analysis, but only as a control variable. Even though it is a proxy indicator for several factors already represented in the analysis (agricultural employment, pollution, divorce and health care), the remaining construct was still too vague for it to be tested in a specific hypothesis. For instance, not only do urban areas have more one-parent families, more people in social isolation and greater problems with drugs, at the same time there is greater access to public health services and medical technology, irrespective of the amount of government health care expenditure.

4.- Data and method

The main source for the national age-, sex- and cause-specific mortality data and age- and sex-specific population data was the *WHO Mortality Database* (http://www3.who.int/whosis/whsa/ftp/download.htm). Data were extracted for 43 European countries and former countries for the period 1968-99, although for most countries several years were missing (see *Table 3*). Both the mortality and population data either existed in or could be aggregated to the required 19, mainly 5-year age intervals (0, 1-4, 5-9, 10-14, …, 80-84, 85+). The mortality data contained causes of death that were coded according to the eighth, ninth and tenth revision of the International Classification of Diseases (ICD). These were aggregated to 63 causes of death from which a final selection of 13 was made based on two criteria: its importance in terms of occurrence and the existence of socioeconomic difference in mortality. When considering the reliability and international comparability of the data for several of the causes of death some apprehension is warranted, particularly for IHD and other forms of heart disease (OHD), as attributions of ischaemic and other heart disease deaths are often registered to selected codes for ill-defined cardiovascular deaths. Accordingly, for the main analysis (not for the descriptive part in the next section) CRB was subtracted from total circulatory system deaths to form a remaining cardiovascular category, which to a large extent contains IHD deaths. Although this might seem to be a rather unorthodox solution to the problem, in this manner more meaningful coefficients of the independent variables will be obtained than when IHD, OHD and a remaining circulatory system disease category are analysed separately. The fact that the most important macro determinants of the specific heart diseases (Figure 3.2), as well as the symptoms and proximate causes (e.g. smoking, hypertension) are similar, this method appears to be justified. A similar aggregation of cardiac diseases has also been done in the past (e.g. Law and Wald, 1999; Murray and Lopez, 1996). Lung cancer and prostate cancer were subtracted from total cancer in order to form the category 'remaining cancer'. Although this is still a rather heterogeneous cause of death group, because over 200 types of cancer remain, their disease process is the same. Only the location may vary: a cell becomes cancerous when the control signals in a normal cell go wrong and begin to divide in an uncontrolled manner. Moreover, they also share important disease determinants such as smoking, alcohol consumption and insufficient intake of fibres and fruit and vegetables. The use of this remaining category together with the other two will also allow total cancer to be modelled more accurately. A rest-category for external causes of death was also created by subtracting traffic accidents and suicide from the total.

One of the most common methods used to compare cause-specific mortality between the countries as well as ascertain the importance of explanatory variables is to calculate standardised death rates. SDR's therefore served as the dependent variable. Pooled cross-section and time-series analysis was employed to analyse the data, for which the statistical programme EViews was used. This tool pools all cross-sections over time to obtain a data set of N*T observations. Thus no distinction is made between cross-sections (country) and time (year) effects.

The explanatory variables for which data could be obtained for both groups of analyses were GDP (in Purchasing Power Parities (PPP)), income inequality, education, employment by economic sector (agriculture and industry), divorce rates, alcohol consumption and urbanisation. Data on pollution, unemployment, smoking, dietary factors (fruit and vegetables; and cereals) and government health expenditure (in PPP and as a percentage of GDP) were additionally acquired for Western Europe. In order to capture country-specific elements, such as the anticipated effect of the Soviet political system on economic and educational factors in Eastern European countries and the former Soviet Union, or certain dietary factors not captured in the two diet variables, dummy variables were initially considered as an option. However, due to the frequent occurrence of a 'near singular matrix' in the estimated residual correlation matrix, dummy variables were not incorporated. Instead, to capture some of the country-specific elements fixed effects were calculated (i.e. different intercepts estimated for each country). When the model displayed autoregression (AR), as indicated by the Durbin-Watson (DW) test, an AR(1) term was included, although only when the iterative process allowed the model to converge (less than a 0.01% change in the coefficient after a maximum of 1000 iterations). Autoregression implies that there is a structural pattern present in the error-term. In the case of positive autoregression this means that the error-term at time t is under- or overestimated and is again under- or overestimated at time t+1. Negative autoregression indicates the opposite: an under- or overestimation of the error-term is followed by an over- or underestimation. Additionally, each model included a term representing mortality at time t-1, as the level of mortality largely depends on the level of the year before. As it was assumed that cross-section heteroskedasticity was present, cross-section weights were also included. All variables, including their sources are listed in *Table 4*. The time series that are available for each country are given in *Table 5*, as well as to which analysis they belong For instance, as divorce has only been legal in Ireland since 1997, it was omitted from the cross-country and time-series analysis. In the modelling procedure, in the first instance all variables were included and subsequently those with the least significance were removed, until only those remained with a p-value of 0.1 or less (one-sided). Each excluded variable was re-tested for possible inclusion.

In order to compare the coefficients of the covariates, elasticities were calculated. Because mortality at time t-1 was included, we are dealing with dynamic models and therefore, both short and long-term elasticities can be determined. Short term elasticity is a type of standardised measure which estimates the relative change in the cause-specific mortality rate (*m*) as a consequence of a relative change in a determinant (*x*). In order to calculate this for the variable *x*, the average *m*-rate and *x*-value are required as well as the coefficient estimate of the *x* variable. Accordingly, the elasticities are calculated in the following manner:

$$\varepsilon_{short} = \frac{dx/\bar{x}}{dm/\bar{m}} = \frac{dm}{dx}\frac{\bar{x}}{\bar{m}} =$$

relative change of *x* in relation to relative change in *m*, whereby *dx* and *dm* represent a very small change in respectively, *x* and *m*; $\bar{x}$ and $\bar{m}$ are regional averages.

In all linear models, the derivative $\frac{dm}{dx}$ translates to the regression coefficient ß. Therefore:

$$\varepsilon_{short} = \beta \frac{\bar{x}}{\bar{m}} \tag{4.1}$$

As it is possible that exogenous variables also have an indirect effect, delayed, long-term elasticities can also be calculated. It may be that an economic shock like the sudden emergence of unemployment not only effects mortality in year t, but also in year t+1, t+2, t+3, etc. The size of this indirect effect depends on both the strength of the direct effect and the proximity of mortality at time t with the previous year and is estimated as followed:

$$e_{long} = e_{short} \times \frac{1}{1-\sigma}\ ,$$ where is the coefficient of y at time t-1.

Before the start of the pooled cross-section and time series analysis lags had to be calculated for the exogenous variables, as the influence of economic and other variables on mortality patterns are usually not contemporaneous, but the result of many years of exposure. Perhaps the best example of this is smoking and lung cancer. Lags, however, are seldom incorporated in mortality analysis and even when included, they do not always give the desired result.

Table 3.- Countries and years for which mortality and population data were obtained and their ICD codes

Albania																				**87**	**88**	**89**			**92**	**93**	**94**	**95**	**96**	**97**	**98**	
Armenia														**81**	**82**			**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	
Austria		69	70	71	72	73	74	75	76	77	78	79	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**
Azerbaijan														**81**	**82**			**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**
Belarus														**81**	**82**			**85**	**86**	**87**	**88**	**89**	**90**		**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**
Belgium	68	69	70	71	72	73	74	75	76	77	78	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**				
Bulgaria	68	69	70	71	72	73	74	75	76	77	78	79	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**
Croatia																								**91**	**92**	**93**	**94**	*95*	*96*	*97*	*98*	*99*
former Czechoslovakia	68	69	70	71	72	73	74	75	76	77	78	**79**	**80**	**81**	**82**	**83**	**84**	**85**														
Czech Republic																			**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	*94*	*95*	*96*	*97*	*98*	*99*
Denmark		69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	*94*	*95*	*96*			
Estonia														**81**	**82**			**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	*97*	*98*	*99*
Finland		69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	*96*			
France	68	69	70	71	72	73	74	75	76	77	78	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**		
Georgia														**81**	**82**			**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**							
Germany																								**91**	**92**	**93**	**94**	**95**	**96**	**97**	*98*	
former GDR		69	70	71	72	73	74	75	76	77	78		**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**									
former FRG	68	69	70	71	72	73	74	75	76	77	78	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**									
Greece	68	69	70	71	72	73	74	75	76	77	78	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	
Hungary		69	70	71	72	73	74	75	76	77	78	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	*96*	*97*	*98*	*99*
Iceland				71	72	73	74	75	76	77	78	79	80	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	*96*			
Ireland	68	69	70	71	72	73	74	75	76	77	78	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**			
Italy	68	69	70	71	72	73	74	75	76	77	78	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**		
Latvia														**81**	**82**			**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	*96*	*97*	*98*	*99*
Lithuania														**81**	**82**			**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	*98*	*99*
Luxembourg				71	72	73	74	75	76	77	78	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**		
Federal Republic of																								**91**	**92**	**93**	**94**	**95**	**96**	**97**		
Malta	68	69	70	71	72	73	74	75	76	77	78	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	*95*	*96*	*97*	*98*	*99*
Republic of Moldova														**81**	**82**			**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	*96*	*97*	*98*	*99*
Netherlands		69	70	71	72	73	74	75	76	77	78	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	*96*	*97*		
Norway		69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	*96*	*97*		
Poland		69	70	71	72	73	74	75	76	77	78	79	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**			
Portugal				71	72	73	74	75	76	77	78	79	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	
Romania		69	70	71	72	73	74	75	76	77	78		**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	*99*
Russian Federation													**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	
Slovakia																			**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	*94*	*95*	*96*	*97*	*98*	*99*
Slovenia																								**91**	**92**	**93**	**94**	**95**	**96**	*97*	*98*	*99*
Spain	68	69	70	71	72	73	74	75	76	77	78	79	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**		
Sweden		69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**			
Switzerland		69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	*95*	*96*			
Ukraine														**81**	**82**			**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**
United kingdom	68	69	70	71	72	73	74	75	76	77	78	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	
Former Yugoslavia	68	69	70	71	72	73	74	75	76	77	78	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**									

Note: The years that are in normal print are classified according to the ICD-8 revision, in italics according to ICD-9, and the bold-printed years pertain to the ICD-10 revision. A propos the ICD-8 data, all countries used the A-list codes with the exception of the former German Democratic Republic. For the years 1969-72 data corresponding to the less extensive B-list data were provided. Regarding the ICD-9 data, all countries provided data according to the B-list. The second column contains the abbreviated code that is referred to in the tables. Data for Germany for the years 1969-78 and 1980-89 were obtained by aggregating the values of the FRG and GDR. Similarly, the Slovak data for 1986-91 were obtained by subtracting the number of deaths and population of the Czech Republic from Czechoslovakia. Data for missing years were interpolated when data for surrounding years were available (e.g. Armenia 1983 = 1982 + 1/3*(1985-1982)). Few cause-specific data were available for the GDR for the period 1969-72.

Table 4.- Overview of exogenous variables and their sources

Variable	*Abbreviation*	*Measured as*	*Source*
National level income	GDP	Geary Kamis PPPs in 1990 US$	GGDC[1]
Income inequality	GINI	A value between 0 and 1 indicating the distribution of income	WIDER/WB/e.o. [2]
Education	EDU	Number of years of education	B-L[3]
Secondary sector employment	IND	% of the labour force empl. in the secondary sector	NC/ILO[4]
Primary sector employment	AG	% of the labour force empl. in the primary sector	NC/ILO[4]
Divorce	DIV	Divorce Rate per 100 marriages	NC/CoE/ISSTAT[5]
Alcohol	ALC	Alcohol consumption – Litres p.p.p year (age 15+)	OECD[6]
Pollution	POL	Sulphur Oxides (1000 tonnes) per km^2	ASL[7] NC[8]
Urbanisation	URB	Percentage of the population resident in urban areas.	UN[9]
Unemployment	UNEMP	Total unemployed as % of labour force	OECD/ES/ILO/e.o. [10]
Smoking	TOBAC	Tobacco consumption – Grammes p.p.p. year (age 15+)	OECD[10]
Fruit	FRUIT	Average amount of fruits & vegetables available p.p.p day (kg)	HFA[11]
Cereals	CEREAL	Average amount of cereals available p.p.p. day (kg)	HFA[11]
Health Care (GDP)	HCGDP	Budget expenditure on health as a % of GDP	OECD[6]
Health Care (PPP)	HCPPP	Budget expenditure on health in PPP's per capita	HFA[11]

[1] Groningen Growth and Development Centre (http://www.eco.rug.nl/ggdc/index-dseries.html#top); Maddison A. (2001), *The World Economy: A millennial perspective*. OECD, Paris.
[2] WIDER World Income Inequality Database, V 1.0 12 September 2000 (http://www.wider.unu.edu/wiid/wiid.htm); World Bank Development Indicators 2002 (http://www.worldbank.org/poverty/data/2_8wdi2002.pdf). Other sources include: for Switzerland, Flückiger, Y. (2002), Personal communications; for Norway, Statistics Norway (www.ssb.no/english/subjects/05/01/incdist/ttab-1999-10-05-01.htm); for several Eastern European countries, The William Davidson Institute (www.wdi.bus.umich.edu/research/research_pdf/gini.pdf); P.R. Gregory (date unknown), "Russia and the Ukraine" (www.undp.org/poverty/publications/case/macro/Russia.doc).
[3] Barro, R.J. & Lee, J.-W. (2000), *"International data on educational attainment: Updates and implications"*, Boston: CID Working Paper no. 42'. The machine readable data file was downloaded from http://www.cid.harvard.edu/ciddata/ciddata.html (the human capital updated files; April 2000). For most countries, the data covered the period 1960-1990/2000 with a bridge of five years. The intermediate years were fitted by means of a first-and-second order function.
[4] Data for Western Europe was obtained from the New Cronos Database (http://europa.eu.int/newcronos); for Iceland and Eastern Europe it came from the ILO LABORSTA Labour Statistics Database (http://laborsta.ilo.org). For the Czech Republic: Statistical Yearbook of Czechoslovakia / Czech Republic (various years).
[5] For most countries, data were obtained from the New Cronos Database (http://europa.eu.int/newcronos). For the USSR successor states, Czechoslovakia and West Germany, (part of) the source was the Council of Europe (2001), Recent demographic developments in Europe, Council of Europe, Strassbourg and CIS STAT, CD-ROM 1998-3: Official Statistics of the Countries of the Commonwealth of Independent States.
[6] OECD Health Data (http://www.oecd.org/EN/statistics/).
[7] The ASL/CAPITA Historical Global Sulfur Emissions Database (http://www.asl-associates.com/sulfur.htm).
[8] The New Cronos Database (http://europa.eu.int/newcronos).
[9] United Nations (2000), *World Urbanisation Prospects: The 1999 Revision, data tables and highlights*. UN Department of Economic and Social Affairs, New York.
[10] For Belarus, Bulgaria, Czech R., Hungary, Latvia, Lithuania, Moldova, Poland, Romania, the Slovak R. and Yugoslavia registered unemployment. Source Western Europe: OECD (Main Economic Indicators) and Eurostat (ES) (Eurostatistics, ESVG-Aggregates) in: Gartner, M. (1999), *EUR macro data* (machine readable data file), University of St. Gallen (http://www.fgn.unisg.ch/eumacro/macrodata/). Source Eastern Europe: ILO (see above). Source Ukraine and Moldova: CIS STAT. CD-ROM 1998-3: Official Statistics of the Countries of the Commonwealth of Independent States. Source Yugoslavia: Mencinger, 1989 in Woodward, S.L.(1995) *Socialist unemployment: The political economy of Yugoslavia 1945-1990*, Princeton University Press, Princeton, USA.
[11] Health For All Database (http://www.who.dk/hfadb).

Table 5.- Countries and years for which exogenous data were obtained and estimated and the mortality analyses in which they were included.

Country	Abbrev	GDP	GINI	EDU	IND/ AG	DIV	ALC	POL	URB	UNEMP	TOBAC	FRUIT/ CEREAL	HCGDP/ HCPPP	Descript. Analysis	Explanat. Analysis
Albania	AL	60-99	-	-	-	60-99	-	60-99	60-99	80-99	-	70-99	-	-	-
Armenia	AR	60-99	67-99	70-99	70-99	70-99	-	-	60-99	-	-	-	-	USSR	-
Austria	AT	60-99	67-99	60-99	70-99	60-99	60-99	60-99	60-99	60-99	60-99	70-99	80-99	West	West
Azerbaijan	AZ	60-99	67-99	70-99	70-99	70-99	-	-	60-99	90-99	-	-	-	USSR	-
Belarus	BY	60-99	67-99	70-99	70-99	70-99	60-99	-	60-99	90-99	-	-	-	USSR	East
Belgium	BE	60-99	67-99	60-99	70-99	60-99	60-99	60-99	60-99	60-99	60-99	70-99	80-99	West	West
Bulgaria	BG	60-99	67-99	70-99	70-99	60-99	60-99	60-99	60-99	90-99	-	70-99	-	East	East
Croatia	HR	60-99	-	70-99	-	60-99	-	-	60-99	80-99	-	-	-	East	-
Czech Rep	CR	60-99	67-99	70-99	70-99	60-99	60-99	60-99	60-99	90-99	-	-	-	East	East
f. Czechosl	CZ	60-99	67-85	60-99	70-99	60-99	60-99	60-99	60-99	-	-	-	-	East	East
Denmark	DK	60-99	67-99	60-99	70-99	60-99	60-99	60-99	60-99	60-99	60-99	70-99	80-99	North	West
Estonia	EE	60-99	67-99	70-99	70-99	60-99	60-99	60-99	60-99	90-99	-	-	-	USSR	East
Finland	FI	60-99	67-99	60-99	70-99	60-99	60-99	60-99	60-99	60-99	60-99	70-99	80-99	North	West
France	FR	60-99	67-99	60-99	70-99	60-99	60-99	60-99	60-99	60-99	60-99	70-99	80-99	West	West
Georgia	GO	60-99	67-99	70-99	70-99	70-99	-	-	60-99	-	-	-	-	-	-
Germany	DE	60-99	85-99	70-99	70-99	60-99	60-99	60-99	60-99	60-99	60-99	70-99	91-99	-	-
Former GDR	DEE	60-99	67-95	60-99	70-99	60-99	60-99	60-99	60-99	-	60-99	70-99	-	East	East
Former FRG	DEW	60-99	67-96	60-99	70-99	60-99	60-99	60-99	60-99	60-99	60-99	70-99	80-99	West	West
Greece	GR	60-99	67-99	60-99	70-99	60-99	60-99	60-99	60-99	60-99	60-99	70-99	80-99	South	West
Hungary	HU	60-99	67-99	60-99	70-99	60-99	60-99	60-99	60-99	90-99	-	70-99	-	East	East
Iceland	IS	60-99	-	60-99	70-99	60-99	60-99	60-99	60-99	60-99	-	70-99	-	-	-
Ireland	IE	60-99	67-99	60-99	70-99	-	60-99	60-99	60-99	60-99	60-99	70-99	80-99	West	-
Italy	IT	60-99	67-99	60-99	70-99	60-99	60-99	60-99	60-99	60-99	60-99	70-99	80-99	South	West
Latvia	LV	60-99	67-99	70-99	70-99	60-99	60-99	60-99	60-99	90-99	-	-	-	USSR	East
Lithuania	LT	60-99	67-99	70-99	-	60-99	60-99	60-99	60-99	90-99	-	-	-	USSR	-
Luxembourg	LU	60-99	67-99	-	70-99	60-99	60-99	60-99	60-99	60-99	-	70-99	80-99	West	-
FYROM	MK	60-99	67-99	-	-	60-99	-	-	60-99	-	-	-	-	East	-
Malta	MT	60-99	-	60-99	-	-	-	60-99	60-99	60-99	-	70-99	-	-	-
Moldova	MO	60-99	67-99	70-99	70-99	70-99	60-99	-	60-99	90-99	-	-	-	USSR	East
Netherlands	NL	60-99	67-99	60-99	70-99	60-99	60-99	60-99	60-99	60-99	-	70-99	80-99	West	-
Norway	NO	60-99	67-99	60-99	70-99	60-99	60-99	60-99	60-99	60-99	60-99	70-99	-	North	West
Poland	PL	60-99	67-99	60-99	70-99	60-99	60-99	60-99	60-99	90-99	-	-	-	East	-
Portugal	PT	60-99	67-99	60-99	70-99	60-99	60-99	60-99	60-99	60-99	60-99	70-99	80-99	South	-
Romania	RO	60-99	67-99	70-99	70-99	60-99	60-99	60-99	60-99	90-99	-	70-99	-	East	East
Russian Fed.	RU	60-99	67-99	70-99	70-99	70-99	60-99	60-99	60-99	90-99	-	-	-	USSR	East
Slovakia	SK	60-99	67-99	70-99	70-99	60-99	60-99	60-99	60-99	90-99	-	-	-	East	East
Slovenia	SI	60-99	67-99	70-99	-	60-99	-	60-99	60-99	80-99	-	-	-	East	-
Spain	ES	60-99	67-99	60-99	70-99	60-99	60-99	60-99	60-99	60-99	-	70-99	80-99	South	-
Sweden	SE	60-99	67-99	60-99	70-99	60-99	60-99	60-99	60-99	60-99	60-99	70-99	-	North	West
Switzerland	CH	60-99	67-99	60-99	70-99	60-99	60-99	60-99	60-99	60-99	60-99	70-99	-	West	West
Ukraine	UA	60-99	67-99	70-99	70-99	70-99	60-99	-	60-99	90-99	-	-	-	USSR	East
United Kingd	UK	60-99	67-99	60-99	70-99	60-99	60-99	60-99	60-99	60-99	60-99	70-99	-	West	West
f. Yugoslavia	YU	60-99	67-90	60-99	-	60-99	-	60-99	60-99	60-99	-	-	-	East	-

For instance, Judge (1995) found no evidence of a lagged relation between mortality and income inequality in British data during the period 1961-91, but suggested that the substantial increase in inequality in the late 1980s might take more time to manifest itself. The effect of smoking is better known, perhaps as it is a proximate risk indicator with a profound impact on population health. Epidemiological research has indicated that for individuals a substantial decline in smoking levels instigates a decline in IHD mortality approximately 15 years later, while for lung cancer it is approximately 30 years (Ruwaard and Kramers, 1993). Because lags vary according to the a priori outcome, i.e. the cause of death, determining the time lags was a difficult process. They were determined by a combination of theoretical reasoning (life course perspective and the aetiology of the disease), the limitations of the data and a series of tests. In most cases the method employed to determine the lag was to conduct a pooled cross-section and time-series analysis for a range of lags for each variable separately but including mortality at time t-1, AR(1) if needed[7], and the cross-section weights. Subsequently, the results were compared and the lag with the highest value was taken. As other, often interrelated, factors were omitted, the association between the variable and the mortality indicator was not always in the expected direction. In these instances the lag with a value closest to zero was selected. Due to the rapid economic transformation and fluctuations in life expectancy in Eastern Europe, it was decided to conduct this lagging exercise separately for both Europe's (see *Tables 6a* and *6b*). GDP for instance, was not lagged in the Eastern European analysis due to the assumption that a change in welfare has an immediate impact on mortality. Similarly, results for all-cause and remaining circulatory system disease mortality show that alcohol has, overall, a long-term protective effect in Western Europe and a short-term detrimental effect in Eastern Europe. Unfortunately, no data could be obtained on drinking patterns and therefore lags for the largest net effect of total consumption were calculated. This is because from both individual and ecological-level studies it is known that alcohol exhibits both health protective and damaging qualities, even with respect to a single cause of death. Moderate consumption protects against the development of IHD (see Rimm *et al.*, 1996 for an overview), while binge drinking elevates the risk of sudden IHD (Britton and McKee, 2000). Cerebrovascular (i.e. stroke) deaths are also associated with heavy drinking (Yuan *et al.*, 1997) and often occur within several days after a weekend of binge drinking

[7] The autoregressive term was excluded when it was insignificant in the calculation of one or more of the lags in a cause-specific model or the model would not converge after 1000 iterations at p=0.0001.

(the so-called Monday peak; Hart et al., 1999). For this reason it was a-priori decided not to introduce a time lag for alcohol consumption for the CRB model. In the case of LDC previous research has shown that a decline in alcohol consumption leads to an almost immediate decline in mortality (Ryan, 1995). Three years was therefore the maximum lag that was considered. Regarding external causes of death, lags were usually just a couple of years or less. Lags for the cancer categories were also similar in the West and East analyses because of their gradual development. Finally, as the effect of a variable may also differ across age due to an accumulation effect all-age mortality is also compared with working age (25-64) and old-age mortality (65+).

After the lags were determined, correlations between the variables were calculated (*Table 7*). In order to avoid problems of multicolinearity, it was decided to exclude a variable when there was a high (0.8) correlation with another variable. The relatively short time-series that were left over after the introduction of a time lag still left a period of about 15-20 years for the time-series analyses: from 1977 to the late 1990s for Western Europe and from 1981 onwards for Eastern Europe.

Besides the concern for differences in the accuracy and comparability of national and regional mortality statistics, particularly the cause-specific data, there were also several issues of reliability and validity with respect to the tested variables that needed to be considered, including their international comparability. Regarding education, we know that Barro and Lee (2001) made a good attempt at producing internationally comparable data on educational attainment that reflected the average knowledge base of a country's population. However, due to the different educational systems, we don't know whether the attainment of, say, ten years of education has the same value in all countries, particularly between Eastern and Western Europe, other things being equal. By splitting the analysis into two, the issue of reliability becomes less of a problem, even though in each case education is not quite the same theoretical construct.

A similar issue of construct validity pertains to the unemployment data. Considering the existing literature on socioeconomic health differences, we know that the working class are less healthy than non-manual workers are (OPCS, 1978; Davey Smith *et al*., 1998). Likewise, the economically inactive, particularly the unemployed, are less healthy than the employed (Martikainen, 1990). Thus, combining the two, the unemployed working class would be theoretically more prone to health problems than those who were previously office workers. This is exactly what is the case. In one study, the level of mortality of inactive men aged 35-64 who were previously upper white-collar employees was 80% lower than among former unskilled workers (Valkonen and Martikainen, 1995). The effect of unemployment at a population level will therefore in part depend on the occupational composition of the unemployed population, something that is not considered here. A second issue is that the data were extracted from several databases, each with their own international differences and operationalisation changes over time. Thirdly, different systems of social security in Europe have impaired the international comparability of unemployment levels as well.

Another data set with operationalisation problems was alcohol consumption. In order to make levels of consumption comparable, alcoholic beverages are converted to percentages of pure ethanol per volume, but this methodology is not always the same across all countries. Moreover, the list of categories are often not exhaustive when official statistics make no consideration for (illegal) home made alcoholic beverages, tax-free sales, smuggled spirits as well as spirits consumed abroad. This underestimation particularly affects Eastern Europe, as consumption from illegal distillations takes up a large proportion of the total there. Similarly, since the breaking up of the former Soviet Union it is common practice for the Fins to spend a day or a weekend in Estonia consuming a vast amount of alcohol. The data for Russia did include estimations of illegal distillations (Treml, 1997), which was also used to estimate alcohol consumption levels in other former Soviet Republics. Another problem is that while the volume of alcohol use for a country was mainly estimated from national sales, production and/or taxation data as population surveys invariably underestimate total alcohol consumption, population-level data cannot identify different drinking patterns. Consequently, similar levels of total alcohol consumption are not comparable between consumption that is usually concentrated into a few occasions when large quantities are devoured, with consumption taking place more evenly over time. The former pattern is associated with more acute problems resulting from intoxication, but the latter with both positive and negative long-term effects (WHO, 2000).

Table 6.- T-value scores of PXSTS analysis using single variables to determine the best lag[1]

a. "West" analyses

	GDP –EDU –URB –HCGDP –HCPPP –CEREALS –FRUIT –								GINI+						IND +				
	0	1	5	10	15	0	15	20	0	1	3	5	10	0	0	1	2	5	7
total	-2.41	-2.18	-3.30	-3.40	**-3.73**		**-3.54**		-1.25	-1.15	1.40	0.22	**1.40**	**-1.70**				**3.53**	*3.64*
cancer_rem			*-5.77*	-5.03	**-5.14**		**-3.33**						**3.88**	**-2.56**				**5.48**	5.45
lung			-11.38	-11.16	**-11.81**		**-8.62**						**5.60**	**-6.67**				**13.43**	10.48
prostate					**6.14**		**2.46**						**-2.69**	**1.70**				**-2.65**	-4.97
circ_rem	-4.60	-4.39	-5.18	-5.36	**-5.60**		**-5.59**		0.05	0.27	1.02	0.91	**2.73**	**-3.20**	4.22	4.34	4.20	**4.85**	*5.06*
CRB	-2.39	-1.61	-2.17	-3.16	**-3.59**		**-1.90**		-1.87	-1.64	-0.33	-0.27	**0.69**	**-1.64**	**4.85**	4.83	4.33	1.86	0.42
resp	*-2.88*	-2.76	-2.61	-2.37	**-2.86**		*-2.18*	**-2.12**[3]	-2.48	-2.03	-1.10	0.34	**3.46**	**-0.70**				2.16	**3.32**
LDC	5.34	4.35	3.01	2.58	**1.57**		**1.19**		6.54	5.89	7.22	**9.22**	3.19	**0.82**				**-3.37**	-4.37
ext_rem	-1.86	-1.90	*-3.36*	-3.19	**-3.21**	*-2.54*	**-2.46**		0.07	0.04	1.10	**2.44**	1.29	**-1.55**	3.33	3.12	2.71	3.00	**3.59**
traffic	-2.20	**-3.42**				**-2.64**			**-1.12**	-1.48				**-3.26**	**5.07**				
suicide	**-9.20**	-8.16				**-6.34**	-5.34		-3.79	-6.51	-0.95	**3.25**		**-4.90**	6.96	8.07	**8.18**		

	DIV +						ALC [2]						TOBAC +			AG +				
	0	1	3	5	10	15	0	1	3	5	10	15	5	10	15	0	1	2	5	7
total	*-0.40*	-1.58	-1.81	-0.69	**-1.64**	-2.99	2.38	2.10	1.95	1.70	1.51	**0.12**		**0.45**	-0.01				**1.61**	
cancer_rem					**-4.77**	*-3.81*				**6.31**	3.84	0.31		**4.58**	0.59				**2.17**	
lung					**-9.78**	*-8.78*				**12.63**	3.50	-3.32		**4.35**	-1.84				**8.26**	
prostate					**3.88**	3.23								**2.81**	2.53				**-2.73**	
circ_rem	-0.56	-2.40	-2.73	-2.69	**-0.33**	-4.96	0.24	-0.16	0.62	-0.09	-1.77	**-3.75**		**-0.90**	-2.39				**3.26**	
CRB	-2.17	-4.50	-2.10	-0.43	**1.48**	0.59	**2.30**							**-2.07**	-3.46	**1.49**				
resp	-1.34	-0.85	-2.00	-1.12	**0.06**	-2.48				3.75	**4.49**	1.76	**1.98**	0.85	0.12					**1.41**
LDC	0.61	2.49	3.06	3.37	**3.57**		**4.08**	2.95	0.27										**-0.04**	
ext_rem	-2.20	-3.20	-1.20	**-1.02**	-2.37		**4.24**	3.23	3.73	4.04	2.19	0.31								**1.85**
traffic	-3.51	-2.13	**-1.12**	-2.46			**1.83**									**1.36**				
suicide	-6.15	**-5.27**	-7.09	-6.01			6.79	5.66	**8.06**	5.48								**3.89**		

	UNEMP +																POL +	
	0	1	3	5	10	15	1	3	5	1	3	5	5	7	5	7	10	15
total	-2.65	-2.25	-1.18	-1.25	-0.90	**0.35**	**-1.73**	-0.70	-1.42	**-4.14**			**-0.98**	0.61	**-2.95**	-1.69	**0.07**	0.07
cancer_rem					-5.56	**-5.53**	**-5.20**	*-5.59*	-4.80	**-6.11**			**-1.16**	2.18	**-4.14**	-3.12		
lung					-10.60	**-8.58**	**-12.23**	-11.23	-11.60	**-13.18**			**-0.80**	2.05	**-6.90**	-4.34	**3.22**	2.15
prostate						**-1.89**	**1.08**	1.10	2.58	**2.66**			**-0.21**	0.32	**0.91**	1.05		
circ_rem	-2.97	-2.91	-3.05	-3.52	**-0.98**	*0.91*	-2.23	-1.97	**-3.63**			**-5.83**	*-2.10*	**-1.62**	-2.61	**-4.03**	**-0.45**	*-0.22*
CRB	-2.69	-3.10	-2.21	-1.89	-1.36	**1.02**	**-2.15**	-0.64	-1.21	**-1.80**			**3.08**	*2.73*	**-2.71**	-1.80		
resp	-1.62	-1.86	-2.15	-2.16	-1.25	**0.19**	**-1.54**	-0.52	-0.54	**-2.43**			**1.77**	2.58	**-1.91**	-0.31	0.96	**1.14**
LDC	-1.87	-0.11	3.82	1.37	5.01	**7.18**	**1.12**	4.14	1.67	**2.90**			**1.74**	2.51	**0.65**	3.92		
ext_rem	-4.59	-4.11	-1.75	-1.44	*-1.00*	**-1.41**	**-3.38**	-2.85	-2.54	**-3.17**								
traffic	-3.07	-1.75	**-1.05**				-2.68	-2.71	**-3.11**			**-4.52**						
suicide	*-5.56*	-7.08	-6.65	**-5.82**			-5.42	-6.30	**-6.45**			**-8.76**						

b. "East" analysis

	GDP –EDU –URB –								IND +						GINI +			
	0	1	5	10	15	0	10	15	0	1	2	5	7	10	0	1	3	5
Total	**-4.24**	-0.64	3.75	0.98	2.08		1.24	**0.48**	-1.73	-2.41	2.08	3.69	**5.35**	3.11	0.95	0.66	-0.88	**1.79**
CANCERrem			1.09	**0.70**	0.95		-0.18	**-0.35**				0.21	0.90	**4.81**				
Lung			4.23	**-4.29**	-3.46		*-4.74*	**-4.57**				**4.17**	3.06	1.29				
Prostate					**6.45**			**7.84**				0.23	5.13	**6.73**				
CIRC_rem	-2.79	-2.44	0.78	**-2.99**	-2.14		-0.88	**-1.58**	-0.74	0.24	1.83	2.65	**4.38**	3.27	-0.27	0.38	0.21	**1.52**
CRB	**-0.64**	0.05	3.59	0.38	0.23		0.26	**-0.21**	-0.53	0.53	1.46	3.03	**3.10**	2.55	-2.18	-1.88	-1.86	**0.26**
Resp	-0.45	0.33	3.62	**-2.89**	*-3.16*		*-2.67*	**-2.16**				**2.18**	-0.53	-3.99	-1.71	-2.07	-1.71	**-0.18**
LDC	**-6.82**	-5.71	1.50	7.08	8.08		5.92	**5.74**				4.70	**7.68**	6.13	**3.96**	2.94	0.41	-1.38
EXT_rem	**-2.14**	2.45	7.61	-1.43	-0.23	1.35	-0.67	**-1.26**	5.50	6.66	10.91	**15.75**	10.42	3.81	**0.24**	-3.10	-5.24	-2.05
Traffic	**3.75**	4.45				**-1.21**			**5.64**						**-4.07**	-4.43		
Suicide	**-5.85**	-4.60				1.49	0.88	**0.70**	-0.51	0.52	**2.15**				-0.26	**1.29**	-0.05	-0.04

	DIV +							AG +						ALC [2]				
	0	1	3	5	10	15	0	0	1	2	5	7	10	0	1	5	10	15
Total	0.16	**0.13**	-1.57	-0.65	*0.45*	-0.83	**2.07**					**-2.51**		**3.98**	2.26	-2.37	1.71	1.75
CANCERrem					**8.34**	-0.23	**2.59**						**-3.21**			-1.21	**8.50**	4.30
Lung					**0.08**	-3.59	**-3.36**				**-0.58**					-0.33	**8.30**	0.95
Prostate					**5.87**	3.96	**9.14**						**-6.86**					
CIRC_rem	-0.24	**0.93**	-1.51	-2.12	-2.68	-3.86	**0.30**					**-1.12**		**3.76**	2.57	2.39	-1.55	-2.08
CRB	*0.61*	**0.43**	-1.23	-0.28	-1.52	-1.15	**2.15**					**-2.15**		**2.54**	1.56	-1.89		
Resp	0.14	**0.52**	-1.32	-1.02	-2.04	-2.95	**-3.94**				**0.19**			**2.91**	2.19	0.87	-0.21	
LDC	*9.73*	**9.43**	6.31	4.70	3.86		**8.27**					**-7.73**		**6.13**	1.13			
EXT_rem	0.97	**1.32**	-0.60	-0.52	-2.12		**1.82**				**-4.12**			**6.30**	-1.37			
Traffic	-6.12	-4.20	-3.29	**-1.46**			**-0.16**	**-3.21**						**3.87**	-4.22			
Suicide	**2.71**	1.98	-0.38	-1.76			**-0.09**			**-0.46**				**2.72**	1.05			

[1] The sign next to variable indicates known or hypothesised direction of association. Lags that are used in the pooled cross-country and time series analysis are in bold. Although it was preferred to use the best lag, this was not always adhered to because some uniformity was also desired.

[2] Alcohol was only considered to be negatively associated with remaining circulatory system diseases and positively to the other causes of death.

[3] Even though a lag of 15 years provided a slightly higher t-value, the coefficient for education in the complete model made little sense. For this reason a lag of 20 years was used even though this meant only time series from 1980 could be used. The result had little implication: education was insignificant and excluded from the best model.

Table 7.- Correlation coefficients between the variables (lags)[1]

a. "West" analysis

	Mortality	GDP (15)	GINI (10)	EDU (10)	IND (7)	AG (7)	DIV (10)	ALC (15)	POL (10)	URB	UNEMP (15)	TOBAC (10)	FRUIT (5)	CEREAL (5)	HCGDP (1)
GDP(15)	-0.44														
GINI(10)	-0.17	-0.32													
EDU(10)	-0.11	0.71	-0.57												
IND(7)	0.64	-0.14	-0.01	-0.12											
AG(7)	-0.19	-0.60	0.66	-0.60	-0.29										
DIV(10)	-0.26	0.61	-0.65	0.76	-0.38	-0.48									
ALC(15)	-0.17	0.17	0.44	-0.39	0.24	-0.04	-0.28								
POL(10)	0.35	-0.04	0.00	0.11	0.19	-0.31	-0.13	0.00							
URB	0.20	0.20	-0.32	0.41	-0.11	-0.54	0.34	-0.14	0.74						
UNEMP(15)	-0.31	-0.07	0.17	-0.32	-0.42	0.16	0.03	0.22	0.07	0.05					
TOBAC(10)	-0.01	-0.15	0.62	-0.23	0.30	0.21	-0.51	0.49	0.35	-0.03	-0.08				
FRUIT(5)	-0.47	-0.27	0.70	-0.54	-0.11	0.66	-0.52	0.38	-0.12	-0.50	0.29	0.63			
CEREAL(5)	-0.25	-0.41	0.73	-0.74	-0.15	0.67	-0.64	0.34	-0.08	-0.41	0.43	0.39	0.80		
HCGDP(1)	-0.40	0.59	-0.09	0.43	-0.21	-0.14	0.42	0.17	-0.25	0.09	-0.02	0.03	-0.05	-0.22	
HCPPP(1)	-0.61	0.85	-0.31	0.53	-0.39	-0.43	0.61	0.19	-0.17	0.10	0.26	-0.21	-0.09	-0.20	0.65

b. "East" analysis

	Mortality	GDP	GINI (5)	EDU (15)	IND (7)	AG (7)	DIV (1)	ALC
GDP	-0.27							
GINI(5)	0.50	-0.36						
EDU(15)	0.06	-0.18	-0.05					
IND(7)	-0.41	0.05	-0.48	0.47				
AG(7)	0.05	-0.33	0.36	-0.61	-0.64			
DIV(1)	0.54	0.21	0.28	0.30	-0.20	-0.32		
ALC	0.38	0.05	0.18	0.12	0.01	-0.39	0.36	
URB	0.02	0.44	-0.19	0.45	0.54	-0.75	0.47	0.22

[1] See the last column of Table 5 for the list of countries for each analysis. Only CEREAL and HCPPP were removed for the first analysis as a result of a correlation coefficients that was ≥ 0.8. The lags in brackets only relate to the lags used in the models for total mortality.

The main issue of reliability of the data concerns estimating the missing values in order to complete the time series. The applied method depended on the observed trend or how many years were missing. The methods included taking averages from neighbouring years, linear interpolation between two points, or producing a linear or quadratic estimate (forward or backward extrapolation; see also Spijker, 2002). In a number of cases, the method was rather crude, but it was considered to be the best option given the data that were available. Regarding tobacco consumption, for example, no sex-specific total consumption patterns existed, but these were estimated using male and female smoking prevalence rates (which were also incomplete). Smoking intensity differences were not considered. Although it would be difficult to determine the exact amount of measurement bias, the author considers the data regarding income inequality, unemployment and alcohol the least reliable. The number of estimations that were necessary to obtain time-series data for smoking was also a matter of concern.

A final issue concerns the potential problem of ecological fallacy. Although the unit of analysis is the aggregate level in which the mortality data were unlinked with the exogenous variables, no inferences to the individual can be made (Gravelle, 1998), even though the results presented in this paper were often similar to relationships that have been established at the individual level elsewhere.

5.- Mortality in Europe - a quick descriptive overview

Large improvements have been made in public health this century that has seen life expectancy at birth increase in Western Europe from 47 years in 1900 to approximately 77 years today. In particular, a shift in disease patterns has occurred as infectious and parasitic diseases (e.g. tuberculosis) were gradually replaced by degenerative causes of death (e.g. cancer and heart disease). This change has been referred to as the epidemiological transition (Omran, 1971). Living conditions which were previously conducive to the spread of infectious and parasitic diseases were rapidly replaced by more sanitary living conditions, improved medical technology, and better lifestyles (Olshansky and Ault, 1986)˙ Initially, most of the gain in life expectancy came from a decrease in infectious diseases in general and infant mortality in particular. However, by the 1960s, the benefits of the decline in these two components of mortality on the life expectancy were practically exhausted, even though progression was still being made in this area (Vallin and Meslé, 2001). Instead, during the second half of the century, improved survival rates at older ages also took place, resulting in a further advancement of life expectancy. This occurred at a time when countries modernised and social, economic, and health conditions improved. However, the health transition did not occur simultaneously across Europe and although it seems that differences are becoming smaller, there are also indications that other countries may develop into the new frontrunners in health. For instance, around 1900, life expectancy was 7 years lower in Italy compared to the Netherlands (43 vs. 50 years, respectively; Livi-Bacci, 1992). In 1970-5 this difference was only 2 years (72 vs. 74 years, respectively) and in 1990-5 it was about equal (77.5 years; UN, 1998). Although quite recent predictions were that Italy would slightly surpass the Netherlands by 2025 (81.6 vs. 81.2 years, respectively; Van Hoorn and De Beer, 1998), this has already occurred (78 vs 78.8 years, respectively; Council of Europe, 2001). The main cause has been the stagnation of female life expectancy in the Netherlands. Current differences in all-cause mortality between countries in Europe are very large, particularly for men. In 2000, Iceland recorded the highest level of male life expectancy at birth with 78.0 years, compared to just 59.0 years in the Russian Federation. Among women, the difference was less severe, although still substantial: 82.7 years in Spain vs. 71.4 years in Moldova. In 1965, the range in life expectancy at birth was no more than 10 years for both men and women (Council of Europe, 2001).

These differences are particularly evident when viewing levels of mortality by cause of death, especially among men. From 1971 to 1997, much of the rapid mortality decline in Europe came from circulatory system diseases and in particular IHD. Improvements were also made in respiratory system diseases and external causes of death (mainly traffic accidents).

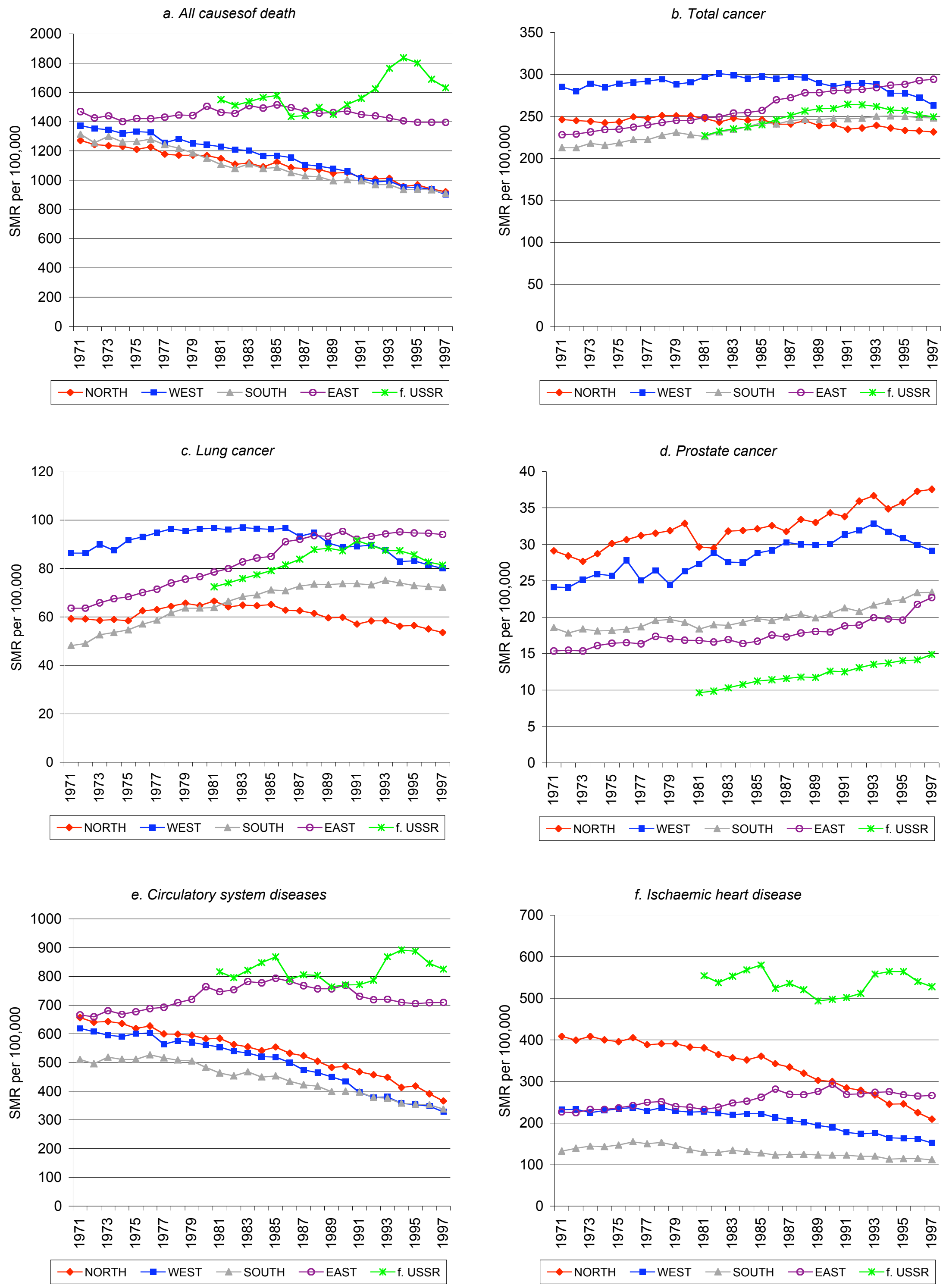
However, when viewing the results for men for different macro regions in Europe, this pattern is not the same everywhere (see *Figures 6. a-n*). The total mortality trend for northern, western and southern Europe was remarkably similar, while eastern Europe has remained largely stable throughout this period. Mortality in the selected countries of the former USSR (data since 1981) increased first and decreased since the mid-1990s.

The male cancer rate seems to have peaked in all macro regions except eastern Europe, which now have the highest levels. Although at only between a quarter and one-third of total cancer, the regional trend for lung cancer appears to be the same. Over the last 20 years, the level of prostate cancer has risen everywhere and the level in northern Europe is approaching that of lung cancer (in Norway it has surpassed it already). In the former USSR successor states, levels of prostate cancer are the lowest and a decline has been observed in western Europe since 1994.

Although southern Europe is known for its low levels of circulatory system diseases, the steady decline in northern and western Europe has attenuated the difference to almost nothing. On the other hand, while the level in Eastern Europe was previously about the same as in northern Europe, as said before, this part of Europe did not get exposed to both the health movement and improvement in medical technology and health care (Guo, 1993). As a result, mortality actually increased until the early 1980s after which it declined slightly. In the case of the former Soviet Union, levels in 1997 were the same as in 1981, but on the decline. Not surprisingly, the trend in IHD was very similar, with one exception. In the case of eastern Europe, levels were stagnant, on par with western Europe and below northern Europe until about 1981, after which mortality slightly increased, surpassing the level of northern Europe by the mid 1990s. However, this trend can partly be ascribed to differing and changing coding patterns. Although most countries experienced first a sharp increase and subsequently a decrease in the level of other heart diseases after changing to the ICD-9 coding system (an exception was northern Europe who did not change to ICD-9 until later), this was most visible in eastern Europe. Furthermore, the former USSR recorded the lowest levels of OHD. In 1981 their level was just $1/10^{th}$ of eastern Europe, in 1997 still at one-third. With respect to CRB, both the downward trend and level of mortality between northern and western Europe were very similar. Mortality in southern Europe also declined, but its level was consistently 50 deaths per population of 100,000 higher. The highest levels were in eastern Europe and the former USSR, and seemed to have followed the same pattern as total mortality.

Levels of respiratory system diseases have been, albeit rather erratic, decreasing. Levels of southern and eastern Europe have approached and even gone below levels of western and northern Europe. After a sharp decline in the 1980s, levels in the former Soviet Union increased sharply in the early 1990s after which it declined again. It still lies above the other macro regions.

Figure 6.- SMR per 100,000 for different macro regions[8] in Europe, 1971-97, men



[8] Arithmetic averages were taken of country-specific scores. For a list of the countries belonging to each macro region, see Table X.

Figure 6 Continued

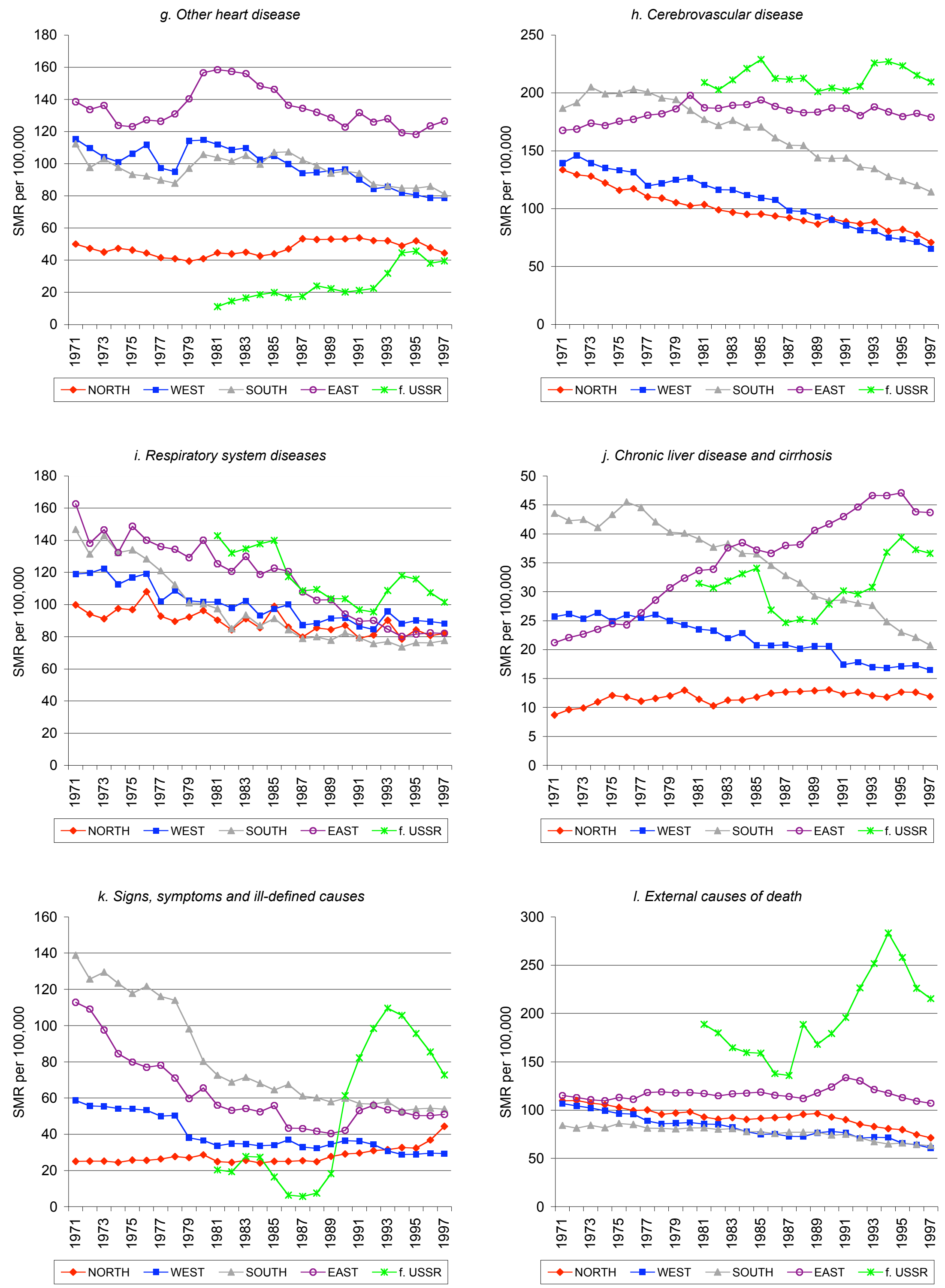
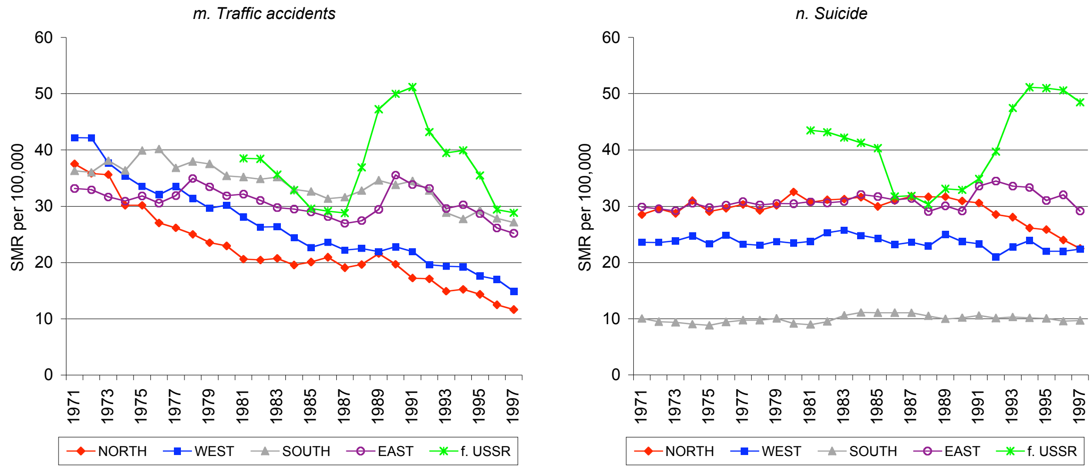


Figure 6 Continued



The figure for LDC gives two opposite trends: one for southern Europe, who went from experiencing the highest levels in 1971 to just above average in 1997. On the other hand, eastern Europe recorded a steady increase in mortality until the mid-1990s. Levels were even above that of the former Soviet Union, although this may be partly due to coding differences and competing causes. The latter because of the likelihood that many people succumb to an external cause before they would otherwise die from LDC as levels of external causes were very high in the former Soviet Republics.

Figure 6k provides a time trend of “signs, symptoms and ill-defined causes” for each macro regions. Between 1971 and about 1980, in part due to the change in ICD coding system, there was a clear downward trend. An exception was northern Europe, where levels were already low. After this period, levels stayed about the same in western Europe, continued to decline in southern Europe, but less abrupt, fluctuated in Eastern Europe and from 1990 rose very steeply in the New Independent States. This last trend is consistent with the overall mortality trend of this region and these deaths were likely to be undermined by external causes.

External causes has seen a slow but steady decline in Western Europe, but in Eastern Europe excluding the former USSR the level has only subsided recently. In 1994, rates in the former USSR successor states skyrocketed to about four times the levels in southern and western Europe. At that time, the highest ratio was between Russia and both the UK and the Netherlands at more than 10:1. Although levels of traffic accidents and suicide were also highest in these newly formed, but turbulent states, it was responsible for only about one-third of the total number of standardised external deaths, compared to 50% or more elsewhere. About a further 20-30% (depending on the year) came from violent deaths, accidental (alcoholic) poisonings and accidental falls. The bulk of the remaining deaths were registered as the Soviet equivalent of 'events of undetermined intent'.

Table 8 summarises the mortality data that was used in the multivariate analysis for Western and Eastern Europe by giving the total SDR per population of 100000 for each Macro Cluster and the cause-specific proportions between 1977/81 and the late 1990s (for men only). The table shows that during this period, total mortality was very similar between the three Western European Clusters, but differed slightly in the causes of death: in the South a lower proportion died from remaining circulatory system diseases and suicide but more from CRB and remaining causes of death, while Eastern Europe stood out with high proportions of CRB and external causes of death and a lower fraction of cancer deaths.

Table 8.- Contribution of causes of death to total mortality for each European Macro Cluster between late1970s/early 1980s to the late 1990s, men only

	WEST	NORTH	SOUTH	EAST	USSR
Cause of death					
Total mortality (SMR per 100000)	1079.82	1046.40	1009.07	1460.58	1780.21
Remaining cancer	16.10	13.90	15.96	11.01	9.89
Lung cancer	7.82	5.35	7.82	6.12	5.59
Prostate cancer	2.63	3.22	2.04	1.22	0.60
Remaining circulatory system diseases	32.45	39.68	27.52	40.38	35.53
CRB	9.07	8.47	12.44	11.68	15.29
Respiratory system diseases	9.08	7.76	8.54	6.80	7.56
LDC	2.14	1.16	3.41	2.58	1.38
Remaining external causes	2.81	3.82	2.89	4.29	8.89
Traffic accidents	1.96	1.78	2.80	1.81	2.11
Suicide	2.07	2.78	1.03	1.69	2.73
Remaining causes of death	13.87	12.08	15.54	12.44	10.43

6.- Results

Because of historical differences in the economic development within Europe, it was decided to conduct two groups of analyses, one with Western and one with Eastern European countries (aptly named 'West' and 'East'). In each case, the results of two series of models are presented: one with all variables in the model, which will determine the validity of the theoretical premises made earlier (called the 'complete' model); and one with a restricted set of exclusively statistically significant variables in order to answer the empirical question about which variables are useful for making mortality scenarios (referred to as the 'best' model). For the West analysis, the results of the complete and best models are given in *Tables 9a* and *9b*, respectively. For Eastern European, the results can be found in *Tables 10a* and *10b*. The short and long-term elasticities are given in *Tables 11a* and *11b*. For comparative purposes, the results for women are briefly summarised the end of this section (Tables *14a* and *14b*).

Each model fitted the data very well. In the complete models, the adjusted R^2 ranged between 97.0% and 99.8% in the West analysis and between 92.0% and 99.9% in the East analysis. It should be mentioned that when only mortality at time t-1 was included or just the exogenous variables, it usually explained an almost identical proportion of the variation in the data. Given the *general* short-term stability of the mortality patterns and the independent variables, this was expected. Models without mortality at t-1 was no option as these showed a high level of negative autocorrelation.

One point to bear in mind when interpreting the results is with regard to the fact that in many instances, the exogenous variables were lagged in time, which differed according to cause of death as well as between Eastern and Western Europe. In regard to the latter, the effect of several of the variables on mortality appeared to be more contemporaneous in Eastern than in Western Europe. This was particularly the case with GDP, divorce and alcohol consumption. The variables that were significant in most of the cause-specific models were GDP, the proportion of the workforce employed in industry, alcohol consumption and urbanisation. Divorce can be added to this list for Western Europe and education for Eastern Europe. The results for each hypothesis are described in detail below.

H1. Differences in mortality in Europe can partly be explained by differences in absolute income.

Results showed that in the complete pooled model that estimated the effect of 13 explanatory variables on cause-specific mortality for Western European countries in the period 1981-1999, GDP was significant ($p<0.10$) regarding all cause mortality, lung cancer, CRB, respiratory system diseases, remaining external causes and traffic accidents. Except for lung cancer, the associations were in the expected direction, thus indicating that also at the population level absolute welfare leads to lower mortality. Although lung cancer therefore still appears to be a 'welfare disease', Table 6a showed that without controlling for other variables, the association between GDP and lung cancer would have been significantly negative. However, by considering as many variables as possible we progress closer towards isolating the 'real effect' of the factors that explain differences and changes in mortality at the macro level. In the case of lung cancer, the proportion of industrial workers and fruit and vegetable consumption showed the largest influence on the association between absolute welfare and mortality in the presence of the remaining variables[9], perhaps because during the time that wealth increased, the proportion employed in industry declined and dietary factors improved. There were also instances of multicollinearity between GDP and other exogenous variables in other cause-of-death models where the omission or inclusion of a variable had a considerable effect on the association between GDP and mortality. The most important confounders were:

- Smoking and urbanisation levels in the remaining cancer model that made GDP insignificant.
- Smoking and industrial employment in the remaining circulatory system disease model that more than halved the effect of GDP, making it statistically insignificant.
- Divorce and pollution in the model for respiratory system diseases that doubled the coefficient of GDP.
- Agricultural employment in the models for remaining external causes and suicide that made GDP significant, as agricultural employment was negatively associated with both causes of death as well as with GDP.

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[9] Each variable was removed from the complete model in order to ascertain the change in the coefficient of the variable in question (in this case GDP). The most 'influential' variable was permanently deleted from the model and the procedure was repeated unless no large change occurred in the coefficient of the variable of interest.

In the case of total mortality, CRB and traffic accidents, the removal of one individual variable from the model did little to the coefficient of GDP, but when all variables were removed at once, the value of the GDP coefficient in the latter two causes of death halved. In the reduced models, i.e. only those containing the significant variables, GDP was included in the same models as where it was significant before, with the addition of prostate cancer, which was like lung cancer also positively associated with GDP. Mortality from prostate cancer has steadily become more important (*Figure 6d*) and suggested causes for this have been the increasing use of diagnostic modalities, environmental carcinogens and higher life expectancy (Haas and Sakr, 1997), of which first and last factors are positively associated with welfare. The life expectancy argument was deduced from the fact that mortality occurs progressively at older ages, either from the same cause or substituted by more debilitating chronic conditions such as stroke or Alzheimer´s disease (Olshansky and Auld, 1986) but also prostate cancer. In fact, the disease incidence of prostate cancer increases faster with age than any other epithelial malignancy[10]. By the age of 80, as many as 60 to 70% of men have histologic (microscopic) evidence of carcinoma in their prostates (see Oh *et al*., 2000). In other words, if men live long enough and do not die of an external cause, it is highly likely that they would succumb to prostate cancer. The increase in propensity of certain causes of death is therefore an indication of declining levels of total mortality and therefore a positive association between GDP and a cause of death should not necessarily be interpreted as erroneous. Lastly, the short-term elasticities calculated for the best model were generally low, that is, in half of the causes of death where GDP was included in the model, a 1% increase in GDP would be expected to change less than 0.1% in the SDR. The highest elasticity was recorded for respiratory system diseases (-0.33). In the long term, a relative change in mortality due to an increase in GDP is likely to be highest for CRB (-0.75).

In the second set of analyses, the complete model indicated the importance of GDP as a discriminating factor of mortality differences in Eastern Europe in both time and space in each of the cause of death categories except CRB, respiratory system diseases and LDC. The association was negative and significant for total mortality, remaining and lung cancer, remaining circulatory system diseases, remaining external causes of death and suicide. A positive and significant association was established for prostate cancer and traffic accidents. Regarding prostate cancer, the same arguments are given as for Western Europe.

[10] Cancer that begins in the cells that line an organ.

A possible explanation for the traffic accident model is that car ownership is positively associated with wealth. Also in these analyses, on several occasions, one or more variables clearly influenced the association between GDP and mortality.

- If the variable divorce were omitted from the model for remaining cancer, GDP would be statistically insignificant.
- The lack of association between GDP and CRB as well as respiratory system diseases was for the most part due to education. On the contrary, by controlling for education in the model of remaining external causes of death GDP became significant.
- Without considering alcohol consumption in the LDC model, the coefficient for GDP would have been significantly negative.
- Urbanisation attenuated the positive association between GDP and prostate cancer mortality.

Between the complete and best models GDP was significantly associated with the same causes of death. The short-term elasticities were highest for suicide and total mortality (-0.18), as well as for traffic accidents (+0.19), but in the long term, lung cancer would benefit most by an increase in GDP (-1.32).

To summarise, it appears that GDP is a more important differentiating variable in Eastern than in Western Europe, as it was significant on more occasions and its elasticity for total mortality is also higher. This result was expected as GDP and mortality are not linearly associated and therefore health in the East gains more with an equal amount of extra wealth than in the West because its absolute standard of wealth is as yet lower. In particular, the Eastern European results indicate that GDP was significant in two of the models pertaining to causes of death that have been linked with psychosocial factors (heart disease and suicide). In the Western European analysis, these causes were only associated with relative welfare (see also the next hypothesis). In other words, the effect of GDP on health appears to be different between the two Europe's. There were two exceptions: all-cause and remaining external cause-of-death mortality, where in both Europe's GDP was negatively significant. It should be noted however that some potentially confounding variables such as smoking that were used in the West analysis could not be tested in the analysis for Eastern Europe due to a lack of data.

H2. Differences in mortality in Europe can partly be explained by differences in relative income

While absolute welfare might play a greater role in Eastern Europe, relative welfare was important on more occasions in Western Europe, where the Gini coefficient was significant on five occasions in both the complete and best models, namely for remaining circulatory system diseases, respiratory system diseases, LDC, traffic accidents and suicide. The Gini coefficient was not significant in the model for total mortality due to the effects of GDP and smoking, which were, together with alcohol consumption and the fraction of industrial employers, the main confounders in the model for remaining cancer. Due to problems of multicollinearity, it was impossible to determine which variables caused the bivariate association with lung cancer mortality to disappear[11], while regarding remaining external causes it was clearly on the account of alcohol consumption. In the model for respiratory system diseases, the significance and elasticities of absolute income was higher than that of relative income. This, however, is consistent with the literature, as it is suggested that the direct physiological effects of absolute material circumstances, such as poor diet, damp housing, inadequate heating, which are known risk factors for respiratory system diseases, are more important than relative material circumstances (Walda *et al.*, 2002; Wilkinson, 1996, Wolleswinkel-van den Bosch J., 1998). The short-term elasticities were low: respiratory system diseases recorded the highest with 0.12. The long-term elasticity was highest for LDC (0.64).

In the analysis for Eastern Europe, the Gini coefficient was not tested for the three categories of cancer due to the fact that a maximum latency period of five years was considered to be insufficient in capturing the effects of differences in income inequality on the level of mortality. Regarding the other causes of death, the indicator for income inequality was only significant for remaining circulatory system diseases, respiratory system diseases and LDC, but the effect was in the expected positive direction. Regarding the first two mentioned causes, the positive association of relative income was for a large part determined after controlling for differing educational levels and the proportion of industrial workers, although alcohol consumption patterns did reduce the effect of the Gini coefficient somewhat. The differing levels of alcohol consumption over time and space caused the Gini coefficient to become insignificant in the model for total mortality. In the

[11] A minimum of five variables needed to be removed before the income inequality variable became significant.

process of obtaining the best models, the relative income indicator was no longer significant in the model for respiratory system diseases (due to GDP and agricultural employment), but became important in the model for suicide after eliminating the irrelevant variables and introducing the AR term. The short-term elasticities for remaining circulatory system diseases, LDC and suicide all equalled about 0.05. In the long term LDC scored highest with 0.23.

The difference in the results of the complete models for Western and Eastern Europe was that in the East analysis, income inequality was not significant in the models for CRB, traffic accidents and suicide. Regarding traffic accidents the lack of significance of the variable is not surprising, as in poorer countries absolute welfare is a more important factor in the affordability of motor vehicles. The fact that the explanation for the result of suicide does not seem to hold (yet) for Eastern Europe also appears to be due to the overriding influence of absolute welfare. The removal of GDP from the model would make relative welfare a significant factor in the explanation of mortality differences, so the initial apparent effect of relative welfare was explained by absolute welfare.

H3. The share of secondary sector employment in total employment is positively associated with mortality.

The most common socioeconomic health studies are those that compare levels of mortality between socioeconomic groups, such as manual vs. non-manual workers. In many countries, these differences have been established for all the major causes of death, also after controlling for potentially confounding factors such as smoking and alcohol consumption. In this macro study, it was hypothesised that the share of industrial workers in the workforce was positively associated with mortality, also after controlling for national level consumption patterns (as the socioeconomic gradient in smoking or diet could not be determined for the time period and countries included in this data set). The result from the pooled analysis for Western Europe showed that in both the complete and best models the variable was significant and in the expected direction for total mortality, lung cancer, both categories of circulatory system diseases, LDC, traffic accidents and suicide. Compared to the bivariate associations established earlier (Table 6a), the addition of other variables caused the seemingly erroneous statistically significant negative association between industrial employment and prostate cancer to turn insignificant and regarding LDC to significantly positive. The main confounding variables were GDP for prostate cancer and unemployment, income inequality and divorce for LDC. GDP was also the main variable that nullified the positive associations between industrial employment and both respiratory system diseases and remaining external causes of death. Short-term elasticities were generally low, but traffic accidents and CRB stood out with respectively 0.36 and 0.18. Their long-term elasticities, as well as that for remaining circulatory system diseases were close to 1.

The independent effect that the share of industrial employment in the workforce has on mortality in Eastern Europe was less visible than one would anticipate, as it did not show a significant effect in the complete models for the important causes lung cancer and both circulatory system disease categories. Once again due to multicollinearity, the earlier established bivariate associations changed direction or magnitude after other factors were included in the model. For CRB this was alcohol consumption, agricultural employment and education; for remaining circulatory system diseases, education; and for lung cancer, GDP and education. In the model for total mortality, by ultimately adding education, alcohol consumption or GDP to the model, it would half the _-value of industrial employment. According to the results of the best model, a 1% decrease in the share of industrial employment would reduce mortality from traffic accidents by more than 0.5% and about 0.33% from the group of remaining external causes on the short term and over 1.6% in the long term. The figures for total mortality were, respectively 0.18% and 0.25%. The short-term effect is about four times higher than what was calculated for Western Europe, the long-term effect was actually slightly lower.

The causes of death where industrial employment was significant in both the West and East models were total mortality, LDC, traffic accidents and suicide. Particularly after controlling for GDP and education, the effect of industrial employment on Eastern European mortality disappeared in several of the models. The population-level results for Western Europe were in that sense more consistent with what has been found in individual-level studies (e.g. Kunst *et al.*, 1998a; OPCS, 1978). Although an association between industrial employment and remaining cancer was found in Eastern Europe, no account could be taken for smoking levels.

H4. Unemployment is positively associated with mortality.

Unemployment could only be tested for Western Europe and after taking into account all other variables it showed an independent positive effect in just three causes of death: respiratory system diseases, LDC and remaining external causes. Little changed in the coefficients after removing the irrelevant variables, but when considering that several of the bivariate associations between unemployment and causes of death were negative, the importance of controlling for other variables becomes apparent, in particular alcohol and smoking consumption. On a population basis, the effect on mortality of a 1% increase or difference in unemployment was very minor.

H5. Education is negatively associated with mortality.

While education increases knowledge about health-related behaviour and coping-strategies, it also leads to more economic growth. In other words, it is also related to GDP and therefore, if GDP would be replaced by education in the best models for Western Europe where education did not produce a significant independent effect, one could expect similar results. This was exactly what happened on two of the five instances where this was possible (total mortality and lung cancer). Conversely, when the statistically significant education was replaced by the insignificant GDP (in the models for remaining circulatory system diseases, LDC and suicide), this only happened in the first model. This implies that for the other two the effect of education on mortality was not a function of economic welfare. In the models for remaining external causes and traffic accidents, GDP and education were both significant, thus indicating that in these instances education had a clear independent effect on health, irrespective of the level of welfare (in time and space). Although the average educational level is generally higher in more egalitarian countries (Alderson and Nielson, 2002), the Gini coefficient only confounded the association between education and LDC mortality. Education and income inequality were not interchangeable variables and in three of the models both socioeconomic factors were significant (LDC, traffic accidents and suicide). In the best model for LDC the coefficient for education was about half to that of the complete model. This was mainly due to the removal of agricultural employment. Education was significant in the best model for remaining circulatory system diseases after removing the insignificant fruit and vegetable consumption variable. The highest short-term elasticities were found for LDC and external causes of death, particularly traffic accidents (-0.47). In the long term, the elasticity for LDC was a massive -2.4.

In the analysis for Eastern Europe, education was significant in a large number of cases, although not always in the expected direction, as its association was significantly positive in the models for remaining and prostate cancer, LDC and traffic accidents. Again, in the case of traffic accidents, it might be a question of affordability. Although GDP was also included in the model (and also positively associated), the level of education in the Eastern European analysis in relation to traffic accidents may be an indicator of personal rather than national economic welfare, as the existence of educational differences in driving capabilities or the optimisation of health services after a traffic accident at this level of aggregation seems unlikely. Regarding the remaining cancer model, it was unfortunate that smoking behaviour could not be controlled for. Former socialist countries may have undergone a change in social gradient in smoking more recently than the West (Bobak *et al*., 2000). Therefore, due to the long latency period, the positive health effect of education will not yet have capitalised. It is also possible that the positive association was due to the underreporting of cancer deaths, which has been observed in the past in the New Independent States (Rahu, 1992 in Anderson and Silver, 1997). If this would be the case, the premise would be that underreporting occurs in times or places where education is lowest. The result for prostate cancer may again be due to a substitution effect, as prostate cancer is a function of an ageing population and education is negatively associated with total mortality. The result for LDC cannot be explained, as the literature clearly shows heavy drinking to be more common among the lower educated – the main risk factor for LDC (see Ross and Wu, 1995 for references). Changing the latency period for education in the model to 0, 5 or 10 years did not alter the result. Very few large-scale studies have been conducted on educational differences in LDC, perhaps because the emphasis has mainly been on occupational differences. One exception is the study by Singh and Hoyert (2000) who found marked differentials among men in the United States. Besides for total mortality education demonstrated a protective effect in the models for both categories of circulatory system diseases, respiratory system diseases, remaining external causes and suicide. The only alteration in the best models was that education was no longer associated with LDC after the exclusion of particularly agricultural employment. The highest short-term elasticities were recorded for traffic accidents (+1.48), suicide (-0.60) and remaining external causes (-0.53). The long-term effects are impressionable: respectively +4.44, -1.49 and -2.60. The effect of a 1% increase in education on total mortality was also considerable: an estimated 0.46% short-term and 0.63% long-term reduction.

Education appears to play a more important role in differentiating mortality in Eastern Europe than in the West, especially because it featured in the model for total mortality and its effect on mortality was substantial. However, there were four instances in the Eastern European models where the association was positive, while the models for Western Europe all conformed to the current theory. Regarding remaining cancer mortality and mortality from traffic accidents, it is possible that the diffusion process from high to low socioeconomic groups in terms of car ownership and smoking habits and its effect on mortality is still at an earlier stage in Eastern Europe than in the West.

H6. Air pollution is positively associated with total mortality, lung cancer, remaining circulatory system diseases and respiratory system diseases.

Among the four causes of death that the pollution variable was tested in the Western European analysis, it was significant each time except for lung cancer. However, this was only after controlling for one or more variables: GDP and divorce in the model for total mortality, smoking in remaining circulatory system diseases and GDP, income inequality, agricultural employment and fruit and vegetable consumption in respiratory system diseases. In other words, in the case of GDP this suggests that its mortality lowering effect obscured the detrimental effect of air pollution. In several countries, particularly Greece, both variables increased substantially for most of the period since the 1960s. Regarding the model for total mortality the main reason for the 2.5 times greater value in the complete model when compared to the best model was due to the omission of the autoregressive term (the complete model would otherwise not converge). Results of the best model showed that the overall effect of a 1% decline in air pollution on total mortality would not reduce total and lung cancer mortality by more than 0.01% and respiratory diseases by 0.16%. The long-term elastiticies were, respectively 0.07 and 0.20. Unfortunately could this hypothesis not be tested for Eastern Europe.

H7. Divorce is positively associated with mortality.

In the complete models for Western Europe each of the significant coefficients of divorce was positive, of which there were seven in all. Given the bivariate associations between divorce and remaining cancer, lung cancer, respiratory system diseases and the three external cause of death, of which some were actually significantly negative, the real effect of divorce (if any) only became apparent after controlling for other variables. The most important confounders were GDP, industrial employment structure and the level of education, although in the remaining cancer model no single or even several confounder variables could be determined, as most of them contributed just a small amount. The main difference between the complete and best models was that the reduction in variables (and as a consequence the standard error), allowed divorce to become significant in the model for lung cancer, while the addition of an autoregressive term in the all-cause mortality model more than halved the coefficient for divorce. Even though divorce showed an independent effect in the majority of models, the short-term elasticities were all below 0.1 and the long-term elasticities up to 0.21 (traffic accidents).

In the analysis for Eastern Europe, the cause-of-death models in which divorce showed an independent effect were lung and remaining cancer, respiratory system diseases, LDC, remaining external causes and suicide. This applied to both the complete and best models. All significant associations were positive. The omission of the insignificant variables had only a marginal effect on the coefficients for divorce. The highest short-term elasticity was recorded for suicide (0.16) and the highest long-term elasticity for remaining external causes (0.47).

There were few differences between the results for Western and Eastern Europe. Even though divorce in the complete model for total mortality was not significant in Eastern Europe, the elasticity was the same as in Western Europe: for every 1% decline in divorce, mortality would be expected to decline by 0.02% (table not shown). One difference worth mentioning is that divorce appears to have an effect on suicide levels in the East, but not in the West. We know that greater financial insecurities and lower standards of living exist in Eastern Europe. It is therefore possible that the psychosocial effects that emanate from no longer being able to benefit “from economies of scale in the purchase and use of housing and other goods and services” (Joung, 1996) are greater in the East than in the West. The coefficient for divorce changed little when the Eastern European model was applied to the

Western data, i.e. without the potential confounders alcohol consumption, unemployment and health care expenditure.

H8. Smoking is positively associated with mortality from total mortality and the selected natural causes except LDC.

As only an approximation of tobacco consumption in former East Germany was available, the smoking hypothesis was only tested for Western Europe. It could not be rejected in all but one of the possible cause-specific models (i.e. CRB). In other words, also at the population level, smoking is an important risk factor for the major diseases. Regarding total mortality, smoking was only significant in the best model. Even though the value of the coefficient attenuated slightly, the fewer variables and the additional autoregressive term caused the standard error to decline and the coefficient significant. In each best model, the elasticity for smoking was less than 0.1. The long-term elasticity, however, was above 0.4 for lung cancer and remaining circulatory system diseases, which suggests that changes in smoking behaviour at the population level takes a long time to take full effect on health.

H9. Alcohol is negatively associated with total mortality and mortality from remaining circulatory system diseases.

In the West analysis, the results of the model for remaining circulatory system diseases (which mainly pertains to IHD) confirmed the presupposition of the protective long-term qualities of alcohol, although this effect was not large enough to significantly influence total mortality. In fact, the association was almost significantly positive, but as alcohol also has health-damaging properties this result is conceivable. The short-term elasticity for the rest category of circulatory system diseases was just under -0.1. The effect in the long term (over and above the 15-year latency period) was –0.4.

In comparison to the previous results, in the East analysis alcohol was both times positively associated with mortality, with short/long term elasticities of 0.14/0.19 for total mortality and 0.08/0.25 for remaining circulatory system diseases.

H10. Alcohol is positively associated with mortality from lung cancer, remaining cancer, CRB, LDC and external causes of death.

As alcohol is the main causal factor of LDC it was not incongruous to see it have a higher t-value than the other variables in the complete model of Western Europe. Neither surprising was that the coefficient in the heterogeneous cause-of-death model for remaining cancer was positive and statistically significant, as alcohol is known to instigate a number of specific forms of neoplasm, in particular in the upper respiratory and digestive tracts, oesophagus, pancreas, bladder and kidney (Nizard and Nuñoz-Perez, 1994). Only regarding lung cancer was alcohol not significantly positively associated, which, given its bivariate association was not anticipated. Just by adding the industrial employment variable to the bivariate model caused the t-value of alcohol to declined from 12.63 to –0.36. Although this would seem to signify that the share of industrial workers in the workforce has a large effect on the level of alcohol consumption, it was in fact a combination of different factors associated with industrial employment that caused it.[12] There was no change in the causes of death where alcohol exhibited a positive association when the best models were ascertained. Both short-term and long-term elasticities were highest for LDC (0.26; 2.08(!)) and remaining external causes of death (0.14; 0.57).

In each of the Eastern European models where alcohol was tested, its association with mortality was positive and highly significant. The addition of other variables to each model had little influence to the strength of the association, with the exception of urbanisation. By including this variable to the models for total mortality and remaining external mortality, the strength of the association of alcohol doubled. The short-term elasticities varied between 0.05 for remaining cancer to 0.18 for remaining external causes and between 0.16 and 0.86 with respect to the long-term elasticities for the same models.

H11. Fruit and vegetable consumption is negatively associated with mortality from natural causes.

Fruit and vegetable consumption could only be tested in the models for Western Europe. With all other variables included, fruit and vegetable consumption demonstrated an

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[12] By using the same method as described in the previous footnote, four variables were needed to be removed from the complete model before the association between alcohol consumption and lung cancer mortality would become significant (besides industrial employment also GDP, pollution and government health care expenditure; ≈0.05).

independent negative effect on all three categories of cancer, as well as total mortality. This confirms the protective qualities of this dietary factor in the prevalence of cancer mortality, something which has been established at the individual level on many occasions (see Clinton *et al.*, 2000). Without a number of confounders, fruit and vegetable consumption would no longer have been significant in the two circulatory system disease models. In relation to CRB, this was clearly due to differences in the prevalence of industrial employment over time and across countries. The value of the coefficients varied little between the complete and best models. The short-term elasticities were all below 0.1, but in the long term a 1% increase in fruit and vegetable consumption can expect a decline in cancer mortality by 0.55%.

H12. Government health expenditure is negatively associated with mortality.

This hypothesis could only be tested with the Western European data set. Although the t-values of the calculated lags were negative and significant for most causes of death, when all other variables were included in the model, the health effect of the proportion of GDP spent by the government on health care disappeared in most instances. Conversely, in the case of prostate cancer it became negative and significant, in part due to industrial employment and GDP. In three other complete models the association was statistically significant and negative: for respiratory system diseases, remaining external causes and traffic accidents and in all four models the variable remained significant after the irrelevant ones were removed. The main reason why government health care expenditure showed no effect in the models for lung cancer and remaining circulatory system diseases was due to its underlying association with both urbanisation and industrial employment. The highest short-term elasticity was recorded for respiratory system diseases (-0.13); the highest long-term elasticity for both remaining external causes of death and traffic accidents (-0.29).

Lastly, no formal hypotheses were stated for urbanisation and agricultural employment, as their association with cause-specific mortality has not been consistent according to international evidence. The association between urbanisation and mortality in the West analysis was negative in each of the models except respiratory system diseases and LDC. A specific characteristic of urban areas that possibly contributed to this negative association and which was not already captured in the other variables is *access* to health care, which is greatest in the most urbanised countries. In the case of traffic accidents, greater availability of public transport and better road conditions are more likely contributors. The two positive associations may be due to certain health-damaging factors related to housing conditions and life style that are more typical of urban areas and which were not completely covered by the variables in the model. The short-term elasticities in the best models were high: about +1 for respiratory system diseases and –1 for traffic accidents, while no long-term elasticities were higher than for urbanisation: about –4 for suicide and +4 for LDC.

In regard to Eastern Europe, according to Kingkade and Arriaga (1997) male urban dwellers under the age of 75 in Moldova, Russia and the Ukraine in 1989 lived on average about 2.3 years longer than their rural counterparts[13], of which about three-quarters was due to external causes. The remaining fraction was mainly the result of respiratory system diseases. The authors of the article unfortunately failed to provide any explanation for the urban-rural patterns, but results from a Baltic study, where similar urban-rural differences in mortality from respiratory system diseases and external causes of death were found in the 1980s, suggested that the rural excess may be due to differences in the level of education, standards of hygiene, poorer medical services and housing as well as alcohol consumption (Krúmi__ and Zvidri__, 1992). With the exception of respiratory system diseases, the macro-level analysis presented here show a different picture, as the coefficient for urbanisation was significantly positive on six occasions. However, because the results pertain to inter-country differences and changes over time rather than within-country differences, the results may not be erroneous. It is plausible that the effects of the economic transition hit the most urbanised and industrialised countries hardest, even though the rural areas in these countries suffered even more, although a more likely scenario is that it is a typical example of ecological fallacy (Blakely and Woodward, 2000), as certain urban-rural differences, particularly alcohol consumption, were not covered by the data.

Agricultural employment was not an important control variable, because when excluded the coefficients of other variables usually did not change by much. In the Western European models it did exhibit independent protective effects for external causes of death and LDC and detrimental effects for respiratory system diseases. While the bivariate

[13] They employed the 'years of live lost' method, in which they adopted age 75 as the age that people should live to in the absence of premature mortality. It also excludes mortality at extreme old age where measurement errors have been more pronounced.

correlations between agriculture and each external cause of death category was positive, the complete model showed that agriculture actually had protective properties, as particularly education and GDP were the main confounders. The elasticity was highest for traffic accidents (-0.18). In the analysis of Eastern Europe, agricultural employment was negatively associated with remaining circulatory system diseases, CRB and traffic accidents and positively associated with remaining cancer, prostate cancer and respiratory system diseases. The effect was strongest for traffic accidents. With both agricultural and industrial employment variables in the model, one could indirectly make a comparison with service sector employment. Results here confirm that also at the macro level farmers and agricultural labourers are often characterised by mortality levels somewhere in between white and blue-collar workers as found at the individual level by Kunst (1997), OPCS (1978), Valkonen *et al.* (1993) and Vagerö and Lundberg (1995).

Fixed effects

Although the selected variables disentangled some of the country differences in mortality, the list of variables was by no means exhaustive, but by including fixed effects in the model equation, part of the country-specific variation in the data was filtered out. The fixed effect is the value of the y-intercept, i.e. the modelled country-specific SDR when the independent variables including mortality at time t-1 and the autoregressive term (if needed) equal to zero. A good model has fixed effects close to zero for all cross-sections.

The results, given in Figure 7a a-k and 7b a-k, show that for the complete model for total mortality in Western Europe the fixed effect was highest for Finland, which was also the country with the highest level of mortality. Norway and Denmark would have had similar death rates as Finland, were it not for these unmeasured characteristics. The selected variables explained the low mortality in Greece well. In the scatter plot for lung cancer, Belgium clearly stands out as the country with the highest mortality level but where the risk factors did not explain it very well. It is possible that it was partly caused by unfavourable level of industrial employment and urbanisation, as when these two were excluded from the model, the fixed effects were similar to that of most countries. In the case of prostate cancer, risk factors are less clear because the disease is mainly associated with ageing. The result confirm that much is left unexplained as the data points are all very close to the trend line. With respect to remaining cancer, the fixed effects of a group of six countries were clustered around the same value, indicating that, irrespective of the level of mortality, a similar amount was left unexplained. With regard to remaining circulatory system diseases, the low fixed effects of Greece seem to would have been caused by the high amount of fruit and vegetable consumption there. The selected variables also helped to explain the particularly high level of mortality in Finland. The opposite can be said about France. Regarding cerebrovascular disease, the range of fixed effects was not large. The high level of CRB mortality, but lower than expected fixed effect in Greece was partly explained by the industrial employment variable. In the respiratory system and LDC models there was no correlation between fixed effects and the level of mortality and neither were the fixed effects alike. Finland had by far the highest level of remaining external causes of death and without controlling for differences in alcohol consumption, the difference in the fixed effect with the other countries would have been greater still. Levels of traffic accidents were highest in Austria, Belgium and Greece. For Greece this was partly induced by the low level of urbanisation (which is an indicator for, among others, road conditions). On the other hand, (low) urbanisation was partly responsible for the lowest level of suicide in Greece.

For Eastern Europe the range of values of the fixed effects was in most instances much larger than what we saw for Western Europe, but then again, fewer explanatory variables could be used. It seemed that the selected variables explained mortality best for former East Germany, Bulgaria and the Czech Republic and less for Moldova, particularly when we consider that its mortality level approximates that of Russia. For Moldova the (common) coefficient of industrial employment and urbanisation might have been an overestimation. The differences in the fixed effects regarding remaining cancer, lung cancer and respiratory system diseases may be partly explained by the omission of a measurement on smoking, although it was surprising to see how small the range of fixed effects were for lung cancer. However, if the 1990 cross-sectional data by Peto *et al.* (1994; in Lopez, 1997) on tobacco-attributable cancer deaths (all ages) for the former USSR successor states is anything to go by, differences among the countries included in the study presented here were small (between 42% and 52%). In the case of respiratory system diseases, the negative effect of urbanisation and positive effect of education seemed to have had less an effect on Belarus', East German, Czechoslovakian, Moldavian and Russian mortality, because if these two variables are excluded, the fixed effects decline to a level similar to that of the remaining countries. With remaining circulatory system diseases, education and alcohol appeared to explain part of the high level of mortality in the two Baltic States. For CRB it was agriculture that gave Romania and Moldova their high fixed effects even though their actual level of mortality was about average for Eastern Europe. These two countries also had disproportionally high fixed effects for traffic accidents. These last examples pertain to bordering countries which have economic and ethnic/cultural resemblances. The fixed effects concerning prostate cancer and LDC appear to correspond well to the level of mortality in each country, which indicates that some important variables were not accounted for. In the model for remaining external causes of death, the two extreme fixed effects came from Moldova (high) and East Germany (low). It seemed that the detrimental effect of urbanisation did not explain mortality very well for Moldova, while non-natural mortality in East Germany was unusually low during all but the last two years (1989 and 1990), possibly as a result of under-reporting. In part due to the effect of alcohol consumption, the fixed effects of the two Baltic States in the suicide model were much lower than expected, while there is still much left unexplained for Belarus, Hungary and Russia.

How much of mortality is explained by the exogenous variables?

When the Western and Eastern European cause-specific models only included fixed effects and the mortality rate of the previous year in its equation, it usually explained more than 97% of the mortality data, although this was very much aided by the fact that the data were cross-country weighted. Nevertheless, while predicting mortality by extrapolating past trends would not provide larger differences in the explained variance than a model with more explanatory variables, the difference in the unexplained variance might be more of a reflection of cross-country differences. This theoretical premise was somewhat thwarted when mortality was remodelled with the omission of mortality at time t-1, as the adjusted R^2 was about equal and often higher. For instance, the exogenous variables explained 99.7% of total mortality in Western Europe although this was reduced to 89.6%[14] without the fixed country effects and cross-country weights. The two circulatory system disease categories showed similar high percentages. The R^2 of the external causes were lower but still above 50%. The variables in the East analysis performed less well once the fixed country effects and cross-country weights were excluded: e.g. just 26.2% of the variation

[14] 82.2% of the variation was explained when just GDP, industrial employment and fruit and vegetable

was explained in the model of circulatory system diseases (see Tables 9a and 10a). Regarding Western Europe though, it appears that mortality at time t-1 and the exogenous factors are independently able to predict mortality accurately. Although the previous year's mortality rate was an independent variable in the model in order to allow for a better estimate of the effect of the exogenous variables, it additionally restricted the level of (negative) autocorrelation. Without it, the D-W statistic was often less than 0.3 instead of the preferred 2.0.

The robustness of the models

The continuing rectangularisation of the survival curve has meant that the age distribution of mortality from degenerative causes had shifted progressively towards older ages. As there is little more to gain in the survival of infants and at this moment and death rates of the oldest old are not improving much in some European countries, and in some cases they are even rising (Van Hoorn and Broekman, 1999), it would be logical to assume that in most instances the effect the exogenous variables associated with mortality differences across space and time will be strongest at the middle and early old age, rather than at young or extremely old ages. If so, the consequence would be that cause-specific mortality projections which incorporate exogenous variables require age-specific coefficients, rather than a general effect across all ages. Although at this stage a complete age-specific analysis has not yet been conducted, the robustness of the most important cause-specific models has been tested by splitting up mortality into ages 0, 1-44, 45-64 and 65+. This was done by applying the original all-age 'best' model to the different age categories. Although controlling for consumption patterns in the infant mortality model or applying a lag 15 years for education in the 1-44 age group model might not appear to be theoretically correct, the purpose here was not to test a hypothesis but to ascertain whether different age-specific models would be needed if the results of this study are used for mortality projection. Moreover, in this way, the age-specific coefficients and elasticities of the relevant variables could be compared[15]. It should be noted that the incorporation of some latency period regarding infant, child and early-adult mortality is theoretically warranted

consumption were included in the model.

[15] In fact, the age-specific coefficients should add up to the coefficient that was ascertained for the all-age model when there was no autoregression. By a high level of positive or negative autoregression, the value of the coefficients are less accurate, which cannot be resolved with the addition of an autoregressive term if the model does not converge.

form the life course perspective, because it introduces the possibility of accommodating for, for instance, parental and childhood social status (here at the population level, of course). An excess of additional results was avoided by only considering those causes-of-death where two or more age-groups contributing at least 2.5% of total mortality in both Europe's, as it made no sense to test the robustness of the models for each cause-of-death when the contributions by the respective age groups were only minor (see also *Table 12*). All four age groups were only tested for total mortality, while the two oldest age groups were used to evaluate the robustness of the models for remaining cancer and lung cancer and both categories of circulatory system diseases.

Results showed that for Western Europe, the cause-specific models for ages 65+ coincided very well with the models for all ages (*Table 13*). This is not surprising as 69% of all mortality occurred in this age group. Perhaps the only exception was lung cancer, where the elasticity for GDP was twice as large for this age group. However, it confirms that lung cancer is still a welfare disease for the older cohorts. Neither were the all-cause mortality results for age group 45-64 far off from the general pattern. There was one exception, namely that the elasticity for industrial employment was twice as high, which also occurred in the two circulatory system disease models. As this variable only pertains to the working population, the result was expected and an elasticity of almost 0.4 for CRB indicates that a lot has been gained in terms of health or that large international differences still exist as a result of changes and differences in the economic structure. It also suggests that industrial employment was clearly associated with ill health, even when other risk factors such as alcohol consumption were considered. The elasticity for alcohol consumption in the CRB model for this age group was about four times larger than what was established for all ages. Regarding mortality in age group 1-44, there was no association between industrial employment and total mortality, but this variable was very important for infant mortality, which confirms the importance of contextual factors before birth and during the first year of life. National level welfare in terms of GDP also had an alleviating effect on infant mortality.

Comparing the age-specific mortality models for Eastern Europe proved somewhat problematic for all-cause mortality, as there was a large discrepancy between the age-specific aggregate of the coefficients and the one given for all ages. Regarding the cause-specific models, there were few differences in the age-specific elasticities for the significant variables in the models of remaining cancer, lung cancer and remaining circulatory system diseases, but regarding the CRB model, the highest elasticities were found for ages 45-64. Contextual factors were also important in establishing differences in infant mortality over time and across space in Eastern Europe.

An attempt to test the robustness of the models across time by splitting the time-period into two failed as in most cases the models would not converge or it reached a near singular matrix, as the number of time periods were insufficient.

Women

If we compare the results of the best model for male total mortality in Western Europe with those for women (Table 14a), they appear quite similar. The biggest difference was the negative effect of tobacco consumption in the female model. As the smoking epidemic started much later among women than among men, this result is plausible, at least at the population level, because the majority of the older generation who died, which are the bulk of all deaths, did not smoke. This cohort effect was confirmed when separate analyses for ages 45-64 and 65+ were performed, as smoking was not significant in the youngest age group. This was also found for respiratory system diseases and CRB. Due to the age-specificity of lung cancer, breast cancer and remaining circulatory system diseases, smoking was already positively associated with all-age standardised mortality. GDP was the variable that was most frequently significant (eight times) and compared to men the results were similar. In a similar analysis by Or (2000), women benefited more than men from health care. Results here showed that this was only the case for respiratory system diseases. No association was established for total mortality. Education only played a small role in explaining the time and country differences in female mortality in Western Europe. A noteworthy exception was breast cancer, which could suggest that knowledge is indispensable in the fight against this disease. The industrial employment variable was, as in the case of men, in most cases significant including total mortality and each time it suggested a detrimental effect. Also consistent among both sexes was the negative association between agricultural employment and external cause of death mortality. Another variable that was often significant was divorce. Although the literature suggests that divorce is more detrimental to the health of men than women, at the population level, the elasticities were very similar. The result for unemployment was somewhat surprising. With the exception of the odd result for remaining cancer (negative), unemployment was significant for the same three causes of death as for men: respiratory system diseases, LDC and remaining external causes of death. Even though the variable for the first two causes was lagged 15 years in order to accommodate for risk factor accumulation, as the data were not sex-specific, the data pertain mainly to men as many, especially older, women would never have been part of the paid workforce. It therefore appears that the effect has to do with the social and psychological circumstances that surround unemployment. The female models showed that, like for men, fruit and vegetable consumption had a beneficial effect on the health of a population, particularly with cancer.

The results for Eastern Europe (Table 14b) showed that there were few differences between the male and female cause-specific models. Exceptions were lung cancer, remaining circulatory system diseases and LDC. In the case of lung cancer, the two economic factors GDP and industrial employment were irrelevant in the female model. With regard to remaining circulatory system diseases, the recent phenomenon of income inequality has not yet had an impact on women. The female results also showed that divorce elevated the risk and agricultural employment offered less protection than in the case of men. Interestingly enough, GDP and education played a damaging role in causing female mortality differences in LDC over time and between countries. This suggests that for Eastern European women alcohol-related mortality is more strongly associated with wealth and social status than with social inequality, which the male results showed. For women, the alcohol variable was significant in every cause-specific model and all but once demonstrated a detrimental effect on health. The exception was breast cancer. This result is an example of ecological fallacy as it contradicts the clearly positive (but non-causal) association that is found at the individual level (see White *et al.*, 2002). Similar to the male results was the importance of both GDP and education in the all-cause and remaining circulatory system diseases models.

The short-term elasticities of the common variables in the best models of Western and Eastern Europe for total mortality were little different between the sexes, with two exceptions. Firstly, in the East analysis the detrimental effect of urbanisation was greatest among men and secondly, as mentioned before, a reduction in tobacco consumption would lead to an *increase* in female mortality in the Western Europe, as the full effect at the population level is only recently being felt.

Table 9a.- Results from the pooled model for the different causes of death:“West” analysis: all variables, men

3. R2 adj: var´s only	total	cancer_rem	lung	prostate	circ_rem	CRB	resp	LDC	ext_rem	traffic	suicide
Cause at T-1	0.69 ***	0.77 ***	0.88 ***	0.71 ***	0.79 ***	0.70 ***	0.21 ***	0.87 ***	0.76 ***	0.61 ***	0.85 ***
GDP*1000	-9.15 ***	-0.01	0.38 **	0.13	-0.95	-1.59 ***	-2.93 ***	0.04	-0.40 **	-0.30 **	0.00
GINI	0.49	0.04	0.02	0.03	0.68 *	-0.20	0.54 **	0.10 ***	0.03	0.09 *	0.04 ***
EDU	-5.82	-0.27	0.27	-0.05	-2.48	1.43	-1.85	-0.88 **	-1.04 **	-1.36 **	-0.57 **
IND	3.42 ***	-0.03	0.38 ***	-0.05	1.40 ***	1.02 ***	-0.19	0.05 **	0.01	0.28 ***	0.06 *
AG	0.16	-0.30	0.07	-0.05	-0.06	0.10	0.67 *	-0.13 *	-0.47 ***	-0.61 ***	-0.17 ***
DIV	0.76 **	-0.01	0.02	0.04 ***	-0.08	0.10 **	0.32 ***	0.02 ***	0.03 **	0.06 ***	0.01
ALC	1.16	0.49 **	-0.02		-2.74 ***	0.62 *	0.92 **	0.52 ***	0.43 **	0.23 **	0.06 **
POL	4.99 **		0.20 *		1.29 *		4.40 ***				
URB	-0.20	-0.50 **	-0.21 *	-0.03	-0.60 *	0.02	1.21 ***	0.15 **	-0.18	-0.30 ***	-0.22 ***
UNEMP	-1.17	0.01	0.05	-0.05	0.40	0.14	1.00 ***	0.10 ***	0.13 *	-0.03	0.02
TOBAC*1000	9.36	2.49 ***	1.14 ***	0.49 ***	10.12 ***	0.60	3.78 **				
FRUIT*10	-1.98 *	-0.58 ***	-0.26 **	-0.06 *	0.16	0.06	-0.20	-0.05			
HCGDP	3.04	-0.01	-0.10	-0.30 ***	0.03	0.00	-1.47 **	-0.02	-0.31 *	-0.36 *	0.09
AR(1)											
Fixed Effects											
Austria	276.93	68.41	0.82	11.64	73.80	-7.48	-15.55	-9.09	26.61	32.37	19.24
Belgium	271.27	81.18	13.80	12.97	60.49	-8.44	-66.81	-16.56	32.70	45.37	26.24
Switzerland	295.54	65.83	-1.18	13.06	58.15	-9.67	4.95	-10.94	31.76	34.70	19.18
West Germany	274.28	80.98	2.49	12.65	72.06	-8.59	-47.54	-13.40	32.19	39.68	22.71
Denmark	320.83	78.22	7.89	11.88	92.73	-8.34	-28.85	-12.61	36.07	42.59	24.87
Finland	329.92	64.77	2.87	12.62	88.45	-0.80	18.73	-8.33	39.53	37.25	22.17
France	264.80	78.13	6.77	11.70	70.26	-10.65	-37.83	-15.63	32.01	37.26	20.93
Greece	249.72	72.97	10.35	9.68	23.69	5.01	-54.57	-8.56	34.42	46.89	17.80
Italy	277.33	77.92	9.43	10.27	50.19	1.26	-29.79	-11.15	28.41	36.62	16.89
Norway	316.45	73.20	5.11	14.47	80.12	3.75	4.58	-8.99	35.00	41.46	21.79
Sweden	285.58	74.20	3.82	13.24	101.81	-6.56	-21.61	-11.46	36.19	40.37	23.77
United Kingdom	274.17	79.68	7.69	10.83	77.45	-3.88	-24.56	-15.03	29.70	36.49	22.06
Durbin-Watson	2.60	2.42	2.60	2.32	2.42	2.26	2.28	2.18	2.22	2.18	2.24
1. R2 adj	98.33	99.81	99.76	98.62	99.68	98.19	97.02	99.57	97.56	97.11	98.13
2. R2 adj: T-1 only	97.94	99.74	99.53	98.69	98.30	97.90	86.04	99.30	97.03	96.09	97.02
	99.71	99.85	99.81	98.09	99.77	99.35	97.36	96.02	98.70	97.81	97.57
4. 3 ex F-E & weights	89.56	86.82	80.80	79.67	88.31	90.57	86.74	77.99	52.12	73.44	68.35

Method: GLS (Cross Section Weights)
Sample: 1981 1999; Total panel (unbalanced) observations 433
* p< 0.10; ** p<0.05; *** p<0.01 (one-sided)

Table 9b.- Results from the pooled model for the different causes of death:“West” analysis: significant variables only, men

3. R2 adj: var´s only	total	cancer_rem	lung	prostate	circ_rem	CRB	resp	LDC	ext_rem	traffic	suicide
Cause at T-1	0.87 ***	0.77 ***	0.90 ***	0.71 ***	0.85 ***	0.81 ***	0.53 ***	0.87 ***	0.75 ***	0.61 ***	0.85 ***
GDP*1000	-4.06 ***		0.23 **	0.17 ***		-0.84 ***	-1.71 ***		-0.49 ***	-0.30 **	
GINI					0.55 **		0.36 ***	0.06 ***		0.09 *	0.04 ***
EDU					-3.32 **			-0.37 **	-0.87 **	-1.35 **	-0.42 **
IND	1.38 **		0.32 ***		1.33 ***	0.66 ***		0.06 ***		0.28 ***	0.03 **
AG							0.39 **		-0.41 ***	-0.59 ***	-0.16 ***
DIV	0.32 **		0.02 *	0.04 ***		0.11 ***	0.27 ***	0.02 ***	0.03 **	0.06 ***	
ALC		0.40 ***			-2.52 ***	0.32 *	0.73 ***	0.49 ***	0.39 ***	0.22 **	0.05 ***
POL	1.97 *		0.19 **				3.35 ***				
URB		-0.34 **	-0.22 ***					0.13 ***		-0.30 ***	-0.21 ***
UNEMP							0.75 ***	0.10 ***	0.16 ***		
TOBAC*1000	7.06 **	2.77 ***	0.73 ***	0.57 ***	8.37 ***		1.81 **				
FRUIT*10	-1.70 ***	-0.44 ***	-0.24 ***	-0.06 **			-0.27 **				
HCGDP				-0.24 **			-0.57 *		-0.39 **	-0.37 *	
AR(1)	-0.50 **		-0.31 ***		-0.24 ***	-0.28 ***	-0.40 *	-0.11 **			
Fixed Effects											
Austria	115.55	52.35	6.06	6.14	17.44	-1.79	18.97	-11.52	17.36	32.17	19.01
Belgium	107.35	60.38	18.47	6.89	6.10	-1.62	3.57	-18.35	17.54	44.94	25.51
Switzerland	131.55	49.02	5.19	7.77	5.28	-3.84	28.39	-14.00	23.73	34.50	18.65
West Germany	112.04	60.55	8.92	6.13	11.67	-1.91	8.29	-15.96	19.17	39.35	22.34
Denmark	133.29	58.15	13.53	5.95	24.35	-1.01	21.94	-15.59	22.78	42.25	24.27
Finland	133.46	47.68	7.57	7.32	25.26	1.91	38.35	-11.68	30.12	36.85	21.65
France	121.15	60.27	11.73	6.20	17.69	-5.07	12.09	-17.58	21.43	36.87	20.72
Greece	131.42	48.51	15.72	4.27	-9.10	7.62	-0.01	-14.26	24.46	46.24	17.25
Italy	132.65	58.63	14.13	4.99	3.87	2.64	16.00	-13.88	18.34	36.11	16.72
Norway	132.45	54.91	10.46	9.25	17.67	5.21	39.37	-11.85	23.62	41.15	21.01
Sweden	116.52	54.63	9.66	7.36	27.28	-1.25	28.01	-14.21	23.05	40.15	23.20
United Kingdom	106.09	60.35	12.59	5.01	16.47	0.57	24.65	-16.82	15.59	36.14	21.57
Durbin-Watson	2.09	2.42	2.13	2.35	2.05	2.00	2.21	1.99	2.20	2.18	2.25
1. R2 adj	98.86	99.82	99.80	98.61	99.63	98.34	95.18	99.59	97.60	97.15	98.15
2. R2 adj: T-1 only	97.94	99.74	99.53	98.69	98.30	97.90	86.04	99.30	97.03	96.09	97.02
	98.80	99.87	99.54	97.77	99.08	98.03	96.00	99.31	98.51	97.81	96.76
4. 3 ex F-E & weights	97.016	75.98	98.7506	70.484	98.473	97.041	90.537	99.218	23.958	73.439	67.628

Method: GLS (Cross Section Weights)
Sample: 1981 1999; Total panel (unbalanced) observations 433
* p< 0.10; ** p<0.05; *** p<0.01 (one-sided)

Table 10a.- Results from the pooled model for the different causes of death:“East” analysis: all variables, men

3. R2 adj: var´s only	total	cancer_rem	lung	prostate	circ_rem	CRB	resp	LDC	ext_rem	traffic	suicide
Cause at T-1	0.48 ***	0.71 ***	0.89 ***	0.32 ***	0.69 ***	0.76 ***	0.56 ***	0.74 ***	0.80 ***	0.65 ***	0.74 ***
GDP x 1000	-30.67 ***	-3.08 ***	-1.46 **	0.23 **	-10.96 ***	0.11	2.28	0.06	-1.01 **	1.05 ***	-0.83 ***
GINI	0.57				1.47 *	-0.17	0.34 *	0.09 ***	-0.05	-0.01	0.01
EDU	-62.88 ***	2.44 **	-0.69	0.79 ***	-30.38 ***	-6.96 **	-6.93 ***	0.40 *	-5.89 ***	5.08 ***	-2.45 ***
IND	5.73 ***	0.66 *	0.13	0.05	0.70	0.00	1.03 ***	0.37 ***	0.88 ***	0.48 ***	0.19 ***
AG	-1.74	0.96 ***	0.00	0.08 *	-2.30 *	-1.41 **	0.60 *	0.10	0.06	-0.41 ***	0.03
DIV	1.91 ***	0.44 ***	0.05	0.01	0.31	-0.02	0.30 ***	0.00	0.25 ***	-0.03	0.16 ***
ALC	13.36 ***	0.64 ***	0.57 ***		3.98 ***	1.89 ***	0.90 ***	0.40 ***	1.36 ***	0.45 ***	0.24 ***
URB	14.82 ***	1.06 ***	0.08	0.25 ***	2.58 **	1.17 ***	-1.85 ***	0.01	2.26 ***	0.14	0.14
AR(1)			-0.16 **								
Fixed Effects											
Bulgaria	-24.22	-99.62	2.36	-18.82	230.68	48.62	116.54	-21.08	-148.92	-66.00	4.45
Belarus	229.69	-91.78	8.82	-21.12	310.22	53.84	144.12	-22.84	-118.23	-67.58	13.77
Czech Republic	-67.94	-81.18	7.91	-13.55	242.37	16.90	125.42	-22.63	-163.00	-80.81	6.78
Czechoslovakia	87.21	-78.00	9.02	-15.06	261.79	31.01	137.25	-21.93	-150.51	-79.53	8.21
East Germany	-184.69	-105.71	-0.01	-19.25	228.88	-12.15	152.21	-22.86	-177.77	-84.62	5.94
Estonia	59.03	-84.12	9.95	-14.84	247.20	30.92	91.03	-23.00	-143.39	-64.99	7.98
Hungary	150.34	-62.15	8.68	-7.20	229.64	24.07	115.37	-2.81	-134.37	-67.09	13.51
Latvia	55.82	-83.97	9.16	-15.74	224.59	37.55	102.14	-22.89	-141.45	-58.63	8.60
Moldova	483.54	-77.92	7.43	-17.66	300.99	87.70	97.02	1.69	-82.44	-41.84	7.92
Romania	126.23	-98.28	1.80	-15.82	252.96	71.08	113.03	-13.08	-122.59	-51.43	3.73
Russia	109.29	-92.86	6.72	-23.49	234.75	52.45	151.83	-24.07	-136.27	-71.43	12.16
Slovak Republic	219.46	-63.59	7.88	-12.51	300.38	27.91	111.56	-16.79	-118.66	-71.58	10.25
Ukraine	167.30	-98.51	5.12	-22.05	283.17	57.14	145.55	-20.11	-123.82	-66.89	9.58
Durbin-Watson	1.49	2.29	2.04	2.08	1.77	1.95	1.95	1.45	1.53	1.73	1.79
1. R2 adj	99.53	99.85	99.45	99.44	99.51	98.57	93.84	96.34	98.21	92.02	97.03
2. R2 adj: T-1 only	99.29	99.71	99.38	98.99	99.28	98.39	92.09	91.53	97.22	91.84	96.91
	99.77	99.95	99.59	99.55	99.17	98.84	95.93	97.78	98.21	84.42	97.62
4. 3 ex F-E & weights	57.76	78.13	71.36	72.76	26.24	47.17	60.04	73.30	66.11	23.03	56.54

Method: GLS (Cross Section Weights)
Sample: 1981 1999; Total panel (unbalanced) observations 257
* p< 0.10; ** p<0.05; *** p<0.01 (one-sided)

Table 10b.- Results from the pooled model for the different causes of death:"East" analysis: significant variables only, men

3. R2 adj: var´s only	total	cancer_rem	lung	prostate	circ_rem	CRB	resp	LDC	ext_rem	traffic	suicide
Cause at T-1	0.27 ***	0.71 ***	0.89 ***	0.32 ***	0.69 ***	0.76 ***	0.58 ***	0.74 ***	0.80 ***	0.67 ***	0.60 ***
GDP x 1000	-44.97 ***	-3.08 ***	-1.97 ***	0.20 ***	-11.82 ***				-1.04 **	1.03 ***	-1.26 ***
GINI					1.42 *			0.09 ***			0.08 **
EDU	-94.31 ***	2.44 **		0.73 ***	-28.74 ***	-7.66 ***	-6.06 ***		-6.47 ***	5.50 ***	-3.17 ***
IND	7.27 ***	0.66 *	0.17 ***				0.59 ***	0.29 ***	0.84 ***	0.50 ***	0.16 ***
AG		0.96 ***		0.04 **	-3.07 ***	-1.41 **				-0.40 ***	
DIV	2.64 ***	0.44 ***	0.08 *				0.28 ***		0.23 ***		0.16 ***
ALC	18.12 ***	0.64 ***	0.60 ***		3.85 ***	1.79 ***	1.03 ***	0.39 ***	1.39 ***	0.39 ***	0.32 ***
URB	21.66 ***	1.06 ***		0.27 ***	2.33 **	1.15 ***	-1.73 ***		2.29 ***		
AR(1)	0.45 ***		-0.17 ***								0.32 ***
Fixed Effects											
Bulgaria	-18.27	-99.62	3.80	-15.86	297.55	51.30	153.58	-11.61	-144.85	-61.36	23.69
Belarus	334.96	-91.78	9.22	-18.14	378.94	57.68	179.27	-12.92	-112.70	-64.23	37.74
Czech Republic	-61.82	-81.18	9.50	-10.65	311.77	22.00	159.46	-12.94	-157.83	-75.73	30.21
Czechoslovakia	165.49	-78.00	10.42	-12.09	329.84	35.52	170.49	-12.24	-145.59	-74.92	30.95
East Germany	-205.21	-105.71	0.26	-16.53	294.79	-6.41	177.06	-13.43	-172.84	-79.20	28.41
Estonia	120.87	-84.12	13.64	-11.96	327.80	33.18	135.54	-14.04	-139.43	-60.73	33.50
Hungary	261.73	-62.15	9.15	-4.74	288.77	27.96	142.47	5.66	-130.09	-63.38	37.51
Latvia	114.16	-83.97	12.05	-13.00	297.50	40.16	141.61	-14.30	-137.61	-54.75	33.04
Moldova	664.89	-77.92	7.75	-14.58	367.45	88.37	140.28	11.20	-78.06	-40.63	24.12
Romania	171.02	-98.28	1.18	-12.48	321.26	73.33	150.60	-3.10	-117.73	-48.80	20.78
Russia	185.54	-92.86	7.49	-20.75	302.68	55.63	183.05	-14.76	-132.04	-67.01	37.33
Slovak Republic	366.62	-63.59	8.30	-9.49	361.54	32.93	145.84	-7.11	-113.25	-68.48	30.12
Ukraine	253.90	-98.51	4.80	-19.11	350.35	60.50	177.70	-10.43	-118.77	-63.59	31.63
Durbin-Watson	1.91	2.29	2.00	2.08	1.77	1.95	1.96	1.45	1.53	1.74	2.31
1. R2 adj	99.40	99.85	99.43	99.46	99.51	98.61	93.77	96.18	98.21	92.33	97.16
2. R2 adj: T-1 only	99.29	99.71	99.38	98.99	99.28	98.39	92.09	91.53	97.22	91.84	96.91
	99.76 [1]	99.95	99.47	99.55	99.14	98.64	95.30	98.91	98.26	83.92	97.09
4. 3 ex F-E & weights	57.61 [1]	78.13	96.89	70.30	18.88	24.29	34.93	15.56	60.15	19.30	95.23

Method: GLS (Cross Section Weights)
Sample: 1981 1999; Total panel (unbalanced) observations 257
* p< 0.10; ** p<0.05; *** p<0.01 (one-sided)

[1] No convergence could be achieved with the inclusion of AR(1), as specified by the model.

Table 11a.- Short-term elasticities of the covariates, best model only

	Total	Canc_rem	Lung	Prostate	Circ_rem	CRB	Resp	LDC	Ext_rem	Traffic	Suicide
West											
GDP	-0.04		0.03	0.07		-0.12	-0.23		-0.16	-0.20	
GINI					0.04		0.12	0.08		0.10	0.04
EDU					-0.07			-0.13	-0.18	-0.47	-0.14
IND	0.04		0.14		0.12	0.18		0.09		0.36	0.04
AG							0.04		-0.11	-0.18	-0.05
DIV	0.01		0.01	0.04		0.02	0.08	0.03	0.03	0.08	
ALC		0.03			-0.08	0.03	0.10	0.26	0.12	0.10	0.03
POL	0.01		0.01				0.12				
URB		-0.16	-0.21					0.46		-0.93	-0.62
UNEMP							0.02	0.01	0.01		
TOBAC	0.02	0.06	0.03	0.07	0.08		0.07				
FRUIT	-0.03	-0.05	-0.06	-0.04			-0.06				
HCGDP				-0.06			-0.05		-0.08	-0.12	
East											
GDP	-0.18	-0.13	-0.15	0.08	-0.13				-0.07	0.19	-0.19
GINI					0.06			0.06			0.05
EDU	-0.46	0.11		0.36	-0.37	-0.27	-0.43		-0.53	1.48	-0.60
IND	0.18	0.16	0.07				0.21	0.29	0.34	0.54	0.15
AG		0.13		0.05	-0.11	-0.13				-0.23	
DIV	0.07	0.08	0.03				0.10		0.10		0.16
ALC	0.14	0.05	0.08		0.08	0.10	0.11	0.12	0.18	0.14	0.09
URB	0.87	0.41		1.06	0.24	0.33	-1.00		1.53		

Table 11b.- Long-term elasticities of the covariates, best model only

	Total	Canc_rem	Lung	Prostate	Circ_rem	CRB	Resp	LDC	Ext_rem	Traffic	Suicide
West											
GDP	-0.33		0.36	0.23		-0.63	-0.49		-0.64	-0.51	
GINI					0.29		0.26	0.64		0.26	0.29
EDU					-0.45			-0.99	-0.72	-1.23	-0.96
IND	0.32		1.41		0.81	0.94		0.69		0.93	0.30
AG							0.09		-0.43	-0.48	-0.35
DIV	0.05		0.07	0.13		0.12	0.16	0.20	0.10	0.20	
ALC		0.13			-0.53	0.17	0.21	2.01	0.49	0.27	0.17
POL	0.05		0.08				0.27				
URB		-0.70	-2.16					3.53		-2.41	-4.21
UNEMP							0.05	0.11	0.05		
TOBAC	0.17	0.26	0.33	0.23	0.51		0.14				
FRUIT	-0.23	-0.24	-0.62	-0.14			-0.13				
HCGDP				-0.22			-0.11		-0.34	-0.30	
East											
GDP	-0.25	-0.44	-1.32	0.11	-0.42				-0.34	0.58	-0.48
GINI					0.18			0.23			0.13
EDU	-0.63	0.40		0.53	-1.19	-1.12	-1.02		-2.60	4.44	-1.49
IND	0.25	0.54	0.66				0.49	1.12	1.67	1.63	0.36
AG		0.44		0.07	-0.34	-0.55				-0.70	
DIV	0.09	0.28	0.25				0.24		0.47		0.40
ALC	0.19	0.16	0.71		0.25	0.41	0.27	0.47	0.86	0.42	0.23
URB	1.19	1.42		1.57	0.79	1.37	-2.39		7.51		

Table 12 Age and cause-specific proportion of total mortality in Western and Eastern Europe (pooled data set), men only

	Canc_rem	Lung	Prostate	Circ_rem	CRB	Resp	LDC	Ext_rem	Traffic	Suicide	Other	TOTAL
	% of total mortality											
age					Western Europe							
0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.3	1.4
1-44	0.8	0.1	0.0	0.7	0.2	0.2	0.2	1.0	1.3	1.0	1.1	6.6
45-64	4.6	2.6	0.2	7.5	1.2	1.0	1.0	0.9	0.5	0.8	2.4	22.8
65+	9.6	4.4	2.4	26.1	8.3	6.9	0.7	1.3	0.4	0.5	8.4	69.2
all ages	15.0	7.2	2.7	34.3	9.7	8.1	2.0	3.3	2.2	2.3	13.2	100.0
					Eastern Europe							
0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.1	1.3	1.8
1-44	0.8	0.2	0.0	1.3	0.3	0.4	0.3	2.6	1.2	1.0	1.5	9.6
45-64	4.2	2.9	0.1	9.1	2.9	1.7	1.3	2.3	0.6	1.0	2.6	28.8
65+	5.5	2.6	0.9	27.9	10.7	4.5	0.8	1.1	0.3	0.5	5.1	59.8
all ages	10.5	5.6	1.0	38.3	13.9	7.0	2.5	6.0	2.1	2.6	10.5	100.0

Table 13.- Testing the robustness of the model: short-term elasticities according to age group

	Total	Total	Total	Total	Total	cancer_rem	cancer_rem	cancer_rem	lung	lung	lung	circ_rem	circ_rem	circ_rem	CRB	CRB	CRB
	All ages	0	1-44	45-64	65+	All ages	45-64	65+	All ages	45-64	65+	All ages	45-64	65+	All ages	45-64	65+
West																	
GDP	-0.04	-0.12	-0.05	-0.07	-0.05				0.04	0.00	0.08				-0.12	-0.17	-0.12
GINI												0.04	0.01	0.05			
EDU												-0.08	-0.18	-0.06			
IND	0.04	0.19	-0.01	0.08	0.05				0.14	0.10	0.16	0.11	0.17	0.09	0.18	0.37	0.18
AG																	
DIV	0.01	0.03	0.00	0.01	0.01				0.01	0.00	0.00				0.02	0.02	0.02
ALC						0.03	0.08	0.01				-0.08	-0.13	-0.06	0.03	0.11	0.03
POL	0.01	0.01	-0.01	0.01	0.01				0.01	-0.01	0.01						
URB						-0.16	-0.30	-0.10	-0.22	-0.11	-0.27						
UNEMP																	
TOBAC	0.02	-0.05	0.05	0.03	0.01	0.06	0.06	0.07	0.03	0.04	0.04	0.07	0.12	0.06			
FRUIT	-0.03	-0.24	0.00	-0.01	-0.04	-0.05	-0.13	-0.03	-0.07	-0.04	-0.07						
HCGDP																	
East																	
GDP	-0.18	-0.09	-0.10	-0.05	-0.10	-0.13	-0.13	-0.05	-0.15	-0.18	-0.12	-0.13	-0.11	-0.10			
GINI												0.06	-0.01	0.05			
EDU	-0.46	-0.51	-0.49	-0.14	-0.48	0.11	0.13	0.10				-0.37	-0.34	-0.35	-0.27	-0.35	-0.25
IND	0.18	0.46	0.29	0.28	0.12	0.16	0.16	0.18	0.07	0.07	0.05						
AG						0.13	0.15	0.11				-0.11	-0.18	-0.06	-0.13	-0.23	-0.11
DIV	0.07	-0.03	0.02	0.02	0.06	0.08	0.10	0.08	0.03	0.01	0.07						
ALC	0.14	0.03	0.13	0.08	0.11	0.05	0.04	0.03	0.08	0.12	0.04	0.08	0.10	0.06	0.10	0.21	0.07
URB	0.87	-0.25	0.96	0.52	0.51	0.41	0.48	0.23				0.24	0.40	0.20	0.33	0.67	0.22

Table 14a.- Results from the pooled model for the different causes of death:"West" analysis: significant variables only, women

	total	cancer_rem	lung	breast	circ_rem	CRB	resp	LDC	ext_rem	traffic	suicide
Cause at T-1	0.82 ***	0.77 ***	0.81 ***	0.86 ***	0.90 ***	0.80 ***	0.21 ***	0.83 ***	0.78 ***	0.51 ***	0.82 ***
GDP*1000	-3.22 ***	-0.56 ***	0.12 ***		-0.57 ***	-0.76 ***	-1.37 ***		-0.31 ***	-0.10 **	
GINI			-0.03 ***	-0.09 ***					0.09 ***		0.03 ***
EDU				-0.31 **							-0.29 **
IND	1.55 ***			0.06 ***	0.27 **	0.62 ***	0.24 *		0.07 **	0.11 ***	0.07 ***
AG		-0.37 ***	0.05 ***				0.78 ***		-0.25 ***	-0.13 ***	-0.10 ***
DIV	0.48 ***		0.01 ***	0.03 ***		0.10 ***	0.25 ***			0.01 *	0.01 ***
ALC	0.70 *	0.11 *	0.06 ***	0.07 ***	-0.37 **		0.42 ***	0.23 ***		0.04	
POL	2.09 ***						2.31 ***				
URB		-0.54 ***			-0.19 *	0.16 ***	0.88 ***	0.02 *		-0.13 ***	-0.05 *
UNEMP		-0.19 *					1.20 ***	0.04 ***	0.09 **		
TOBAC*1000	-6.39 **		0.31 ***	1.05 ***	1.46 *	-1.60 **	-3.09 **				
FRUIT*10	-1.21 **	-0.14 ***		-0.09 ***							
HCGDP	1.99 *			-0.18 ***			-0.93 ***		-0.39 ***	-0.21 **	
AR(1)	-0.49 ***			-0.41	-0.39 ***	-0.28 ***		-0.31	-0.13 **		
Fixed Effects											
Austria	78.65	70.28	0.60	5.81	31.06	-7.77	-37.60	-2.04	4.68	11.12	3.87
Belgium	79.35	86.66	0.09	7.41	31.19	-9.72	-79.72	-3.60	5.93	17.03	6.38
Switzerland	89.85	69.44	-0.79	7.55	26.38	-7.48	-22.64	-3.23	8.20	11.29	4.63
West Germany	71.11	87.11	-0.32	7.02	34.66	-11.08	-65.22	-2.83	6.75	14.55	5.01
Denmark	104.85	88.10	3.63	7.36	31.29	-8.20	-40.41	-3.10	9.63	15.18	6.99
Finland	79.00	68.80	-0.29	5.51	25.60	-5.50	-30.23	-2.42	9.22	11.76	5.19
France	61.82	73.95	-1.03	6.47	28.12	-11.71	-50.93	-3.92	9.07	14.15	4.94
Greece	114.59	70.10	-0.21	8.89	27.55	7.21	-45.71	-3.24	8.98	14.75	4.80
Italy	90.81	74.67	0.20	8.31	27.42	-4.73	-48.48	-2.08	6.48	12.68	3.58
Norway	95.64	75.97	1.06	6.11	26.32	-3.71	-17.33	-2.05	8.17	13.02	5.48
Sweden	77.05	81.00	0.36	5.43	30.91	-10.75	-42.64	-2.54	7.74	14.09	5.89
United Kingdom	84.79	83.54	3.52	6.39	29.33	-6.79	-36.79	-3.16	3.83	13.29	4.43
Durbin-Watson	2.03	2.18	2.42	1.99	1.90	1.97	2.10	2.04	2.09	2.04	2.31
1. R2 adj	98.96	99.85	99.59	99.74	99.31	98.87	92.31	99.06	98.86	97.14	97.59

Table 14b.- Results from the pooled model for the different causes of death:"East" analysis: significant variables only, women

	total	cancer_rem	lung	breast	circ_rem	CRB	resp	LDC	ext_rem	traffic	suicide
Cause at T-1	0.29 ***	0.62 ***	0.81 ***	0.64 ***	0.71 ***	0.77 ***	0.53 ***	0.68 ***	0.84 ***	0.57 ***	0.63 ***
GDP x 1000	-17.63 ***	-2.62 ***		0.25 ***	-4.60 ***		4.71 ***	0.05 *	-0.79 ***	0.21 ***	-0.08 *
GINI				0.05 ***					-0.08 **	0.01 **	
EDU	-67.59 ***	1.64 **		0.72 ***	-18.61 ***	-6.27 ***	-3.78 ***	0.32 **	-1.40 **	1.34 ***	-0.59 ***
IND	3.86 **	1.27 ***					0.33 ***	0.06 ***	0.16 ***	0.13 ***	0.03 ***
AG		1.00 ***				-0.49 *	0.44 **	0.09 ***		-0.13 ***	0.01 *
DIV	1.15 ***	0.13 ***	0.04 ***		0.28 **		0.05 ***	0.02 ***	0.03 *		0.02 ***
ALC	8.20 ***	0.37 ***	0.09 ***	-0.04 **	1.47 **	1.31 ***	0.32 ***	0.18 ***	0.33 ***	0.13 ***	0.03 *
URB	3.53 **	0.26 **	-0.04 ***	0.21 ***	1.36 *	0.81 ***	-1.99 ***	0.11 ***	0.41 ***		
AR(1)	0.34 ***										
Fixed Effects											
Bulgaria	743.96	-64.28	2.90	-13.73	167.59	31.39	124.85	-14.73	-19.11	-13.90	5.59
Belarus	830.04	-59.15	1.78	-16.25	184.31	35.95	126.67	-15.58	-11.62	-14.67	6.51
Czech Republic	743.15	-40.35	4.03	-14.38	165.52	17.01	130.31	-15.90	-17.43	-17.61	6.18
Czechoslovakia	799.09	-45.94	3.20	-12.71	174.45	25.35	131.69	-14.82	-14.67	-17.45	6.27
East Germany	730.94	-56.20	2.48	-15.95	177.60	-0.56	151.33	-15.57	-21.90	-18.21	7.25
Estonia	689.21	-39.83	2.04	-14.77	139.06	18.73	96.47	-16.53	-14.81	-13.36	6.18
Hungary	786.64	-29.42	4.86	-8.93	165.09	18.08	115.29	-6.83	-13.26	-14.63	9.45
Latvia	695.95	-39.65	1.76	-14.61	130.00	26.60	103.25	-15.92	-14.91	-11.88	6.67
Moldova	978.14	-53.49	1.87	-9.46	189.90	52.75	84.57	14.68	-5.11	-8.43	5.21
Romania	775.32	-72.56	2.58	-10.49	180.72	46.57	118.41	-6.77	-15.17	-10.11	3.98
Russia	799.31	-52.50	2.35	-17.39	161.32	40.72	140.76	-15.62	-14.87	-15.26	7.21
Slovak Republic	786.44	-47.02	2.51	-11.46	197.58	19.19	107.79	-12.32	-12.04	-16.18	5.13
Ukraine	832.68	-61.39	2.05	-14.72	188.58	40.85	130.55	-14.36	-13.85	-14.71	6.19
Durbin-Watson	2.04	2.25	2.32	2.15	1.93	1.96	2.06	1.89	1.87	1.90	2.12
1. R2 adj	99.32	99.89	99.15	99.56	99.09	98.93	95.12	93.45	98.05	93.96	97.71

7.- Summary and conclusion

The main interest of this paper was to consider the influence of absolute and relative living standards (GDP and income inequality) on mortality differences between European countries and over time, whereby the study was extended to include the effect of other possible variables. Using pooled cross-country and time-series analysis, two groups of countries were analysed: one with Western and one with Eastern European countries. The analytical method determined a single effect for each independent variable by treating time and space as one dimension. The only methodological difference between the two groups of analyses was that certain variables had a different latency period. For instance, GDP was lagged 15 years in the Western European analysis in order to accommodate for possible life course effects that are associated with welfare, while in the East analysis the bivariate analysis showed that no lag was required. This suggests that the recent economic and social transitions have had an immediate impact on the health of the population. The main conclusion that can be drawn from the results is that absolute welfare is by no means the most important factor in causing mortality differences over time and across space, as all variables that were tested showed independent effects, particularly alcohol consumption in Eastern Europe. Moreover, the association between GDP and mortality disappeared or reduced substantially in some instances after controlling for other factors.

The reason for splitting Europe into East and West into two pooled models was due to their long period of diverging political and economic systems between and the simultaneous different demographic patterns. The fact that sometimes latency periods for the same variables were completely different, such as with GDP, comes therefore to no surprise. The direction of the effect of a variable (i.e. health protecting or damaging) for the formulation of the hypotheses and the subsequent determination of a range of possible time lags were a priori determined for each cause of death.

Lagging exogenous variables was in a sense a way to accommodate for life course factors, whereby a large lag suggests that the effect is the result of an accumulation of risk factors and that contextual experiences in the past were important in determining mortality differences between countries and over time. This appeared to be more often the case in Western than in Eastern Europe. Conversely, there were more instances in the Eastern European models where a variable without a latency period observed that the largest association with a particular cause of death. Besides GDP, also sudden changes in alcohol consumption often lead to sudden changes in mortality. This result led to the conclusion that when socioconomic and other variables are integrated in mortality models the optimum latency periods differs according to the political and economic situation of (the group of) countries. While this observation is based on the results for all ages combined (but standardised), the theory of the life course also tells us that certain exposures may be most profound at older ages. This is why the robustness analysis was performed for the most important causes of death by repeating the analysis using the same models for the late working-age population and retirement age as was used for all ages in order to see whether the established associations were different. Results basically revealed that for Western Europe, the age- and cause-specific all-cause models for ages 65+ coincided very well with the models for all ages. For the 45-64 year olds, in general the elasticities of the variables were higher. This last result was particularly obvious for CRB in Eastern Europe and it illustrates the vulnerability of this period in the life course. It also illustrates that links to the life course in macro-level mortality research are best made when causes of death are analysed. Evidently, changes in the cause of death structure of a population implies changes in behavioural, environmental and other disease determinants that are particular to a cause of death. Needless to say, the results presented in this paper can only be linked to the life course in relation to the experiences of a population, not individuals, but this is consistent with the general goal of the research.

Results for Western Europe showed that besides GDP, the proportion of the workforce employed in industry, divorce, alcohol consumption and urbanisation were the most important factors in terms of the number of causes of death where the association was significant. The largest short-term effect in all-cause mortality was for both industrial employment and GDP: a 1% increase would instigate, respectively a +0.04% and –0.04% change in mortality. The long-term elasticity equalled about a third of a percentage point. Urbanisation and education were the variables that showed on average the highest absolute changes in the cause-specific models. Results for Eastern Europe also indicated the importance of GDP and industrial employment, but the variables education and alcohol consumption appeared in more models. Regarding the elasticity of the variables, in the best models for both total mortality and the causes of death, equal changes in urbanisation and education would also bring out the largest deviations in mortality. For total mortality the elasticities were respectively +0.87 and –0.46 in the short term and +1.19 and –0.63 in the long term. In other words, the results demonstrated that similar changes in the exogenous variables would prompt much higher changes in mortality in Eastern than in Western Europe. Given the economic and social instability in Eastern Europe, the uncertainty regarding the accuracy of future levels of mortality will also be higher there.

GDP

Not all cause-specific results of the first hypothesis asserted that increases in welfare generated in lower mortality. Exceptions were lung cancer in the West analysis, as well as prostate cancer and traffic accidents in the East analysis. For prostate cancer, the main explanation given for this anomaly was a selection effect, as this cause of death is related to ageing. A cohort effect might have been the reason behind the result for lung cancer, as the robustness of the model showed that the association was only significantly positive for the 65+ age group. Moreover, while individual level studies clearly show the protective effect of income on lung cancer (Kardaum and Glerum, 1995; Davey Smith *et al.,* 1996), it is possible that between countries other factors are more important. The positive association between GDP and traffic accidents was likely to be due to the fact that in Eastern Europe cars are still a luxury product for many people and therefore in the more wealthy countries or times, there were more cars and subsequent fatal accidents, in which case it is still an example of a welfare disease.

Regarding total mortality as well as remaining external mortality and traffic accident deaths, the association between GDP and mortality was quite independent of other factors in the models for both Eastern and Western Europe. Among the other models, the variable that confounded most often was alcohol consumption. Perhaps somewhat surprisingly, the proportion of industrial employers had little effect on the association between GDP and mortality in the cause-specific models of Eastern Europe, even though this sector lost many employees after it began operating on market forces. Perhaps due to the incorporation of a time lag there were insufficient time points to affect the GDP-mortality association, while country-differences before the transition were minimal.

Income inequality

In both the Western and Eastern European analysis, the relative income hypothesis did not hold in the models for total mortality and lung cancer, but was significant in several other models, namely remaining circulatory system diseases, LDC and suicide. As each of them has been linked with psychosocial elements in the context of income- or socioeconomic-inequality (respectively, Hemingway and Marmot, 1999; Lynch *et al.*, 2001; and McLoone and Boddy, 1994), it is perhaps not surprising that precisely income inequality was significant in these models, because "relative income involves inherently social elements in the causal processes …[, that is, of your circumstances] in relation to others: of where they place you in the overall scale of things, and of the impact which this has on your psychological, emotional and social life" (Wilkinson, 1996). Ironically, McIsaac and Wilkinson (1997) reported that suicide tended to be more common in more egalitarian countries, but they did not consider a latency period for income inequality before it can have an effect on mortality. As both Table 6 and Blakely *et al.* (2000) suggest, a contemporaneous effect seems unlikely. While the direction of the established associations were all consistent, its absolute effect on mortality was low, as often other, related factors (GDP, industrial employment, education) were also significant.

In terms of age-differences, the effect of income inequality on circulatory system diseases was strongest for the oldest age group in both Europe's. As the measurement is derived from income acquired among the working-age population and could only be lagged 5 or 10 years, it cannot be fully associated with the accumulation of specific cardiovascular risk factors over time that are associated with income inequality, but may be a better reflection of the effect of country differences in social inequality.

Share of secondary sector employment

The initial premise that the share of industrial workers in the employment sector is an important independent variable that causes mortality differences over time and between countries appears to be affirmed for Western Europe with regard to total mortality, lung cancer, both categories of circulatory system diseases, traffic accidents and suicide, in which the specific causes of death comprised about 56% of total mortality. Although the effect of differences and changes in exposure to occupational hazards could not be tested, other known risk factors such as smoking or alcohol consumption did not explain this result. In the case of remaining cancer, respiratory system diseases and remaining external causes (18% of total mortality), differing levels of GDP partly explained the bivariate association between the proportion of industrial workers and mortality, as the decline in the importance of the industrial sectors was offset by new, expanding and more value-adding service sector industries. Hence, these mortality differences were in part the result of wealth differences that emanated from structural differences rather than the structural differences themselves. For instance, in search for a higher return on capital investment, industries such as mining have become more efficient, but at the same time also safer, which has led to a decline in the incidence of work-related mortality from (respiratory) diseases and external causes.

In the Eastern European analysis, on a number of occasions it was education that caused the seemingly positive association between industrial employment and mortality to disappear. The fact that this included both categories of circulatory system diseases could acknowledge the fact that also at the population level, "education may reflect the function as an index of socioeconomic circumstances in early life", as was found in a Scottish prospective observational study (Davey Smith *et al.*, 1998). Although results from a Scottish epidemiological study might appear to have little in common with a macro-level cross-national study, when compared to average Western European standards of welfare both areas are more deprived. Given the results for the other causes of death, also in Eastern Europe, structural changes in the economic sector influences the level of mortality.

The robustness analysis showed that regarding the most important diseases with the exception of lung cancer, the effect of industrial employment was stronger for the age group 45-64 than for those who were retired, but as there was some consideration for a latency period, the risks of living in an industrial society, as opposed to a post-industrial society, continue after retirement age. The result for infant mortality also suggests that infant socioeconomic status, as indicated by the economic structure around the time of death, is also a health determinant at the population level.

Unemployment

While little doubt is cast about the fact that unemployment increases the risk of ill health of an individual from a wide range of diseases (Martikainen, 1990), at the population level the effect of unemployment on mortality is minor, as seen by the lack of significance or otherwise low elasticities. This is because the low level of unemployment in the Western European countries that were studied (with a lag of 15 years only an average of 3%) a very high relative risk is needed to have some bearing on international mortality differences or changes over time. However, given the increases in unemployment since the 1980s and its recent emergence in Eastern Europe, unemployment is likely to become a more important factor. To illustrate this for Western European with LDC mortality, i.e. the cause of death that showed the highest elasticity for unemployment, but restricting ourselves to ages 45-64 and the period after 1988, the short term elasticity increases from 0.01 to 0.07 and the long term from 0.10 to 0.36.

Education

The results pertaining to the hypothesis that considered the role of education in mortality differences in Western Europe demonstrated that education had a distinct association independent of the other interrelated socioeconomic factors GDP, income inequality and unemployment, particularly in the external cause-of-death models. In each case education appeared to have a protective effect. On the other hand, while education was a significant factor in all but two of the Eastern European models, on four occasions the association was positive: for remaining cancer, prostate cancer, LDC, and traffic accidents. As the first and last of these cause-of-death categories are related to welfare (smoking among the elderly and car ownership are still more common among the higher echelons of society), it appears that in the Eastern European context, education approximates personal material circumstances more than in the West. However, the importance of education as a health-promoting factor in Eastern Europe was also very much evident, as a 1% increase in education would produce a much higher reduction in remaining circulatory system diseases, remaining external causes and suicide as well as total mortality than GDP. The cause-specific results also suggest that in Eastern Europe more than in Western Europe, different socioeconomic factors cannot be used interchangeably. It seems therefore that they reflect different aspects of the life course, because "the health effects of occupational hazards in unskilled manual jobs depend directly on work conditions and reducing socioeconomic differentials consequent on such exposures requires changes to work environments. Conversely, health differences according to level of education have been attributed to the direct effects of education, including the acquisition of knowledge regarding health-damaging behaviours" (Davey Smith *et al.*, 1998).

Pollution

The pollution hypothesis could only be tested in the West analysis and the only result worth mentioning is that of respiratory system diseases, because the elasticities for pollution in the total mortality and lung cancer models were very low. Although respiratory system mortality has recently ceased to decline in most countries, it is uncertain if it will rise again in the near future. This is due to the continual decline in SO2 emissions since the 1980s in most Western European countries, combined with the knowledge that it takes a long time before it has a large health effect on a population. However, the time trend and population effect of other air pollutants known to cause respiratory system diseases, in particular small particles Katsouyanni *et al.* (1997), will need to be investigated. Although no test was done for Eastern Europe, the continuing decline in pollution in Eastern Europe should protract the convergence of respiratory system disease mortality within Europe.

Divorce

Hypothesis 6 confirmed that social factors also play a role in explaining the differential mortality in Europe over time and across space. While mortality has been declining in Western Europe between the late 1970s and late 1990s, the level of divorce has seen a steady increase. Results of the analyses showed that divorce had a detrimental effect on health, as it was significant in the models of most of the selected causes of death, including total mortality. Therefore, in countries where divorce is still a recent or minor phenomenon, such as in southern Europe (particularly when we incorporate the ten-year time lag) continued increases in divorce are likely to have an impact on future levels of mortality. Results of the analysis also showed that the magnitude of the effect of divorce was larger in Eastern Europe than in the West. If this measurement for divorce were also an indicator for psychosocial stress in a country, it would be consistent with the current literature on explaining East-West mortality differences. Several studies have shown that the psychosocial risk profiles such as self-esteem, coping sense of coherence, social support, control over work (Kristenson, *et al.*, 1996) and self-rated health[16] (Bosma and Appels, 1996) in Eastern European populations are worse than in the West. The fact that

[16] Self-rated health could be regarded as an indicator of psychosocial conditions when we consider that psychosocial conditions were the most important intermediary factors in the explanation of marital status differences in self-reported morbidity among men (as opposed to material circumstances among women) in the results of different studies (see Joung *et al.*, 1996).

the highest effect for divorce in the cause-specific models of Eastern Europe was found for suicide also lends support to this.

Smoking

As expected, the results of this hypothesis confirmed the negative effect of smoking on health with respect to most major causes of death. Although most countries had their smoking peak around 1980, towards the end of the 1990s country differences were just as large as in 1960. Given the time delay that it takes for smoking to have a fatal impact on health, it is expected that smoking will continue to be an important factor in mortality differences between countries in Europe well into the 21^{st} century. While no smoking analysis was performed for Eastern Europe, the literature also shows large differences in smoking and smoking-related mortality within Eastern Europe and that smoking is the most important contributor to the East-West middle-age male mortality divide (Pajak, 1996; Bobak and Marmot, 1996). Moreover, smoking prevalence rates among men in Western Europe started to decline at an earlier time period than in Eastern Europe, as the post-war popular health movement hardly reached the Eastern media (Guo, 1993), which makes smoking an indispensable factor for future international comparative mortality research.

Alcohol

The first of the two hypotheses pertaining to the effect of alcohol considered its long-term effect on total mortality and remaining circulatory system diseases. The Western European results revealed that alcohol is an important factor in the prevention of heart disease, but the long-term effect on total mortality is indifferent, perhaps because alcohol has a detrimental effect regarding most other causes of death. In the preliminary analysis for Eastern Europe, results showed that the largest association between alcohol and both total mortality and remaining circulatory system mortality occurred without the introduction of a time lag and the association was positive rather than negative. The health-damaging effects of alcohol were confirmed in each of the saturated models, thus implying that this hypothesis did not hold for Eastern Europe. The fact that alcohol had such an immediate and strong positive association with most causes of death in Eastern Europe suggests that some underlying factors instigated this pattern. Moreover, the alcohol variable was also the only variable that was statistically significant in each model for which it was tested (it is not a known risk factor for prostate cancer). So why did the hypothesis that tested the long-term effect of alcohol not hold for Eastern Europe and why is the evidence not to reject the subsequent 'short-term' hypothesis so overwhelming? Unfortunately, there were no data on consumption patterns of alcohol, but this is likely to be more uniform than in the West. In the southern countries of Western Europe, alcohol is usually consumed on a regular basis and in moderate amounts, which is thought to reduce the risk of IHD, while particularly in the Nordic countries alcohol is consumed less frequently but when consumed this is done in larger quantities (i.e. bingeing). This pattern of consumption is also found in Eastern Europe (Bobadilla and Costello, 1997). As it has also been established that binge drinking elevates the risk of sudden IHD (*ibid.*; Britton and McKee, 2000) it seems that in the case of Eastern Europe, at least at the macro level, only the negative health effect was observed[17]. Regarding CRB, where deaths are known to take place within several days after a drinking session, the results for both Europe's were similar. In fact, regarding the short-term effect of alcohol, for all but lung cancer, alcohol consumption proved to be significantly detrimental to health in Western Europe. Thus, this research has shown that at the population level in Western Europe, there are two types of associations between the consumption of alcohol and mortality: positive in the short/intermediate term and negative in the long term. In the case of Eastern Europe, the main effect of alcohol consumption on mortality is contemporaneous and positive. These considerations should be made when alcohol is used to predict future levels of mortality and although the results were clear and consistent, the inclusion of drinking patterns would benefit the accuracy of the results.

Fruit and vegetable consumption

Differences in fruit and vegetable consumption over time and between countries in Western Europe not only exhibited a significant independent association with total mortality, but in particular with cancer after taking the other variables into account. While the results suggests that the macro results agree with epidemiological evidence, more significantly for future mortality projections is that this dietary factor was important in the

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[17] Even if in the saturated model for remaining circulatory system diseases (that mainly contains IHD) a second variable for alcohol is incorporated and lagged 15 years to accommodate for possible protective effects, it showed no association with mortality. The other coefficients barely changed.

model for total mortality. This means that there are more health gains to be made in the west and north of Europe, as they still lag behind in consumption compared to southern Europe (Table 1). This of course applies even more to Eastern Europe and the former Soviet Union. One of the legacies of the old Soviet system has been a diet developed through decades of food and nutrition policies that were very high in fat content and rich in animal products. From the 1960s, consumption of meat and diary products were enhanced by the increased supply that were partly due to large subsidies, which effectively dampened the production of root crops (e.g. potatoes), vegetables and grains that formed an important part of the traditional diet (Popkin *et al.*, 1997; Pearson and Patel, 1997). As the association between the consumption of animal fat and specific diseases including IHD and breast cancer have been clearly established, it is imperative that subsidies and production quotas for high-fat foods are eliminated and replaced by subsidies and production quotas for grains and fruits and vegetables (*ibid.*). While the removal of trade barriers more than 10 years ago could have provided greater access to healthy alternatives, consumption patterns changed little during the 1990s.

Government health expenditure

The last hypothesis, which could only be tested with the Western European data set, stated that government health expenditure has a negative effect on mortality. Although four causes of death indicated a negative association, the effect of health care expenditure on mortality was not very large. The highest elasticity was recorded for traffic accidents and a possible explanation for its independent association with health care expenditure is the improvement that has been made in pre-hospital care (Mock *et al.*, 1998). Perhaps paradoxically, researchers consider road safety programmes to be ineffective, although policy makers advocate it (O'Neill and Mohan, 2002).

Room for improvement

Unfortunately, the time series were far from complete for the majority of economic and other indicators that were used. For this reason, missing years were estimated, usually linearly interpolated, but the method was nevertheless quite arbitrary as they were mainly based on the author's perception of the trend (see also Spijker, 2002). Although in most instances the significant associations that were established in the main analyses were in the right direction, the reliability of the coefficients can be improved if the quality of some of the data is also enhanced.

Before pooled cross-country and time-series analysis was used to ascertain the importance of GDP and other factors on mortality, several obstacles had to be overcome. The method of determining the right time lag, for example, was partly decided by theoretical reasoning and partly constrained by the limitations of the data. For instance, due to the short range of several time series, in particular the employment, smoking and dietary variables, the best latency periods are likely to be longer. Moreover, lags were chosen on the basis of a 'bivariate' model that consisted of mortality at time t-1, the tested variable and when needed, an autoregressive term. If instead each time the complete model was employed, a more accurate or optimal lag may have been found, but this would have been a far more laborious process. Nevertheless, often the established bivariate associations was in the same direction as in the complete models and when this was not the case, it gave reason to ascertain the confounding factors. More importantly though, with an eye on possible future use of these results, it showed how imperative it was to include time lags in this type of macro mortality analysis. When studying specific diseases, this exercise should be repeated for different causes of death as well as age groups. For instance, pollution is a relevant factor to consider when studying infant mortality (Bobak and Leon, 1992), but it should not contain the same time lag, if one at all, as in a study of old-age mortality. Moreover, it is also important to consider the conceptual differences between, say an employment variable lagged 10 years when studying mortality between the ages of 1 and 44 or late working-age mortality. This is because results of the first analysis could signify effects of socioeconomic circumstances during childhood, while the second might tell more about adulthood status. The analyses presented here did not address this aspect because, with the exception of the test of robustness at the end, only all-age mortality was analysed. However, from a theoretical perspective and for projection purposes it would be appropriate to produce separate models for different age groups. This argument could also be made for performing a more detailed analysis for women, as in both cases more knowledge will be gained on how health determinants behave at the population level. We have already seen that although the proportion employed in industry has an effect at each of the four age groups that were analysed for total mortality, the highest effects were found for infants and the 45-64 year olds. The former result was clearly related to (pre-)childhood contextual circumstances, while the latter more with (stress) factors associated with employment. In particular the 65+ group could be split up in order to see up until what age during retirement the effect of past economic structure has an effect on health. In this way, more insights will be gained into the age, cohort and time components of life course influences. Likewise, it will also be useful to analyse different European macro-regions and/or countries with similar mortality regimes or even specific countries separately. Although we would not be able to ascertain certain differences within macro-regions (for example, dietary patterns may be too similar between southern European countries), it will provide more accurate information on the variables that were responsible for the change in mortality over time for specific (macro) regions. There are of course also time-specific changes or transitions, which may have a long- or medium term influence on the mortality pattern, as we have recently observed in Eastern Europe. Something that is also important for future projections is that the model is robust over time. For instance, it could reveal that certain variables are associated with mortality differences in Eastern Europe irrespective of the transition period since about 1990. This was not done here, as under the used specifications the model normally did not converge.

The interpretation of the results can also be improved by separating the time and cross-section effects of the significant variables. It is possible that the effect of GDP on mortality was more the result of an association between GDP and mortality over time, than between countries irrespective of changes over time. Although such an analysis would improve the understanding of how certain health determinants may cause international differences in mortality, it was in this research neither imperative nor possible with the statistical application that was used. To some degree provided the fixed effects did give some indication as to whether country-specific elements were well represented in the variables. The different values and even direction of some of the coefficients between the bivariate analysis and the complete model signified the importance of including a wide range of variables. Nevertheless, the list of variables was by no means exhaustive. In particular, it lacked indicators of psychosocial stress other than divorce, such as measures of self-esteem, control over ones work, or the number of stressful life events, which might explain some of the remaining differences in mortality or invalidate several established associations. For instance, it is thought that such factors are partly responsible for the East-West mortality differences (Bobak and Marmot, 1996; Kristenson *et al.*, 1998). It may also be worth while exploring the effect of several other dietary factors on changing mortality patterns. There is evidence that mortality from IHD in developed countries strongly correlates with past levels of animal fat consumption and serum cholesterol (Law and Wild, 1999). In fact, it may explain the French paradox as "the low mortality from IHD reflects the earlier low levels of complete fat consumption, for which wine is simply an indirect marker – a confounding factor" (*ibid.*). The lagging of dietary factors was crucial in this result, as its maximum effect on heart disease risk was at least 25 years, a lag that could not be utilised in the analyses presented here. This also applies to the other variables with relatively short time series.

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