PERGAMON

Social Science & Medicine 50 (2000) 1047–1058

SOCIAL SCIENCE & MEDICINE

www.elsevier.com/locate/socscimed

Widening inequality in mortality between 160 regions of 15 European countries in the early 1990s

Mary Shaw*, Scott Orford, Nicola Brimblecombe, Daniel Dorling

School of Geographical Sciences, University of Bristol, Bristol, UK

Abstract

This paper presents maps of geographical patterns in mortality for the 160 mainland regions of the 15 countries of the European Union. Standardised mortality ratios (SMRs) for all ages are presented for all causes of death and for lung cancer, ischaemic heart disease, road traffic accidents and suicide. All cause standardised mortality ratios (for deaths under the age of 65) for the years 1990 and 1994 are presented. These data show that while most regions of Europe had decreasing SMRs over this time period, SMRs increased for the 10% of the population with the highest SMRs and the gap between the most and least healthy regions grew. Possible reasons for the observed patterns, the limitations of currently available data and the limitations of studying nation states, are suggested. © 2000 Elsevier Science Ltd. All rights reserved.

Keywords: SMRs; Chronic disease; Inequalities; Europe

Introduction

Most studies of variations in mortality within Europe focus on the role of socio-economic factors rather than geographical disparities at the subnational scale. A major contribution to research in this area has been made by Kunst and Mackenbach (see for example Kunst and Mackenbach (1994a,b) and Kunst et al. (1998a,b)), who have looked at socio-economic differences (measured by educational level, income and occupational class) in mortality in various European countries and also the United States. For example, in Netherlands, Sweden, Denmark and Norway, inequalities in mortality have been found to be relatively small, but in the United States, France and Italy they are found to be twice as large as the average; intermediate positions are held by Finland and England and Wales (Kunst and Mackenbach, 1994a). Having considered data from various sources and at various time points Kunst (1997) finds socio-economic differences in mortality, whether by income, occupation or educational level, to be a variable but persistent phenomenon.

In the search for explanations of the variations in mortality between countries the work of Wilkinson (1992, 1996) has led to a focus on income distribution — which has been found to be closely related to average life expectancy, such that a country with a more equal distribution of income has lower national mortality ratios, whereas a country with a more unequal distribution of income has higher national mortality ratios. As Wilkinson states (1996, p. 212):

> Income distribution has been shown by eight different groups of researchers to be related to national mortality rates in various groups of developed and

* Corresponding author.
E-mail address: mary.shaw@bristol.ac.uk (M. Shaw).

PII: S0277-9536(99)00354-8

less developed countries on ten separate sets of data.

Others have also reported similar findings (Duleep, 1995), although the role of income inequality has recently been questioned by Judge et al. (1995) and Judge (1998). Judge highlights the different measures of income distribution used in different countries and shows that when this relationship is considered in the "most rigorous way possible" the results do not support the proposition that income inequality is a significant determinant of average population health in rich industrialised countries (Judge et al., 1995, p. 572); rather than supporting a monocausal explanation of mortality, Judge suggests that we should be open to the role of many influences which interact over long periods of time (Judge, 1998).

A second factor which has received much attention in the study of variations in mortality between countries is the role of the differential provision and effectiveness of health services, although there is debate regarding the extent of the effect on health. Some researchers report that inequalities in health service provision can account for at least some regional variations in health outcomes (Paci and Wagstaff, 1993). Vagero (1994) contests that service provision must be considered across all European countries if inequalities are to be reduced. However, others have found that in industrialised countries health services do not play an important role in producing or reducing health inequalities. For example, Keskimaki et al. (1995) assert that while there are clear inequalities in mortality in Finland the distribution of health services in Finland is relatively equitable; Haynes (1991) found few regional differences in health service use in the UK despite clear regional variations in self-reported morbidity. Having reviewed 11 aggregate data studies on avoidable mortality and health services Mackenbach et al. (1990) conclude that geographical variation in mortality from causes amenable to intervention has not been shown to reflect differences in health services, rather, they are more closely related to socio-economic factors. The fact that in Britain there are significant and widening geographical inequalities in health (Dorling, 1997) and that Britain has some of the widest regional variations in health in Europe (see below), despite the universal provision of health services which have been free at the point of delivery for the past 50 years, detracts from the hypothesis that health services play a major role in health inequalities.

Other comparisons of patterns of mortality in European countries have focused on specific causes of death, particularly those which account for large proportions of overall mortality or are considered particularly amenable to medical intervention. For example, Leclerc (1989) looked at differences in mortality (in male unskilled workers) between various European countries from cancer, cardiovascular diseases, accidents, respiratory diseases and cirrhosis. Other studies of cancer rates include that by Dickman et al. (1997) which compared rates of various cancers in Nordic countries (Denmark, Finland, Norway and Sweden); Franceschi et al. (1994) have reported on rates of cancer over the time period 1955–1989 in 24 European countries. Levi et al. (1995) looked at rates of 23 types of cancer in 35 countries of the WHO European region for 1990–1992; substantial variations were found. Lung cancer rates were high in Belgium, and low in Sweden and Norway. Negri and La Vecchia (1995) have also looked at trends in lung cancer, reporting upwards trends for males in Southern and Eastern Europe and rising rates of lung cancer for females in all countries. Comparisons of death rates for other causes of death have also been considered, including ischaemic heart disease (IHD) (Tuchsen et al., 1996), suicide (La Vecchia et al., 1994a) and road traffic accidents (La Vecchia et al., 1994b).

However, regional variations in mortality in Europe have hitherto received little analytical attention, despite publication of atlases of regional variation (e.g. WHO, 1997). Studies have mostly been confined to comparisons of regions within a single nation. For example, Amouyel et al. (1994) looked at case fatality rates for myocardial infarction in three regions of France (noting few differences). Luppi et al. (1995) have produced an atlas of mortality in Italy at the small area level in order to identify clusters of disease and high risk areas. De Angelis et al. (1996) looked at the incidence of stomach cancer in Italian regions, finding a marked tendency towards reduced geographic heterogeneity, which they suggest may be related to observed changes in dietary habits. Rodriguez Artalejo et al. (1996) looked at regional variations in IHD mortality within Spain. Van Oyen et al. (1996) report substantial regional variations in mortality and healthy life expectancy in Belgium.

In Britain there is a particularly strong tradition in investigations of regional mortality differentials which goes back more than a century. Many researchers have found that mortality rates are highest in the north and in Scotland and lower in the south (Townsend and Davidson, 1982; Howe, 1986; Britton, 1990; Strachan et al., 1995.) Moreover, there is evidence that these differences have been widening in recent years (Britton, 1990; Dorling, 1997). Langford and Bentham (1996) also report that there are persistent regional variations in mortality in the UK, with generally higher mortality in the North and West, and note that only some of this variation can be explained by regional variations in social deprivation and area type.

However, there are very few published studies which compare regions across Europe. Jozan (1989) reviewed

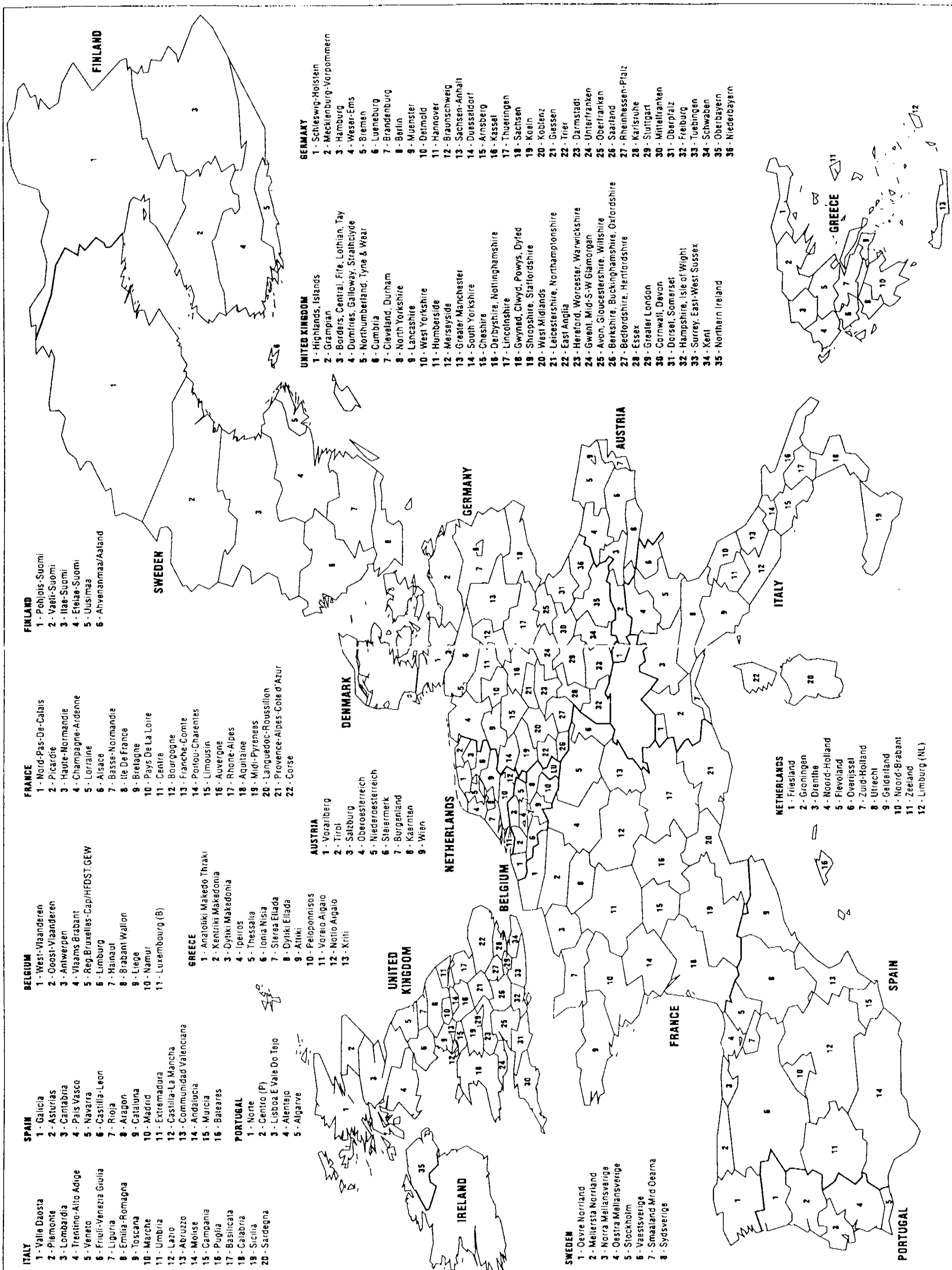

Fig. 1. The European regions.

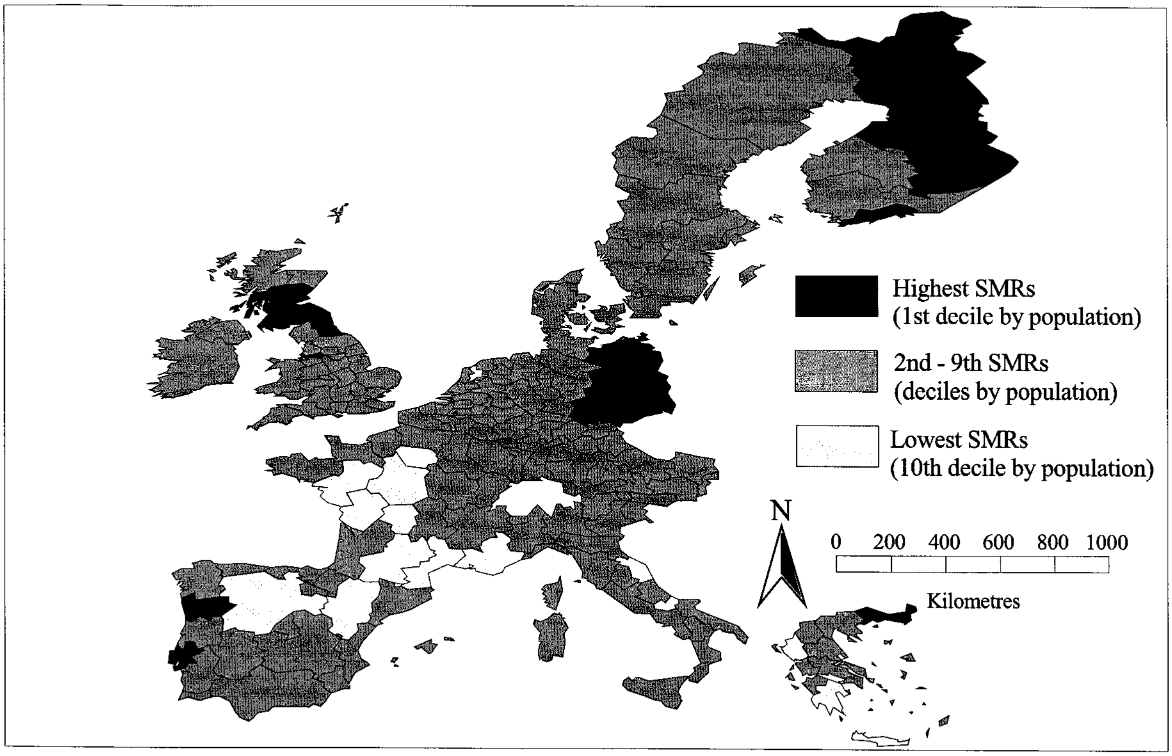

Fig. 2. Standard mortality ratios for all causes of death by population deciles.

both data and published papers available on regional data from various European countries, but no comparison of the regions within and between different countries was made. The European Community Atlas of Avoidable Deaths (Holland, 1993) is an invaluable resource which includes data on mortality by small areas (368 administrative areas). However, only certain causes of death are included (with a view to comparing and monitoring the effectiveness and performance of health services) and differences are described rather than explained or quantified. Using data from an earlier edition of this atlas and Eurostat data, Mackenbach and Looman (1994) looked at mortality and living standards (measured by GDP, car ownership and unemployment) in 133 regions of the 12 countries of the EC. After controlling for confounding variables (such as urbanisation and industrialisation) they found that unemployment had the strongest effect upon mortality. However, this data refers to mortality for 1980–1984.

Comparing mortality at the regional level in Europe has a number of advantages and implications. The areas being compared would generally be of a more similar size (in terms of population) than when country comparisons are made, and the areas will be more homogenous (in terms of socio-economic composition and environmental factors). The number of observed deaths in each region will still be large enough to keep confidence limits extremely small and therefore allow meaningful comparisons.

As Kunst (1997) points out, despite a number of methodological and analytical issues (such as the problem of the 'ecological fallacy') ecological studies are a valuable source of information when individual-level data are not available; when this is the case area data can be a useful proxy socio-economic indicator (Blaxter, 1989). Moreover, area level variations have policy implications and relevance when they coincide with administrative boundaries.

Most importantly, studies which compare nation states are more likely than others to suffer from the ecological fallacy (Dorling, 1991), even when longitudinal individual data are used. This is because, at the most basic level, these studies are comparing the population of countries and countries are not necessarily comparable. For two population groups to be compared in a meaningful way the variation between the two groups should be larger than that within them. The groups should, preferably, be of a similar size and should be defined using objective criteria. None of these conditions hold when comparing nation states

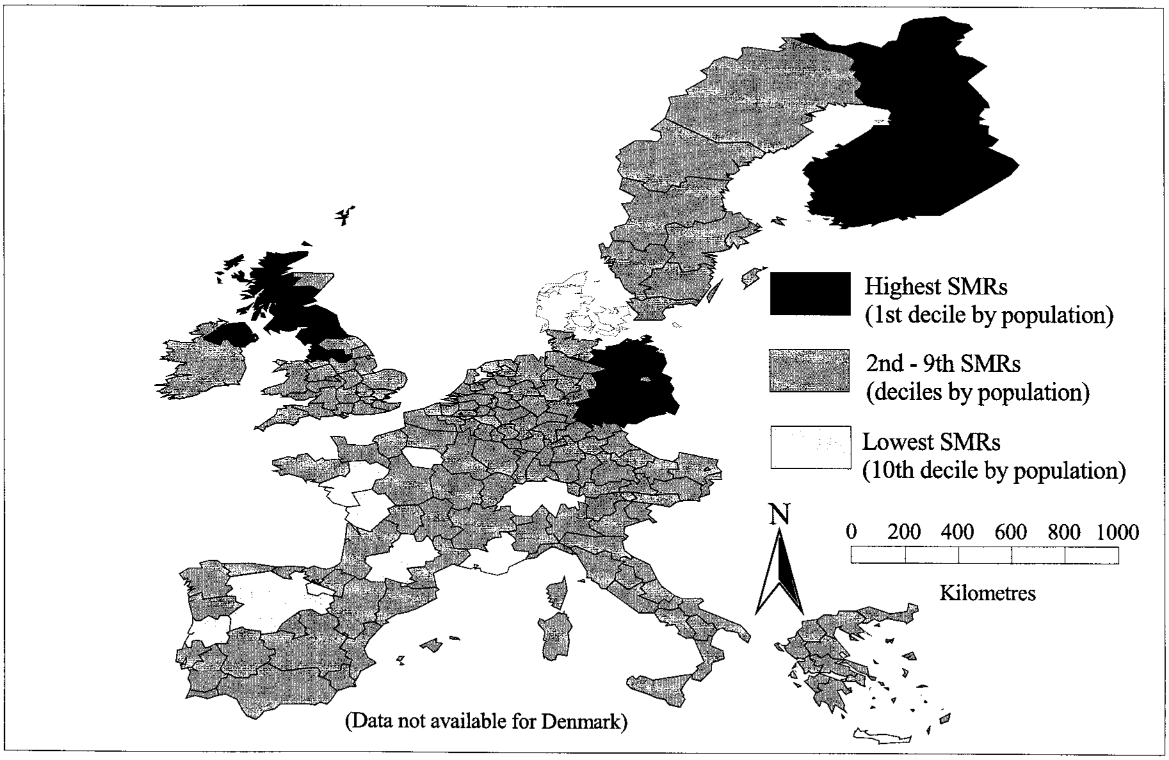

Fig. 3. Standardised mortality ratios for ischaemic heart disease by population deciles.

(which are highly heterogeneous and vary greatly in population size).

The aim of this paper is to make a preliminary investigation of European mortality data at the regional level in order to explore and suggest possible avenues for future research. The initial analyses presented here compare all cause mortality and rates for four specific causes of death with rates in Britain (specifically those highlighted as priorities in the recent government policy document, DoH, 1998) and we also consider whether the spatial polarisation of mortality recently observed in Britain (Dorling, 1997) is also apparent on a broader scale across Europe.

Method

Mortality data for this study were obtained from Eurostat via the Resource Centre for Access to Data for Europe (r.cade) based at Mountjoy Research Centre at the University of Durham (Eurostat, 1995a). The data refer to the 15 European Union member states: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the UK. Mortality data for all countries are coded according to the 9th edition of International Classification of Diseases (WHO, 1977). Population data, derived from national population censuses and surveys, were also obtained from r.cade (Eurostat, 1995b). Standardised mortality ratios (SMRs) are calculated by the indirect method using the following age groups: 0–4, 5–9, 10–14, 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84 and 85 and over; SMRs were standardised using death rates (for males and females) for England and Wales for 1990, 1991 and 1994. This form of standardisation was specifically chosen so that the rates and variation in mortality could be compared with results for Britain. It is likely that standardising to the European rates would produce a somewhat different picture.

Data are analysed at the NUTS 2 (Nomenclature of Statistical Territorial Units) level, which are generally provinces, ‘Regierungsbezike’ (German regions), or groups of counties, for example, Herefordshire and Worcester and Warwickshire in the UK. The base map, showing the regions of the nations of the European Union included in the analyses is presented in Fig. 1. The following non-mainland areas included very small numbers of observations and were thus excluded: Ceuta y Melilla and the Canary Islands (Spain); the Departments d’Outre Mer (France); the

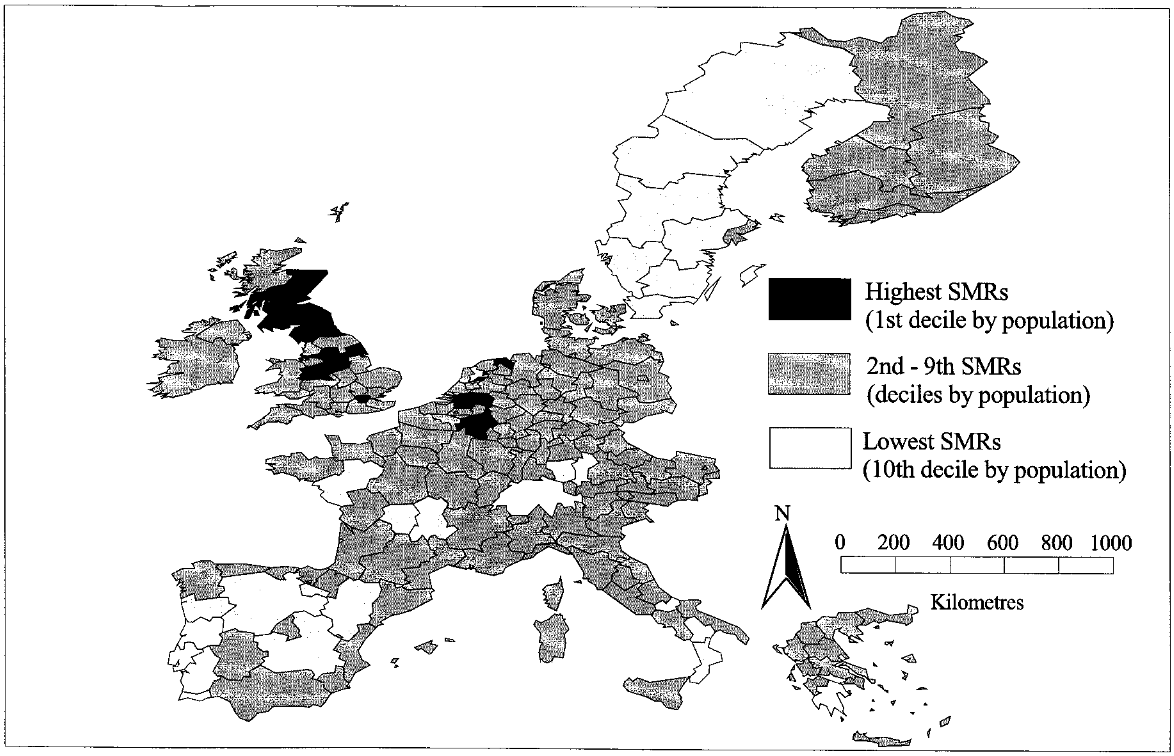

Fig. 4. Standardised mortality ratios for death from lung cancer by population deciles.

Azores and Madeira (Portugal). For the former East Germany, data for the regions Dessau, Halle and Magdeburg were not available and so these regions were amalgamated into Sachsen-Anhalt.

The first set of maps (Figs. 2–6) use mortality data for men and women of all ages. The mortality data used are for 1990, except where, due to omissions in the Eurostat data, approximations are made: Spain, UK (1991); Luxembourg, Netherlands, Portugal (1992); Denmark, Germany and France (1993). Data for Ireland are from 1991 with the exception of deaths from IHD, which are for 1992. Data on IHD are not available for Denmark for any year. Road traffic accident (RTA) data from Scotland were not available in this dataset. The total number of RTA deaths in Scotland in 1991, according to the General Register Office for Scotland, was 506, but this is not given for regions. In Road Accidents Great Britain (RAGB) (HMSO, 1991) the total number of deaths given is 487 (a difference of 4%); as this data is presented by region this source is used. The RTA figure for Northern Ireland is also from the RAGB (1991) data.

The population data for this first analysis are from 1990, except for the following: Ireland, Spain, UK (1991); Belgium, Luxembourg, Netherlands, Portugal (1992); France (1993); Denmark, Germany (1994) which are used in order to be comparable with the regional mortality data available for those countries.

The second set of maps (Figs. 7 and 8) use mortality data for men and women for deaths under the age of 65. Data from two years, 1990 and 1994, are used. For the 1990 calculation all mortality data are for 1990; all population data are from 1990 with the one exception of Portugal where the population data are from 1992. For the 1994 calculation all mortality data are from 1994 with the exception of Italy (1993). Population data are all from 1994. Due to missing data, Germany could not be included in this analysis.

Results and discussion

Figure 2 shows the regions of Europe where standardised mortality ratios (SMRs) are highest and lowest for all ages and for all causes of death in the early 1990s. In order to compare the SMRs in the various regions the population of Europe has been divided into deciles. Thus the dark areas on the map are the regions where 10% of the total population of the European Union have the highest SMRs, ranging from 111 to 127. The SMRs for the tenth of the population with the lowest SMRs by region (lightly shaded) range

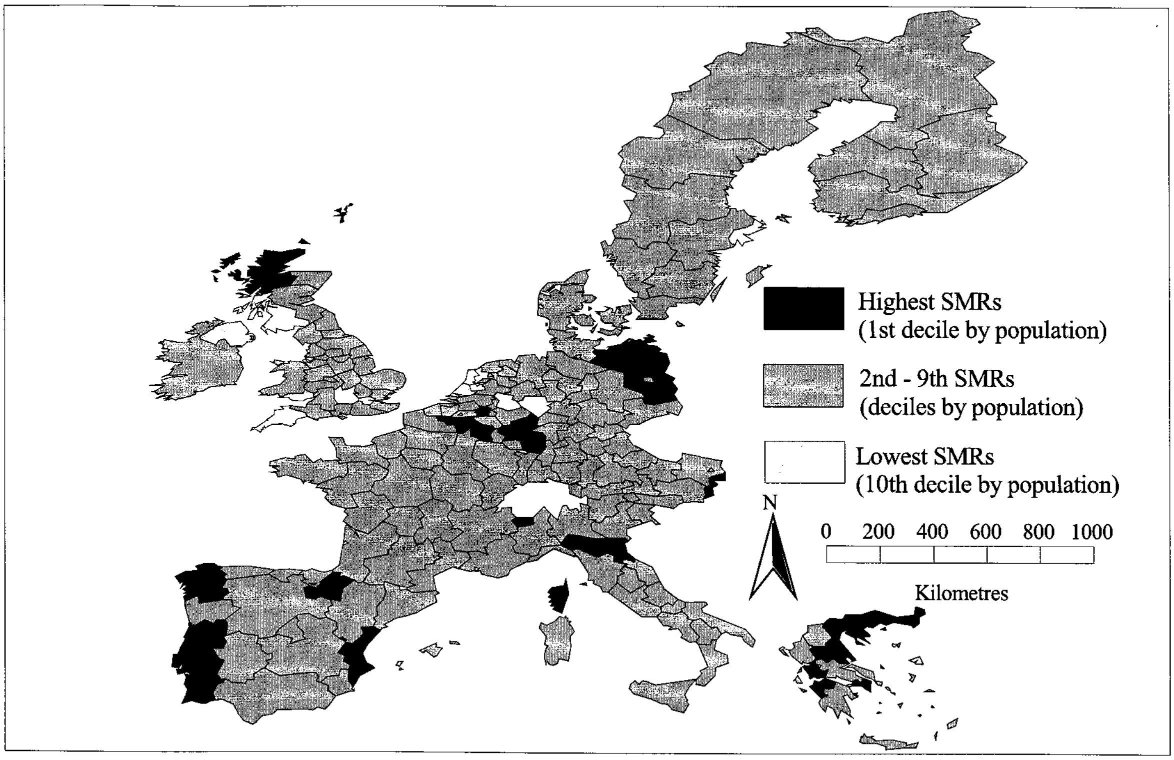

Fig. 5. Standardised mortality ratios for road traffic accidents by population deciles.

from 77 to 85. It is interesting to note that Greece has regions in both the highest and lowest deciles. This implies that when SMRs for countries as a whole are compared the variation within countries may be very much greater than the variation between countries.

Figure 2 indicates that the highest SMRs in Europe are found in regions in Northern England and the industrial belt of Scotland and that these areas are most comparable to East Germany. Other areas in decile 1, in Finland, Portugal and Greece, are peripheral areas containing only a small percentage of the total decile population (the areas of the UK in decile 1 account for 28.4% of the total population on the decile; those in Germany account for 46.2%). Rates are lowest in regions of southern France, but note Fig. 8 which shows change (in SMRs under 65) between 1990 and 1994 indicating that standardised mortality has increased most in these areas.

Figures 3–6 show data for the same time period, for men and women, but for certain causes of death (those highlighted in the recent public health policy plans of the UK government, DoH, 1998). Figure 3 indicates that IHD underlies much of the overall mortality picture. Valkonen (1987) noted a regional pattern of IHD in Finland (with rates being high in the east and low in the west). While region of birth was found to be more important than current location in predicting IHD it was noted that the explanations for the regional variations observed were not well known.

Figure 4 shows that lung cancer partly accounts for the high all cause SMR in the UK, but not in Germany. This corresponds with the findings of Levi et al. (1995) who noted that Scotland has the highest lung cancer rates for females in the world. Rates of lung cancer are low in Scandinavia, and, somewhat surprisingly (given levels of smoking), in Southern European countries. Lung cancer has been shown to vary according to lifestyle (predominantly through smoking), occupational and environmental aspects, diet and others factors, all of which can vary greatly by region (Kubik et al. 1993) and may explain this pattern. However, as seven of the eight regions of Sweden are in the decile with the lowest SMRs this suggests that it may be interesting to look at the diagnosis and coding of lung cancer in that country; Holland (1993) suggests that some of the variation in mortality between countries and areas may be due to variations in data collection and certification of deaths.

Figure 5 shows that rates of road traffic accidents are high in remote, rural or mountainous areas in Greece, the Highlands of Scotland and the Italian Dolomites. This may be a 'conurbation effect', reflect-

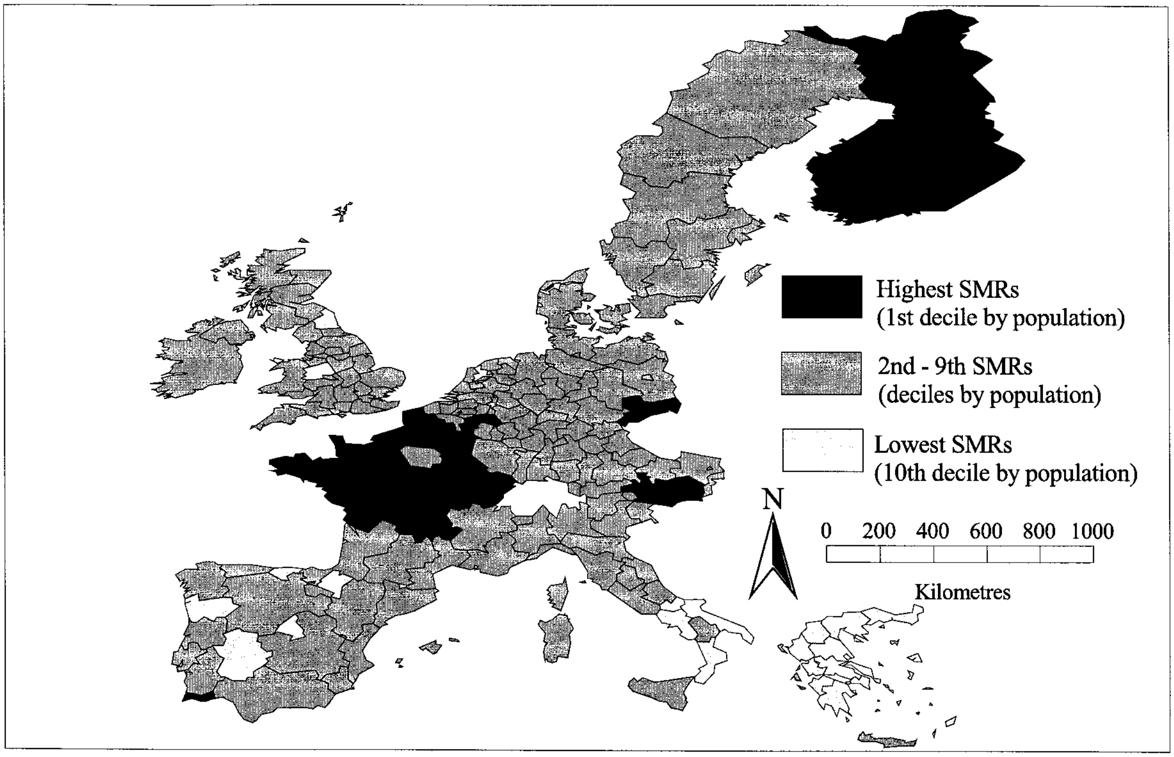

Fig. 6. Standardised mortality ratios for death from suicide by population deciles.

ing the importance of distance to hospital, but it is also the case that the coding of RTA deaths is particularly problematic. Figure 6 shows that suicide is high in France and Finland, again suggesting the possibility that coding may be questionable as the uniformity found across these areas is so strong.

Figure 7 shows SMRs for deaths under 65, for all causes for men and women for 1990 with areas divided into quintiles (by population). The analysis is restricted to deaths under the age of 65 as this is generally considered to be 'premature', and the effect of deprivation on health is particularly apparent in this age group (Carstairs, 1995). Austria, Belgium, Finland, France, Spain and the UK all have regions in the highest and lowest quintiles. Regions of the UK account for 14.5% of the total population of the quintile with the lowest SMRs and 32.8% of the total population of the quintile with the highest SMRs. It thus makes little sense to compare the UK as a whole to other countries given the degree of heterogeneity in the UK — or to ascribe the UK level to *National* Health Services.

Figure 8 maps mortality data for deaths under 65 for 1990 and 1994 to allow changes over time to be considered. The regions where SMRs under the age of 65 have significantly increased and decreased (95% confidence intervals) between 1990 and 1994 are indicated. Increasing SMRs can be observed in regions of Austria, Belgium, Denmark, France, Greece, Italy, Netherlands, Portugal and the UK. Decreasing SMRs can be observed in regions of Austria, Finland, Italy, Portugal, Spain, Sweden and the UK. However, if we take the UK as an example, it is not simply the case that the areas with significantly decreasing SMRs are those which had high SMRs in 1990, nor vice versa.

Table 1
SMRs (all cause, under 65) by population deciles, 1990 and 1994

Decile	1	2	3	4	5	6	7	8	9	10
1990	75.0	85.1	90.6	94.6	97.4	100.6	105.1	109.0	116.3	130.1
1994	73.5	84.0	89.4	94.4	97.8	102.2	105.9	108.7	113.7	134.9
Change	−1.5	−1.1	−1.2	−0.2	+0.4	+1.6	+0.8	−0.3	−2.6	+4.8

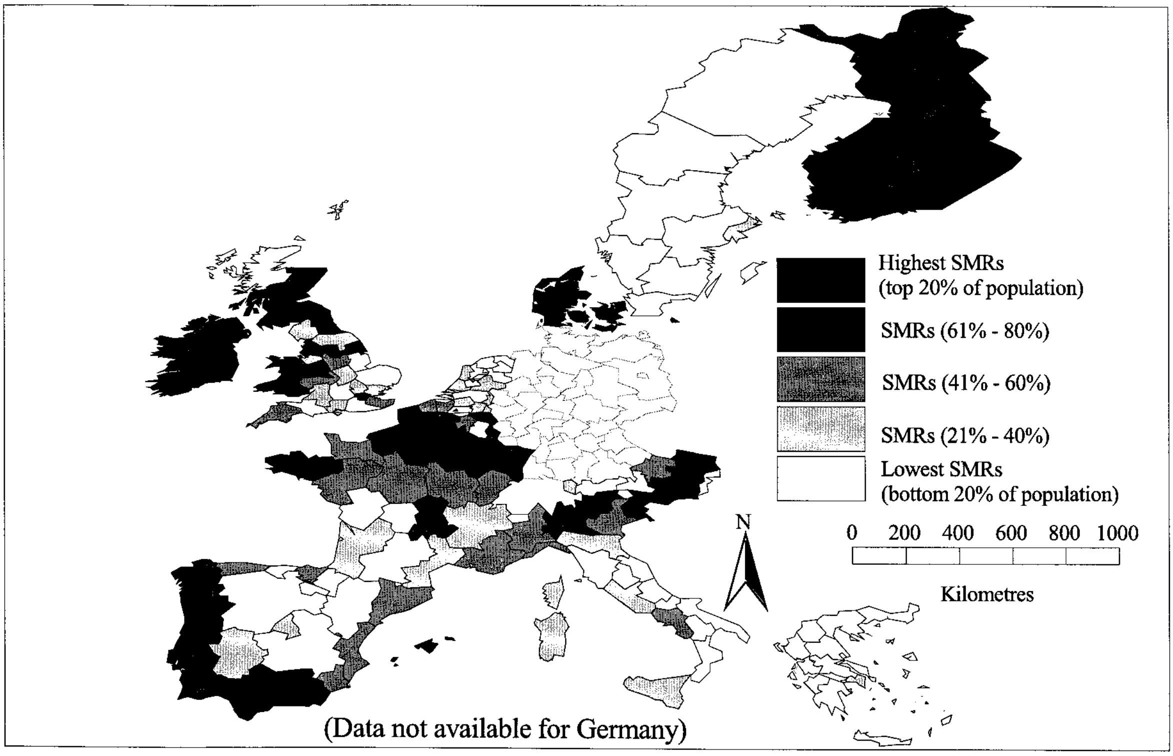

Fig. 7. All cause standardised mortality ratios (< 65) for 1990.

For example, Greater Manchester has increasing SMRs between 1990 and 1994, but was in the quintile with the highest SMRs in 1990; Avon has significantly decreasing SMRs and was in the second lowest SMR quintile in 1990. This is again evidence that when considering the changing mortality rates of nations we are overlooking significant regional variations in change within those states.

Table 1 shows the SMRs (under 65) for each population decile of Europe for 1990 and 1994. The figures have been standardised to the European average. While a number of the deciles, including those which already had relatively low SMRs in 1990, had decreasing SMRs, deciles 5, 6, 7 and 10 have experienced increasing SMRs over the study period. Most notably the SMR of the population decile with the highest death rates was 130.1 in 1990 but by 1994 the SMR of this population decile was 134.9; the total number of 'excess' deaths (the difference between observed and expected values) for this population decile is 19,269. This links with the findings of Kunst (1997), and other researchers, that socio-economic differentials in mortality are widening. These findings are also concurrent with those of Dorling (1997) who reported that the 10% of the population of Britain living in areas of the country with the highest death rates had the worst ever recorded relative mortality ratios in 1990–1992 (with an SMR comparable to those reported here of 142.3). It is interesting to note that there is not a consistent gradient of mortality across the ten deciles, rather, deciles one and ten are outliers, with markedly lower and higher SMRs, respectively.

Conclusions

These preliminary findings suggest that we should interpret comparisons of mortality and mortality change across the various countries of the European Union with caution as using national mortality rates can mask significant regional variations.

Unfortunately, at the time these data were analysed it was not possible to calculate SMRs directly for males and females separately. Hart (1989) points out that a feature of declining mortality in industrial societies is a growing divergence of life expectancies for men and women, and the width of the gap varies by marital status, occupational class and rural/urban area; there are also substantial differences in this gender gap between European countries. Significant sex differences are also apparent when looking at particular causes of death. For example, while lung cancer rates for men

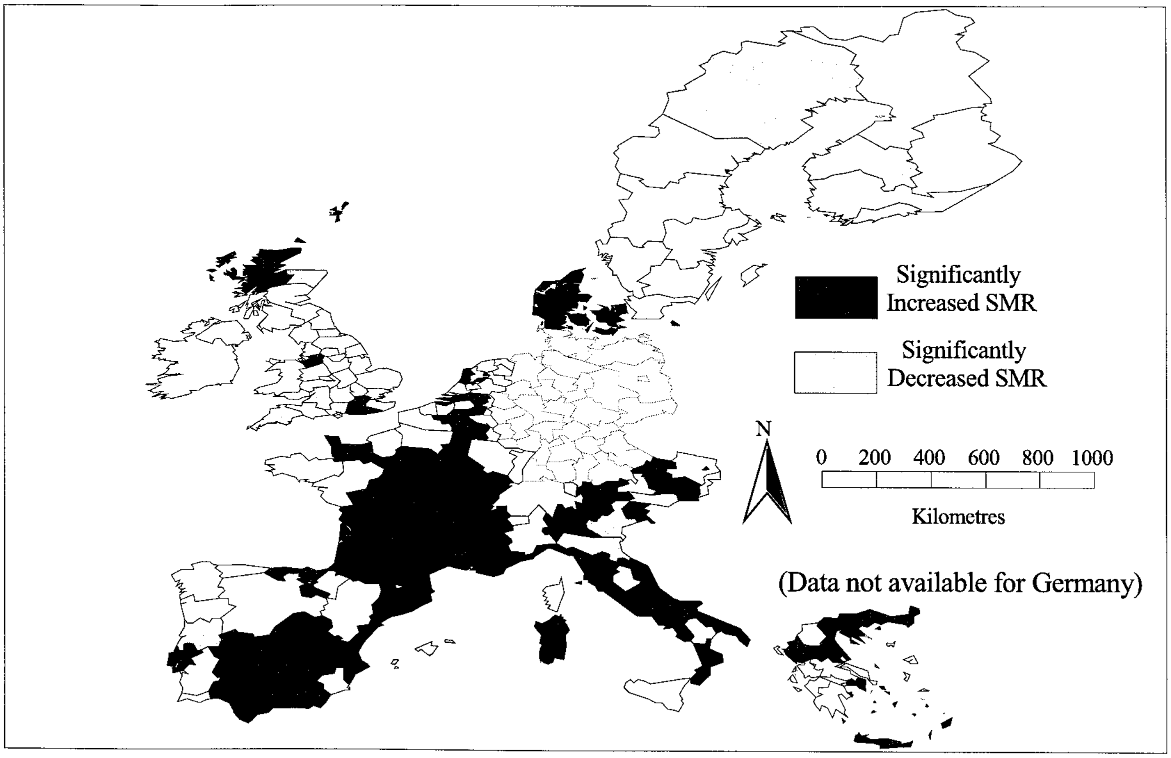

Fig. 8. Regions where all cause standardised mortality ratios (<65) have significantly increased or decreased between 1990 and 1994.

are levelling off or even declining, for women they are rising (Levi et al., 1995). Accidental deaths and deaths by violent means are also much more prevalent in young males (Hart, 1989).

It would be advantageous to be able to look at the role of factors such as income, educational level, lifestyle and environmental factors and so on, in producing the regional variations observed, but there are currently many problems with the comparability of such data, even if data do exist, as Judge et al. (1995) have shown for income measures. For example, unemployment data are available but comparisons between countries have a number of difficulties (Green, 1998). Different employment structures, participation rates and benefit regimes may all affect the comparability of data. Green points out that internationally standardised questions do not necessarily result in internationally standardised answers. Her research shows that unemployment in Netherlands, Italy and the UK tends to be underestimated in International Labour Organisation data. However, if comparable socio-economic data were available for analysis, then these regional variations in mortality could be investigated, and, for example, Mackenbach and Looman's (1994) findings regarding standard of living and Wilkinson's (1996) hypothesis on the effect of income distribution on mortality could be further investigated.

Acknowledgements

This research was conducted under ESRC grant numbers L128251009 and R000271045.

References

Amouyel, P., Arvelier, D., Cambou, J.P., Montaye, M., Ruidavets, J.B., Bingham, A., Schaffer, R., Richard, J.L., 1994. Myocardial infarction in case-fatality in three French regions: the influence of acute coronary care. International Journal of Epidemiology 23 (4), 700–709.

Blaxter, M., 1989. A comparison of measures of inequality and morbidity. In: Fox, J. (Ed.), Health Inequalities in European Countries. Gower, Aldershot.

Britton, M. (Ed.), 1990. Mortality and geography: a review in the mid-1980s, England and Wales. In: OPCS, Series DS, No.9. HMSO, London.

Carstairs, V., 1995. Deprivation indices: their interpretation and use in relation to health. Journal of Epidemiology and Community Health 49 (Suppl. 2), S3–S8.

De Angelis, R., Valente, F., Frova, L., Capocaccia, R., Micheli, A., Chessa, E., Sant, M., 1996. Incidence, mortality and prevalence of stomach cancer in Italian regions. Tumori 82 (4), 314–320.

Department of Health, 1998. Our Healthier Nation: a contract for Health. The Stationery Office, London.

Dickman, P.W., Gibberd, R.W., Hakulinen, T., 1997. Estimating potential savings in cancer deaths by eliminating regional and social class variation in cancer survival in the Nordic countries. Journal of Epidemiology and Community Health 51 (3), 289–289.

Dorling, D., 1991. The visualization of spatial social structure. Unpublished Ph.D. thesis, Newcastle University.

Dorling, D., 1997. Death in Britain: how local mortality rates have changed 1950–1990. Joseph Rowntree Foundation, York.

Duleep, H.O., 1995. Mortality and income inequality among economically developed countries. Social Security Bulletin 58 (2), 34–50.

Eurostat, 1995. Mortality statistics (Regio) [computer file], Luxembourg: Eurostat (producer), r.cade online service (distributor), Universities of Durham and Essex.

Eurostat, 1995. Population statistics (Regio) [computer file], Luxembourg: Eurostat (producer), r.cade online service (distributor), Universities of Durham and Essex.

Franceschi, S., Levi, F., Lucchini, F., Negri, E., Boyle, P., La Vecchia, C., 1994. Trends in cancer mortality in young adults in Europe, 1955–1989. European Journal of Cancer 30A (14), 2096–2118.

Green, A., 1998. Problems of measuring participation in the Labour Market. In: Dorling, D., Simpson, S. (Eds.), Statistics in Society. Arnold, London.

Hart, N., 1989. Sex, gender and survival: inequalities of life chances between European men and women. In: Fox, J. (Ed.), Health Inequalities in European Countries. Gower, Aldershot.

Haynes, R., 1991. Inequalities in health and health service use: evidence from the General Household Survey. Social Science & Medicine 33 (4), 361–368.

HMSO, 1991. Road Accidents Great Britain. HMSO, London.

Holland, W.W., 1983. 2nd ed., European Community Atlas of 'Avoidable Death' Medicine 46, 567–579.

Judge, K., 1998. Income distribution and life expectancy: a critical appraisal. British Medical Journal 311, 1282–1285.

Keskimaki, I., Salinto, M., Aro, S., 1995. Socioeconomic equity in Finnish hospital care in relation to need. Social Science & Medicine 41 (3), 425–431.

Kubik, A., Bonassi, S., Filiberti, R., Reissigova, J., 1993. Regional and national variation in lung cancer mortality in Italy and Czechoslovakia. European Journal of Cancer Prevention 2 (4), 337–344.

Kunst, A.E., Mackenbach, J.P., 1994a. The size of mortality differences associated with educational level in nine industrialised countries. American Journal of Public Health 84, 932–937.

Kunst, A.E., Mackenbach, J.P., 1994b. International variation in the size of mortality differences associated with occupational status. International Journal of Epidemiology 23, 742–750.

Kunst, A., 1997. Cross-national comparison of socio-economic differences in mortality. Ph.D. thesis: Erasmus University, Rotterdam.

Kunst, A.E., Groenhof, F., Mackenbach, J.P., Health, E.W., 1998a. Occupational social class and cause specific mortality in middle aged men in 11 European countries: comparison of population based studies. British Medical Journal 316, 1636–1642.

Kunst, A.E., Groenhof, F., Borgan, J.K., Costa, G., Desplanques, G., Faggiano, F., Hemstrom, O., Martikainen, P., Vagero, D., Valkonen, T., Mackenbach, J.P., 1998b. Socio-economic inequalities in mortality: methodological problems illustrated with three examples from Europe. Revue d'Epidemiologie et de Sante Publique 46 (6), 467–479.

Langford, I.H., Bentham, G., 1996. Regional variations in mortality rates in England and Wales: an analysis using multi-level modelling. Social Science & Medicine 42 (6), 897–908.

La Vecchia, C., Lucchini, F., Levi, F., 1994a. Worldwide trends in suicide mortality, 1955–1989. Acta Psychiatrica Scandinavica 90 (1), 53–64.

La Vecchia, C., Levi, F., Luchinni, F., Negri, E., 1994b. Worldwide patterns of mortality from motor vehicle accidents, 1950–1990. Sozial- und Praventimedizin 39 (3), 150–178.

Leclerc, A., 1989. Differential mortality by cause of death: comparison between selected European countries. In: Fox, J. (Ed.), Health Inequalities in European Countries. Gower, Aldershot.

Levi, F., La Vecchia, C., Lucchini, F., Negri, E., 1995. Cancer mortality in Europe, 1990–92. European Journal of Cancer Prevention 4 (5), 389–417.

Luppi, G., Camnasio, M., Benedetti, G., Covezzi, I., Cislaghi, C., 1995. The Italian mortality map at the municipal level. Epidemiologia e Prevensione 19 (63), 132–141.

Mackenbach, J.P., Bouvier-Colle, M.H., Jougla, E., 1990. 'Avoidable' mortality and health services: a review of aggregate data studies. Journal of Epidemiology and Community Health 44, 106–111.

Mackenbach, J.P., Looman, C.W.N., 1994. Living standards and mortality in the European Community. Journal of Epidemiology and Community Health 48, 140–145.

Negri, E., La Vecchia, C., 1995. Epidemiology of lung cancer: recent trends in mortality with emphasis on Europe. Lung Cancer 12 (Suppl. 1), S3–11.

Paci, P., Wagstaff, A., 1993. Equity and efficiency in Italian health care. Health Economics 2, 15–29.

Rodriguez Artalejo, F., Bahegas, J.R., Garcia Colmenero, C., del Ray Calero, J., 1996. Lower consumption of wine and fish as a possible explanation for higher IHD mortality in Spain's Mediterranean region. International Journal of Epidemiology 25 (6), 1196–1201.

Strachan, D.P., Leon, D.A., Dodgeon, B., 1995. Mortality from cardiovascular disease among interregional migrants in England and Wales. British Medical Journal 310, 423–427.

Townsend, P., Davidson, N., 1982. The Black Report. Penguin, London.

Tuchsen, F., Andersen, O., Costa, G., Filakti, H., Marmot, M.G., 1996. Occupation and ischaemic heart disease in the European Community: a comparative study of occupations at potential high risk. American Journal of Industrial Medicine 30 (4), 407–414.

Vagero, D., 1994. Equity and efficiency in health reform: a European view. Social Science & Medicine 39 (9), 1202–1210.

Valkonen, T., 1987. Male mortality from ischaemic heart disease in Finland: relation to region of birth and region of residence. European Journal of Population 3, 61–83.

Van Oyen, H., Tafforeau, J., Roelands, M., 1996. Regional inequities in health expectancy in Belgium. Social Science & Medicine 43 (11), 1673–1678.

WHO, 1977. Manual of the international statistical classification of diseases, injuries, and causes of death. HMSO, London.

WHO, 1997. Atlas of Regional Mortality in Europe: Subnational Patterns 1980/1981 and 1990/1991. In: European Series, No.75. WHO regional publications, Geneva.

Wilkinson, R., 1992. Income distribution and life expectancy. British Medical Journal 304, 165–168.

Wilkinson, R., 1996. Unhealthy Societies: the Afflictions of Inequality. Routledge, London.