DOES HEALTHCARE SAVE LIVES?

AVOIDABLE MORTALITY REVISITED

Ellen Nolte
Martin McKee

The Nuffield Trust
FOR RESEARCH AND POLICY
STUDIES IN HEALTH SERVICES

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Foreword by John Wyn Owen CB

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The authors

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FOREWORD

The question of how much health care contributes to the health of populations has been debated for several decades. Writing in the 1970s, Professor Thomas McKeown argued that its contribution had been minor, as much of the decline in mortality in industrialised countries took place before effective health care was available. Instead, he emphasised the role of broader social policies, leading to changes such as better nutrition and cleaner water. However, as several commentators have noted, McKeown was describing a period in which health care still had relatively little to offer. It was only in the 1960s and 1970s that safe and effective drugs for many chronic diseases became widely available.

In the 1980s, several researchers, including Professor Walter Holland, the Nuffield Trust's 1997 Rock Carling lecturer, began work on what was variously termed avoidable or amenable mortality. This involved looking at deaths that should not occur in the presence of effective and timely health care. This work suggested that health care was indeed having an impact on premature mortality at the population level.

While this work led to much interest at the time, the concept of avoidable mortality has recently received rather less attention. Yet there are now several reasons why we should revisit it. One is the growing international interest in comparing the performance of health systems, exemplified by the World Health Organization's 2000 World Health Report, with its controversial rankings of health systems. Another is the growing interest in the complex relationship between the health and wealth of nations, exemplified by the report of the Commission on Macro-Economics and Health.

The Nuffield Trust's purpose is to communicate evidence and encourage an exchange around developed or developing knowledge in order to illuminate recognised and emerging issues. As such, it is entirely appropriate that it should contribute to these discussions. One way that it has done this is by publishing this important book, which describes the findings of a study co-funded by the Trust and by Merck & Co., in association with the European Observatory on Health Care Systems.

The authors, Ellen Nolte and Martin McKee, have done an excellent job in assembling the extensive literature that now exists on avoidable mortality, bringing the definitions up to date, and then applying them to patterns of mortality in a range of industrialised countries. They confirm that health care has made an appreciable difference to population health, while showing that the impact varies among countries.

This work bridges two of the Trust's key themes, public health and quality in health care, and I commend it to health service researchers and health policy makers interested in benchmarking the performance of health systems.

John Wyn Owen C.B.
Secretary, Nuffield Trust
February 2004

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EXECUTIVE SUMMARY

Does health care save lives? Commentators such as McKeown and Illich, writing in the 1960s, argued that it played very little part, and might even be harmful. However they were writing about a period when health care had relatively little to offer compared to today. Since then, several writers have described often quite substantial improvements in death rates from conditions for which effective interventions have been introduced. But the debate continues, with some arguing that health care is making an increasingly important impact on overall levels of health while others contend that it is in the realm of broader policies, such as education, transport and housing, that we should look to for future advances in health. Inevitably this is to a considerable extent a false dichotomy. Both are important. But how much does health care contribute to population health?

One way in which this question has been addressed previously is to look at deaths that should not occur in the presence of effective and timely health care, so-called 'avoidable' mortality. However much of this work was undertaken in the 1980s and early 1990s, since when health care has advanced considerably. In addition, 'avoidable' deaths were often limited to those before, for example, the age of 65, a figure that seems inappropriately low in the light of life expectancies that are now about 80 in many countries.

In this review we have traced the evolution of the concept of 'avoidable' mortality from its inception in the 1970s. We have undertaken a detailed methodological critique of this concept, examining questions of attribution, issues relating to comparisons over time and place, and relationships with other indicators of health service provision. To help future researchers we have produced a comprehensive, annotated review of the work that has been undertaken worldwide so far.

We note that 'avoidable' mortality was never intended to be more than an indicator of potential weaknesses in health care that can then be investigated in more depth. We describe examples of where this approach has been successful, drawing attention to problems that might otherwise have been missed.

In contrast, many of the critics of 'avoidable' mortality, or more specifically, mortality amenable to health care *(amenable mortality)*, have asked that it do something it was not intended to do, to be a definitive source of evidence of differences in effectiveness of health care. Thus, it is not unexpected that studies seeking to link amenable mortality with health care resources have failed to do so, especially when undertaken within countries, although it is notable that where gross differences exist, as between western and eastern Europe, the gap in amenable mortality is especially high. For these reasons, it seems justifiable to continue and extend the extensive body of research that has already been undertaken to look at ‘avoidable’ mortality, updating the list of conditions included to reflect the changing scope of health care and extending the age limit to reflect increasing expectation of life. However it must be recognised that the concept of ‘avoidable’ mortality does have important limitations, relating to comparability of data, attribution of causes, and coverage of the range of health outcomes.

Comparisons of health system performance are now firmly on the international policy agenda, especially since the publication of the 2000 World Health Report. Incorporation of the concept of mortality amenable to health care into the methodology used to generate the rankings of health systems in that report would be an advance on the current situation. We show how, within Europe, this would lead to different rankings from those based on overall disability adjusted life expectancy, which is used in the current rankings.

However, any approach based on aggregate data would not address one of the major criticisms of such comparisons, that they do not indicate what needs to be done when faced with evidence of sub-optimal performance. This requires a more detailed analysis of the specific issues facing health systems. Here we propose a new method, in which analyses of amenable mortality identify areas of potential concern that are then examined in more detail by studying the processes and outcomes of care for tracer conditions, selected on the basis of their ability to assess a wide range of health system components.

The second part of the review applies the refined method of amenable mortality analysis to patterns of mortality in the countries of the European Union over the past two decades. This shows that deaths that could be prevented by timely and effective care were still relatively common in many countries in 1980. Reductions in these deaths contributed substantially to the overall change in life expectancy between birth and age 75 during the 1980s. The largest contribution was from falling infant mortality but in some countries reductions in deaths among the middle aged was equally or even more important. These countries were Denmark, The Netherlands, the United Kingdom, France (for men) and Sweden (for women).

In contrast, during the 1990s, reductions in amenable mortality made a somewhat smaller contribution to improved life expectancy, especially in the northern European countries. However they remained important in southern Europe, especially in Portugal and Greece, where the initial death rates had been higher.

These findings provide clear evidence that improvements in access to effective health care have had a measurable impact in many countries during the 1980s and 1990s, in particular through reductions in infant mortality and in deaths among the middle aged and elderly, especially women. However the scale of impact has, to a considerable extent, reflected the starting point. Thus, those countries where infant mortality was relatively high at the beginning of the 1980s, and which had the greatest scope for improvement, such as Greece and Portugal, unsurprisingly saw the greatest reductions in amenable mortality in infancy. In contrast, in countries with infant mortality rates that had already reached very low rates by the beginning of the 1990s, such as Sweden, the scope for further improvement was small.

Similarly, the scope for improvement in amenable deaths in adulthood was greatest in those countries where initial rates were highest. The corollary of this is that as rates fall in all countries, the extent of variation decreases. As a consequence, it seems likely that, in the 21st century, the ability to compare health system performance using mortality data at the aggregate level is likely to be limited, simply because the differences will be relatively small. This does not, however, mean that there is not scope for analyses that use amenable mortality rates to screen for potential problems that can then be explored in more depth. It also does not exclude the use of amenable mortality to gain new insights into inequalities in access to care within populations.

BACKGROUND

The publication by the World Health Organisation (WHO) of the 2000 World Health Report[1], with its rankings of the performance of health care systems, as well as subsequent methodological work by the OECD, has placed the issue of health system performance on the international health policy agenda.[2]

As defined by the WHO, health system performance has three dimensions, health attainment, responsiveness, and fairness of financing. Health attainment is defined as healthy life expectancy, or the length of time that someone in the country in question can expect to live in good health. This measure has the advantage that it can be obtained for many countries, although it should also be noted that the adjustment of life expectancy for levels of health in most cases involves a process of estimation and, in a majority of countries even life expectancy must be estimated because of the absence of comprehensive mortality data. However it also has an important weakness. Overall health attainment will reflect the influence of very many different factors, only some of which lie within the health care system. Thus, for example, in western Europe there is a significant correlation between overall health attainment, as reported in the World Health Report, and national levels of consumption of fruit and vegetables, as an indicator of a healthy diet.

Yet it is apparent from everyday experience that health care has some influence on levels of health. Many conditions that would once have been fatal can now be cured, such as common childhood infections. The discovery of insulin has transformed juvenile onset diabetes from what was once an acute, rapidly fatal disease of childhood into one that is compatible with a normal lifespan. The crucial question is not whether health care contributes to population health but how much it does? Is its effect only marginal or does it play a more important role? And, in the debate about health system performance, is it possible to build on what is known about this relationship to create a more refined measure of health system performance that can inform international comparisons?

The question of whether health services make a meaningful contribution to population health has long been debated.[3] Several authors, writing from a historical perspective in the late 1970s, argued persuasively that health care had contributed little to the decline in mortality that had occurred in industrialised countries from the mid nineteenth to mid twentieth century. They proposed that this improvement was most likely to be due to the influence of factors outside the health care sector, in particular nutrition, but also improvements in the environment.[4,5,6] Indeed some, such as Illich, have argued that developments in health care in the 1950s and 1960s were actually damaging health, introducing the word iatrogenesis.[7]

The name of Thomas McKeown is perhaps that most closely identified with the argument that health care contributed little to population health.[4] His study of the decline in mortality in England and Wales between 1848/54 and 1971 provided some memorable images, in particular how the largest part of the decline in mortality from tuberculosis predated the introduction of immunisation or effective chemotherapy (Figure 1).

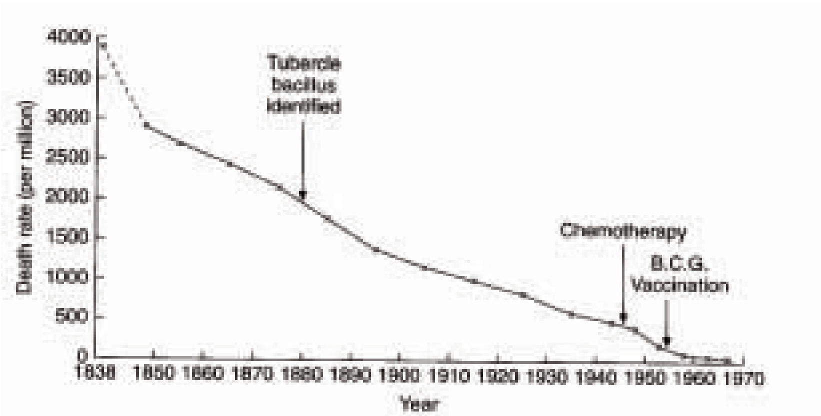


Figure 1 **Mortality from respiratory tuberculosis in England and Wales**
(source: McKeown[4])

Yet while this representation is accurate, it is also true that the introduction of chemotherapy had a quite remarkable impact on death rates from tuberculosis among young people, as can be seen in Figure 2, which shows the year on year decline in mortality from tuberculosis in England and Wales at different ages between 1945 and 1955, the period during which chemotherapy was being introduced.

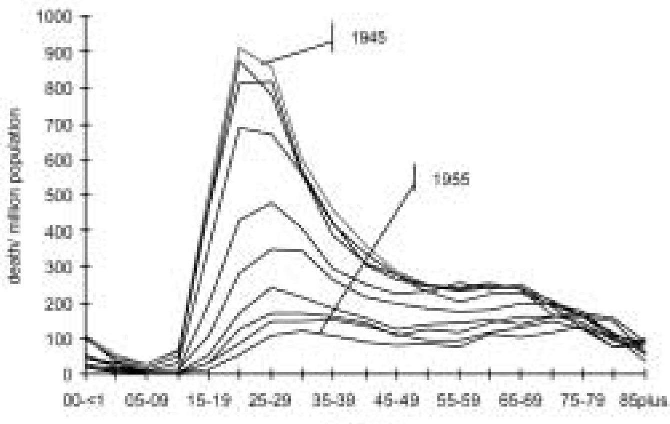


Figure 2 **Death rates from tuberculosis in successive years between 1945 and 1955 in England and Wales by age group**
(source: Office for National Statistic mortality data)

McKeown's arguments have been embraced enthusiastically, in particular by groups seeking to challenge the perceived emphasis given to health care in the debate about the determinants of health, with arguments implying that, as in the late nineteenth and early twentieth centuries, health care continues to contribute little to population health. However, as the example of tuberculosis shows, the reality is not quite so simple. Thus, Mackenbach has examined changing mortality over a similar period, 1875/79 and 1970, in The Netherlands, and come to a somewhat different conclusion.[8] He accepts that antibiotics were only introduced after mortality from infectious diseases had already fallen substantially but he showed how their use was associated with acceleration in the rate of decline. Thus, between 1921 and 1939, when only some sulphonamides were available in The Netherlands, the annual decline of mortality from infectious diseases was 4% per annum, whereas subsequently, when antibiotics such as penicillin became widely available, mortality from infectious disease declined by 10% per annum. Setting an (arbitrary) cut-off point at 1946 to mark the general introduction of antibiotics in The Netherlands, he estimated, on the basis of the known effects of antibiotics on specific infectious diseases, that between 1.6 and 4.8% of the total decline in infectious disease mortality between 1875/79 and 1970 could be attributed to medical care. Further analyses also examined the potential impact of the decline in mortality from common surgical conditions, such as appendicitis and cholecystitis, resulting from improvements in surgery and anaesthesia from around 1930, and from perinatal conditions, reflecting improvements in antenatal and perinatal care since the 1930s. Taking account of all of these factors he estimated that between 5 and 18.5% of the total decline in mortality between 1875/79 and 1970 in The Netherlands could be attributed to health care.

More recently there have been a series of reviews of the contribution of health care to health and there is now consensus that McKeown was correct to the extent that "curative medical measures played little role in mortality decline prior to mid-20th century."[9] However the rapidly changing scope and nature of health care does not mean that this can be assumed still to be the case.

Indeed, the scope of health care has changed enormously in the second half of the twentieth century. The change is not only in the more obvious areas such as new pharmaceuticals and technology but also in new and more effective ways of organising care, such as the introduction of multi-disciplinary stroke units or integrated screening programmes, and in the development of evidence-based care, enabling traditional but ineffective treatments to be discarded while innovative and effective ones are adopted and diffused more rapidly. Thus, while health care may have made little contribution to population health in the past it may now be playing a rather more important role.

Several approaches have been developed in attempts to quantify this contribution. The most widely used makes use of the ready availability of mortality data at a population level and is based on the concept of deaths from certain causes that should not occur in the presence of timely and effective health care. This has given rise to the development of a variety of terms including "avoidable mortality" and "mortality amenable to medical/health care".

Although attempts to systematically assess the quality of medical care using routine data of vital statistics go back to the 1950s[10] and the actual term “avoidable mortality” has been used since at least the 1960s[11], its origins in the form in which it is commonly understood date from the work of Rutstein and co-workers to develop a measure of the quality of medical care in the mid-1970s. This concept has been commented on and/or reviewed by several authors, most notably Holland, Mackenbach and Westerling.[12,13,14] However much of this work dates from the late 1980s and early 1990s and it has received relatively little recent attention. Indeed, as the 2000 World Health report shows, the concept has been overlooked in some influential recent studies. In addition, the rapid increase in the pace of change in health care, as well as increasing expectation of a healthy life, make it important to revisit this concept. Does ‘avoidable’ mortality still offer a means of assessing health system performance and is the list of causes of death previously deemed to be avoidable still valid?

This publication is in three parts. Part I reviews the existing literature on ‘avoidable’ mortality to create a framework for analysis that takes account of contemporary circumstances and part II applies this framework to routinely available mortality data in European countries. Part III provides a comprehensive, annotated review of empirical studies of ‘avoidable’ mortality that have been undertaken worldwide so far.

PART I:
THE CONCEPT OF 'AVOIDABLE' MORTALITY
A LITERATURE REVIEW

Methods

Literature on "avoidable mortality" was identified from a variety of sources. The main ones were MEDLINE and HMIC. These were searched for the years 1966 (Medline) or 1979 (HMIC) to the present, using the search terms "amenable mortality", "avoidable mortality", "amenable causes", "avoidable causes", "unnecessary deaths", "untimely deaths", "quality of health care", "health care and (health) outcome". References cited in papers identified by this search were followed up. The review concentrates on literature published in peer-reviewed journals and includes empirical studies as well as conceptual papers. In addition, the series of European Community (EC) publications on avoidable deaths were included as they have made a major contribution to the conceptual development of 'avoidable' mortality. Therefore, related literature, although not necessarily peer-reviewed, was also included whereas national statistical reports, some of which touched on the concept of avoidable mortality, were not included. The only exceptions were one study published by the Centers for Disease Control (CDC), which formed the basis for subsequent studies on 'avoidable' mortality in the USA. In addition, a conference paper presented by Mackenbach that updated his earlier work was used as was a report commissioned by the UK Department of Health that reviewed and extended further the list of 'avoidable' causes of death that had formed the basis for the EC studies of avoidable deaths. Studies looking at selected causes of 'avoidable' death such as tuberculosis or cervical cancer only were excluded as were those using the term avoidable death or mortality in a broader sense without referring particularly to the underlying concept of "avoidable mortality". Finally, the review is limited to work published in English, French or German.

The first section looks specifically at the evolution of the concept of 'avoidable' mortality and how it has changed over time. This is followed by an overview of the findings of studies applying this concept at the population level. The third section will examine the conceptual problems that arise when using "avoidable mortality" as an indicator of quality of care, and is followed by a concluding section that will explore alternative approaches.

Evolution of the concept of 'avoidable' mortality

The concept of "avoidable mortality" as it has been used over the last 25 years, stems from the Working Group on Preventable and Manageable Diseases led by David Rustein of Harvard Medical School in the USA in the 1970s.[15] They introduced the notion of 'unnecessary untimely deaths' by proposing a list of conditions from which death should not occur in the presence of timely and effective medical care. Medical care was defined in its broadest sense as prevention, cure and care, and including "the application of all relevant medical knowledge [...], the services of all medical and allied health personnel, institutions and laboratories, the resources of governmental, voluntary, and social agencies, and the co-operative responsibility of the individual himself". Using this broad definition, the Working Group selected over 90 conditions as 'sentinel health events' since cases of disease, disability or death from these conditions were considered to be preventable and/or treatable by appropriate and timely medical care.

Whilst acknowledging that the chain of responsibility to prevent the occurrence of such a disease or death may be complex (Box 1), and that the physician cannot be solely responsible for failures that result in a sentinel health event, the authors argue that the physician nevertheless has a crucial role as being the "one competent to provide the leadership and the professional guidance" to inform (community) action to prevent such events. Information on sentinel health events may therefore serve as an index of the quality of care delivered by particular providers, agencies, and institutions or by particular health care sectors. Following this line of reasoning, the list includes not only conditions where the role of medical care appears to be obvious, as for example in the case of appendicitis, but also conditions where the contribution of medical care is usually believed to be small, such as lung cancer.

The conditions thus identified were separated into those where even a single case of disease or disability or untimely death justifies an immediate enquiry into the question 'Why did it happen?' as, for example in cases of botulism or death from cervical cancer ('clear-cut' indicators or 'single case index') and conditions where not every single case is considered preventable or manageable but in which appropriate medical care should be associated with a lower incidence of that condition, such as the vascular consequences of treated or untreated hypertension ('index based on rates'). In addition, each condition was categorised as to whether the unnecessary disease or disability or untimely death is treatable and/or preventable. Thus, diphtheria is considered a disease preventable by immunisation whereas unnecessary untimely death from this condition may be both preventable, again by immunisation, and treatable, by administering antitoxin and antibiotics. However, lung cancer is considered preventable only, by means of actions such as reducing or eliminating exposure to cigarette smoking, asbestos and some other occupational factors, as treatment is rarely successful once the disease has arisen. In addition, some conditions were considered sentinel only at certain ages, for example deaths from acute respiratory infections under age 50.

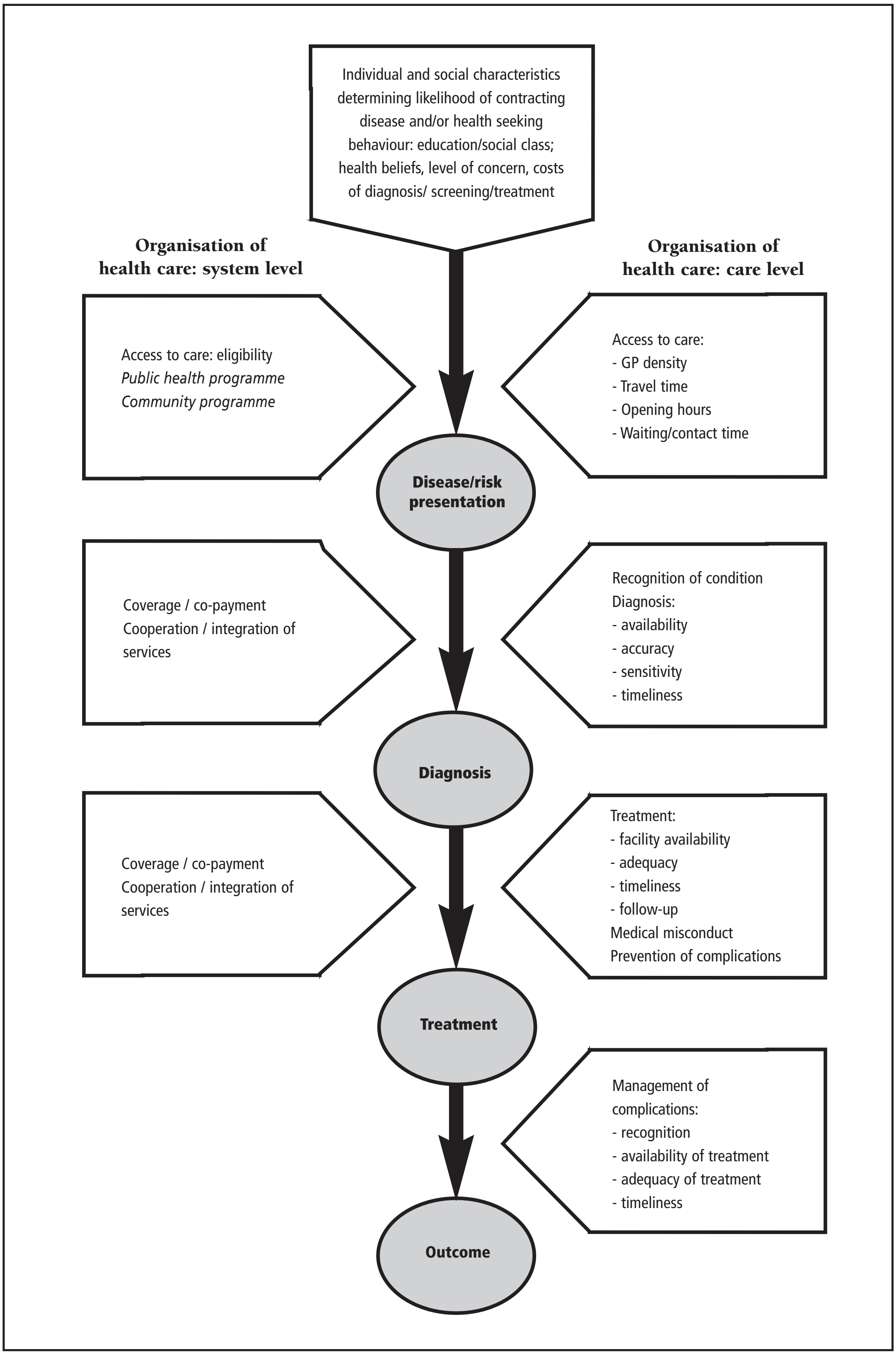
Box 1 Health care related factors influencing health outcome

"The unnecessary case of diphtheria, measles, or poliomyelitis may be the responsibility of the state legislature that neglected to appropriate the needed funds, the health officer who did not implement the program, the medical society that opposed community clinics, the physician who did not immunize his patient, the religious views of the family, or the mother who didn't bother to take her baby for immunization [...] Death from cancer of the lung may be due to the patient's unwillingness or inability to give up cigarette smoking, the reassuring statements put out by the advertiser or manufacturer, the absence of an effective health-information program in the public schools and in the community, or, more rarely, from an error in diagnosis or from poor surgical care."[15]

In 1996 Westerling reviewed published evidence of avoidable factors influencing death.[16] He showed that of the studies included 45% identified inadequate diagnosis and 51% inadequate treatment as avoidable factors. Other important factors identified were delay in diagnosis (22%) or treatment (31%), failure in preventing, recognising or treating complications (34%), deficiencies in management of care, such as coordination of different levels of care (17%) as well as some patient characteristics, especially psychosocial factors and health care seeking behaviour (20%). These factors varied according to outcome, however, with, for example, avoidable factors for trauma death being related, mainly, to hospital care, e.g. delay in diagnosis of injury, failure to recognise injury severity, lack or delay of surgical treatment and failures in the management of complications. The overall proportion of trauma deaths potentially avoidable was estimated at 27%. In contrast, about half of deaths from asthma were identified as having avoidable factors, largely delays in seeking professional help, attributable to lack of information and education but also to poor access to care in remote areas and inadequate assessment or treatment of asthma episodes.

The flowchart shown overleaf illustrates some main factors related to health care that have a potential impact on the health outcome.

Box 1 Health care related factors influencing health outcome - *continued*



Rutstein et al.'s original work was undertaken in the mid 1970s, when the 8th revision of the International Classification of Diseases (ICD), used to classify causes of death, was in use. Consequently, in 1977 and 1980 revisions of the lists of unnecessary untimely disease, disability and death were undertaken to take account of the recently introduced 9th revision, as well as to consider certain advances in health care.[17,18] These lists have formed the basis for practically all subsequent studies on 'avoidable mortality'.

A first empirical application of this concept was undertaken by Adler in 1978 who used conditions that were considered single case markers by Rutstein et al. to "demonstrate the usefulness of this approach" to measure the quality of medical care by evaluating preventable mortality in the USA in 1968-1971.[19] However Charlton et al. were the first to apply this concept at the population level to analyse regional variation in mortality in England and Wales in 1974-78, also introducing the terms "avoidable deaths" and "[conditions] amenable to medical intervention".[20] Based on Rutstein's list they selected 14 disease groups chosen to reflect different aspects of health care including primary care, general practice referrals to hospitals and hospital care.[21] However conditions whose avoidance was considered to be outside the scope of medical care, such as lung cancer and causes of death that were very rare, were excluded (Table 1). Age limits were set within which each cause was deemed potentially avoidable, most often 5-64 years. Table 1 also lists, for each condition, those health care providers and related interventions that were considered relevant to prevent untimely death.

Using various modifications of their original list of avoidable conditions that, following the findings of the Hypertension Detection and Follow-up Program Co-operative Group subsequently also included cerebrovascular disease, Charlton et al. extended their work to examine trends in mortality amenable to medical intervention at the national[22,23] and international level, for example in England & Wales, USA, France, Japan, Italy and Sweden between 1956 and 1978.[24]

A subsequent study to assess the impact of health care or health services using the concept of 'avoidable mortality' was undertaken by Poikolainen and Eskola who looked at trends in Finland between 1969 and 1981.[25] Their list of conditions considered amenable to health services was also based on the work by Rutstein and co-workers and covered a total of 22 conditions or groups of conditions, including five causes of perinatal death (Table 2). Similar to Charlton et al.[20] their list included conditions such as tuberculosis, cervical cancer, hypertensive disease and asthma and excluded conditions such as lung cancer whose prevention, they argued, depended mainly on efforts outside the health services. Again, as with Charlton et al., they defined an upper age limit, which was usually 65 years, although for some conditions such as diabetes or asthma this limit was set lower, at age 50. However acknowledging that there had been innovations in health care, they also analysed a separate set of seven "partly amenable" conditions that had become amenable during the study period. These included ischaemic heart disease, non-melanoma skin cancer and meningitis.

In a further study that compared 25 developed countries, Poikolainen and Eskola extended their original list, covering in total more than 70 amenable conditions and another 20 partly-amenable conditions (Table 2), thus expanding the concept of "avoidable mortality"

Table 1 **Amenable causes of death: Charlton et al**

Cause of death [20,21]	ICD 8	ICD 9	Age	Health care providers	Intervention
Hypertensive disease †	400-404	401-405	5-64	*primary care*, hospital	Case detection, anti-hypertensive medication
Cancer of cervix uteri	180	180	5-64	primary care, hospital, *community health services,* pathological services	Screening, surgery, radiation therapy
Pneumonia & bronchitis	480-486, 490	480-486, 490	5-49	*primary care*, *hospitals*	Antibiotics, early detection of complications
Tuberculosis (excl. silico) ‡	011-019	010-018	5-64	public health programme, *primary care*, hospital	Immunisation, contacts tracing, antibiotics
Asthma	493	493	5-49	*primary care,* hospital	Therapy, casualty department care
Chronic rheumatic heart disease	393-398	393-398	5-44	*primary care,* hospital	Case detection of streptococci, antibiotics, prophylaxis
Acute respiratory disease	460-466, 470-474	400-466, 470-474	5-49	*primary care,* hospital	Early detection of complications, antibiotics
Bacterial infections*	004, 034, 320, 381-383, 390-392, 680-686, 710, 720	004, 037, 320-322, 382-384, 390-392, 680-686, 711, 730	5-64	*primary care,* public health programmes, hospital	Early detection of complications, antibiotics
Hodgkin's disease	201	201	5-34	primary care, *hospital*, *pathological services*	Case detection, chemotherapy and radiation therapy
Abdominal hernias	550-553	550-553	5-64	primary care, *hospital*	Case detection, surgery prior to complications
Acute & chronic cholecystitis	574-575	574-575.1	5-64	primary care, *hospital*	Case detection, surgery prior to complications
Appendicitis	540-543	540-543	5-64	primary care, *hospital*	Case detection, surgery prior to complications
Maternal deaths	630-678	630-676	10-44		
Deficiency anaemias	280-281	280-281	5-64	*primary care,* hospital, pathological services	Case detection, laboratory services
Perinatal mortality	-	-			

† subsequently combined with cerebrovasuclar disease (ICD8,9: 430-438; age 35-64); ‡ Silico tuberculosis excluded in ICD8; not separately identified in ICD9
* mismatch of codes: ICD8 034 = streptococcal sore throat, ICD9 037= tetanus; no explanation by authors

considerably.[26] They also drew up an explicit list of "not amenable" conditions. Importantly, this list of not amenable conditions included cerebrovascular disease, a condition that had just been added to the list of conditions considered amenable to health care by Charlton et al.[24] Also in contrast to other work, chronic rheumatic heart disease was considered only partly amenable to medical care. Reasons for this selection were not, however, given.

At the same time, building on the work by Charlton et al.[20], the EC Concerted Action Project on Health Services and 'Avoidable Deaths', established in the early 1980s, adopted and modified the concept of avoidable mortality, resulting in the publication of the European Community Atlas of 'Avoidable Death' in 1988, a major work that has since been updated twice.[27,28,29,30,31] The first edition and the first volume of the 2nd edition each cover 17 disease groups, which were considered to be effectively treatable or preventable by health care services (Table 3). Health care services were interpreted as to include primary care, hospital care, and collective health services such as screening and public health programmes, e.g. immunisation. The conditions were chosen on the basis of having "identifiable effective interventions and health care providers". Named 'avoidable death indicators' these causes intended to "provide warning signals of potential shortcomings in health care delivery".[27]

Table 2 Amenable causes of death: Poikolainen & Eskola

Cause of death[25,26]	ICD 8 (A-List)	Age	1986	1988
Amenable to medical care				
Infectious diseases (1986)	A1-12, 16-17, 20, 22-26, 34-38, 42, 78, 119, 123	0-64	✔	
Infectious diseases (1988)	A1-20, 22-26, 28, 31, 33-43, 119, 123	0-64		✔
Malignant neoplasm of cervix uteri	A55	0-64	✔	✔
Diabetes mellitus	A64	0-49	✔	✔
Goitre, thyrotoxicosis, avitaminoses & nutritional defiencies	A62, 63, 65	0-64	✔	✔
Epilepsy	A74	0-64	✔	✔
Inflammatory diseases of eye, cataract, glaucoma	A75-78	0-64		✔
Active rheumatic fever	A80	0-64	✔	✔
Hypertensive disease	A82	0-64	✔	✔
Venous thrombosis and embolism	A87	0-64		✔
Acute respiratory infections; influenza; pneumonia	A89-92	0-49	✔	✔
Bronchitis, emphysema & asthma	A93	0-49	✔	✔
Hypertrophy of tonsils; empyema & abcess of lung	A94-95	0-49/64		✔
Diseases of teeth and supporting structures	A97	0-49		✔
Peptic ulcer	A98	0-64	✔	✔

Table 2 Amenable causes of death: Poikolainen & Eskola (*continued*)

Cause of death[25,26]	ICD 8 (A-List)	Age	1986	1988
Amenable to medical care				
Gastritis & duodenitis	A99	0-64		✔
Appendicitis	A100	0-64	✔	✔
Intestinal obstruction & hernia	A101	0-64	✔	✔
Cholelithiasis & cholecystitis	A103	0-64	✔	✔
Acute nephritis	A105	0-64		✔
Diseases of genito-urinary system	A107-110	0-64		✔
Complications of pregnancy, childbirth & the puerperium	A112-118	0-64	✔	✔
Diseases of skin; arthritis & spondylitis; rheumatism	A120, 121, 122	0-64		✔
Cleft palate and cleft lip	A129	0-64		✔
Birth injury & difficult labour	A131	0	✔	✔
Conditions of placenta & cord	A132	0	✔	
Haemolytic disease	A133	0	✔	✔
Anoxic & hypoxic conditions	A134	0	✔	✔
Other causes of perinatal morbidity & mortality	A135	0	✔	(1)
Partly amenable to medical care				
Meningococcal infection	A19	0-64	✔	(2)
Other bacterial/viral disease,	A21, 29, 44	0-64		✔
all other infective/parasitic disease				
Malignant neoplasm of buccal cavity and pharynx	A45	0-64	✔	✔
Malignant neoplasm of larynx	A50	0-64	✔	
Malignant neoplasm of skin	A53	0-64	✔	✔
Benign neoplasm & unspec.	A61	0-64		✔
Other endocrine and metabolic disease	A66	0-64		✔
Other diseases of blood & blood-forming organs	A68	0-64		✔
Meningitis	A72	0-64	✔	✔
Other diseases of nervous system & sense organs	A79	0-64		✔
Chronic rheumatic heart disease	A81	0-64	✔	✔
Ischaemic heart disease; other heart disease	A83-84	0-64	(3)	✔
Other diseases of circulatory system	A88	0-64		✔
Other diseases of respiratory system	A96	0-64		✔
Other diseases of digestive system	A104	0-64		✔
Other diseases of genito-urinary system	A111	0-64		✔
Other diseases of musculoskeletal system	A125	0-64		✔
Symptoms and other ill-defined conditions	A137	0-64		✔

(1) partly amenable only; (2) amenable to medical care, see above; (3) IHD only

Table 3 Amenable causes of death: European Community atlas of 'avoidable death'

Cause of death [27-31]	ICD 9	Age	Volume			Health care providers	Intervention
			1988/91	1993	1997		
Infectious diseases							
Typhoid	001	5-64	✔			*Public health programme,* primary care, hospital	Case detection, immunisation, treatment of complications
Whooping cough	033	0-14	✔				
Tetanus	037	0-64	✔				
Measles	055	1-14	✔				
Osteomyelitis	720	1-64	✔				
Intestinal infections	001-009	0-14		✔		*Public health programme,* primary care, hospital	Case detection, immunisation treatment of complications
Tuberculosis	010-018, 137	5-64	✔		✔	*Public health programme,* primary care, hospital	Screening, early detection of cases, immunisation contact tracing, antibiotics
Malignant neoplasm of breast	174	25-64		✔		*Public health programme:* screening in ages 50-64, primary care, hospital	Case finding, screening, surgery, radiotherapy, chemotherapy
Malignant neoplasm of skin	173	35-64		✔		*Public health programme,* primary care, hospital	Primary prevention, case finding, surgery, radio therapy
Malignant neoplasm of cervix uteri*	180	15-64	✔		✔	*Community health services,* primary care, hospital	Screening, cytology, surgery, radiotherapy
Malignant neoplasm of cervix uteri and body of the uterus*	179, 180, 182	15-54	✔		✔	*Community health services,* primary care, hospital	Screening, cytology, surgery, radiotherapy
Malignant neoplasm of testis	186	0-64		✔		Public health programme, primary care, *hospital*	Case finding, surgery, chemotherapy, radiotherapy
Hodgkin's disease	201	5-64	✔		✔	Primary care, *hospital*, pathological services	Case detection, chemotherapy, radiotherapy
Leukaemia	204-208	0-44		✔		*Hospital*	Chemotherapy, radiotherapy, bone marrow transplant

Table 3 Amenable causes of death: European Community atlas of 'avoidable death' (*continued*)

Cause of death [27-31]	ICD 9	Age	Volume			Health care providers	Intervention
			1988/91	1993	1997		
Chronic rheumatic heart disease	393-398	5-44	✔		✔	Primary care, *hospital*	Case detection of streptococci, antibiotics, prophylaxis, valve replacement surgery
Ischaemic heart disease	410-414, 429.2	35-64		✔	✔	*Primary care,* hospital, health education	Primary prevention
Hypertensive & cerebrovascular disease	401-405 430-438	35-64	✔		✔	*Primary care*, hospital	Case detection, antihypertensive medication, treatment of complications of hypertensive disease
All respiratory diseases	460-519	1-14	✔		✔	Primary care, hospital	Early detection of complications, antibiotics
Asthma	493	5-44	✔		✔	*Primary care*, hospital	Casualty department care, treatment, early referral of status asthmaticus
Peptic ulcer	531-534	25-64		✔	✔	Primary care, *hospital*	Anti-ulcer drugs, surgery for complications
Appendicitis	540-543	5-64	✔		✔	Primary care, *hospital*	Case detection, surgery
Abdominal hernia	550-553	5-64	✔		✔	Primary care, *hospital*	Case detection, surgery prior to complications
Cholelithiasis & cholecystitis	574-575.1, 576.1	5-64	✔		✔	Primary care, *hospital*	Case detection, surgery prior to complications
Congenital cardiovascular anomalies	745-747	1-14		✔		*Hospital*	Drugs, surgery
Maternal deaths (all causes)	630-676	All ages	✔		✔	Primary care, *hospital*	Antenatal care, obstetric care
Perinatal mortality	All causes	< 1wk + stillbirths	✔		✔	Primary care, *hospital*	Antenatal care, obstetric care, paediatric neonatal care

Table 3 Amenable causes of death: European Community atlas of 'avoidable death' (*continued*)

Cause of death [27-31]	ICD 9	Age	Volume 1988/91	1993	1997	Health care providers	Intervention
Malignant neoplasm of trachea, bronchus, and lung	162	5-64	✓			Health education	Primary prevention
Cirrhosis of liver	571	15-74	✓			Health education	Primary prevention, treatment for alcoholism
Motor vehicle accidents	E810-825	All ages	✓			Hospital accident & emergency department, health education	Primary prevention, emergency treatment

* overlap due to possible variation in coding practice: in some countries cancer of cervix uteri may be included in codes 179 and 182

The indicators were designed to illustrate different components of health care provision: primary, secondary and preventive, and to assess the outcome of health services for the residents of defined geographical areas. Three disease groups included in the list were considered "primary prevention indicators", as their avoidability was believed to be more dependent on actions outside the direct control of health services. For the remaining 14 conditions/groups of conditions it was believed that it was "reasonably certain" that effective treatment or secondary prevention is available.

The 2nd edition, published in 1991 was supplemented by a second volume in 1993, covering a further eight conditions, reflecting advances in medical knowledge and "extensions of the abilities of the health services and their technical infrastructures."[30] However, compared with the 14 causes covered earlier, the role of health services in the reduction of mortality from these eight conditions was less certain. The authors believed it "reasonably certain that effective treatment or primary or secondary prevention could be provided by health services, although there is considerable controversy over the avoidability of death from, for example, congenital anomaly." Consequently it was assumed that while not all deaths from these causes would be avoidable, health services could contribute substantially to minimising mortality. As with the concept of 'partly amenable' conditions developed by Poikolainen and Eskola[25], the supplemented list included ischaemic heart disease and skin cancer.

Finally, the 3rd edition of the EC Atlas of 'Avoidable Death' used a combination of causes from the 17 plus eight conditions included in earlier editions, resulting in a total of 16 conditions (Table 3).

Similar to Charlton et al.[20] age limits were set for each condition to improve the "validity of mortality as an indicator of health service outcome", set at under 65 for most causes.[27] As noted above, the conditions selected were intended to cover a range of different health services. The authors did, however, emphasise that they did not include all conditions for which death is avoidable by medical intervention or that every death from some of the selected causes would be avoidable but they expected that a proportion could be prevented. Finally, and unlike Charlton et al.[20], the EC group also included conditions whose control mainly depends on policies of primary prevention (health policies) as noted earlier, namely lung cancer, liver cirrhosis, and motor vehicle accidents.[27,29] These conditions were, however, no longer included in the most recent edition.[31]

Work on the EC Atlas of 'Avoidable Death' has stimulated a number of country-specific analyses by participating research groups in Europe, such as in Belgium[32], France[33], The Netherlands[34], Ireland[35] and Scotland[36] and beyond in Sweden[37], Spain[38], the former German Democratic Republic[39,40], Greenland[41], New Zealand[42], Canada[43], the USA[44] and Singapore.[45] The list of causes of death considered avoidable has, however, varied between studies with even those originating from the work on the EC Atlas using a more or less modified selection of amenable conditions and varying age ranges. For example, in their case study in France, Jougla et al., based on the work by the EC, extended this list to include cancer of the oral cavity, nephritis and a larger list of infectious diseases. They also extended the age range of infectious diseases to cover ages 5-64.[33]

In an early review of work on avoidable mortality, looking at 11 papers that had been published until the late 1980s, Mackenbach and co-workers noted that this variation in what is included is likely to reflect different views on the avoidability of death from certain conditions as well as the availability of mortality data and variation in the frequency of death of certain conditions in certain countries.[13] Thus some authors include conditions that are considered particularly relevant in the respective study region, for example meningitis and diabetes mellitus in New Zealand[46] while others explicitly exclude certain conditions because of their low frequency as for example with hypertension and asthma in Greenland.[41] Adopting Rutstein's broad definition of medical care[15] this last study did, however, include causes such as boat injuries, suicide and alcohol-related injuries as they were considered important causes of death in Greenland. This example illustrates the point made earlier on the variation in opinions as to whether a particular condition is to be classified as avoidable or not. However, the reasons used are often not made explicit as noted by Mackenbach et al.[13] who reported that a sound discussion of reasons for the inclusion or exclusion of specific causes of 'avoidable' death is almost always lacking.

In an attempt to quantify more specifically the contribution of medical care to changing mortality in The Netherlands, Mackenbach and colleagues linked trends in mortality to specific innovations in medical care.[47] Based on Rutstein's list[15] they selected a range of conditions that were considered to reflect all medical care innovations for which the positive impact on disease incidence or case fatality was relatively undisputed (Table 4). In contrast to Rutstein, however, they used a more restricted definition of medical care as "the application of biomedical knowledge through a personal service system", adapted from McDermott.[48] As with Charlton et al.[20] their list thus excluded conditions for which effective intervention is considered to be outside the direct control of the medical care system, including many forms of primary prevention. However mass immunisation and screening were considered integral part of the medical care system. In addition, whilst many studies of avoidable mortality published thus far had analysed data within only a designated age range, Mackenbach et al. could not identify clear evidence as to whether effects of

Table 4 Amenable causes of death: Mackenbach et al.

Cause of death[47]	ICD 9*	Medical care Innovation
Diseases of the thyroid	*240-246*	Specific medical therapies, e.g. introduction of insulin [1922]
Diabetes mellitus	250	
Pernicious anaemia	281.0	
Other anaemia	*Remainder of 281*	
Peptic ulcer	531-534	Improvements in surgery/anaesthetics, e.g. introduction of intravenous fluid therapy [around 1930]
Appendicitis	540-543	
Cholelithiasis & cholecystitis	574-575.1, 576.1	
Abdominal hernia	550-553	
Ileus without hernia	560	
Benign prostatic hyperplasia	*600 (222.2)*	
Maternal causes	*(630-676)*	Improvements in antenatal and perinatal care [since ca. 1930]
Complications mainly related to pregnancy	640-648	
Complications occurring mainly in the course of labour and delivery	660-669	
Complications of the puerperium	670-676	
Perinatal causes		
Diseases of the mother	760	
Birth injury	761-763, 767	
Haemolytic disease	773	
Other	Remainder of 760-779	
Tuberculosis	010-018, 137	Chemotherapeutics, e.g. sulphonamides [1936], and antibiotics, e.g. penicillin [1947]
Pneumonia/influenza	480-487	
Septicaemia	038	
Infections of the urinary system		
Other infectious diseases		
Congenital digestive anomalies	*(749), 750, 751*	Surgical repair of congenital anomalies [since ca. 1950]
Congenital cardiovascular anomalies	745-747	
Rheumatic heart disease	393-398	Prophylaxis [since ca. 1950]; heart valve surgery [ca. 1965]
Diphtheria/whooping cough/ tetanus/poliomyelitis	032, 033, 037, 045	Mass immunisation [since 1953]
Nephritis and nephrosis	580-589	Haemodialysis [since ca. 1960]
Hypertensive disease	401-405	Hypertension detection and treatment [since ca. 1960]
Cerebrovascular disease	430-438	
Cancer of lip	*140*	Improvements in cancer treatment, esp. combination chemotherapy [since ca. 1970]
Cancer of skin	173	
Cancer of kidney	*189*	
Hodgkin's disease	201	
Cancer of testis	186	
Leukaemia	204-208	
Cancer of cervix uteri	180	Mass screening [since 1976]

* ICD codes assigned by EN

medical care were limited to certain age groups only and thus did not apply age limits. The only exceptions were diabetes mellitus (<25 years) because improved survival had been shown to be limited to young ages only, as well as renal cancer (<15 years) and leukaemia (<15 years) because these diseases involve different pathological process in children and in adults, with markedly different responses to treatment.

In a recent update of their work Mackenbach extended their original list of amenable conditions to account for advances in medical care, with substantial innovations in, for example, treatment of ischaemic heart disease, such as thrombolytic therapy, as well as rectal cancer and hip fracture.[49]

More recent work on avoidable mortality has increasingly focused on differentiating more clearly between causes that are amenable to medical intervention, through secondary prevention and treatment ('treatable' conditions) and those amenable to interventions that

Table 5 Amenable causes of death: Westerling

Cause of death[50,51]	ICD 9	1993*	1996*
Medical care indicators			
Malignant neoplasms of large intestine, except rectum	153	✔	✔
Malignant neoplasms of rectum and rectosigmoid junction	154	✔	✔
Malignant neoplasms of cervix uteri	180	✔	✔
Hodgkin's disease	201		✔
Diabetes	250		✔
Meningitis, bacterial	320		✔
Chronic rheumatic heart disease	393-398		✔
Hypertensive and cerebrovascular disease	401-405, 430-438	(1)	✔
Chronic bronchitis and emphysema	491, 492	✔	✔
Pneumonia other than viral	ICD 8: 481, 486	✔	
Asthma	493	✔	✔
Gastric and duodenal ulcer	531, 532	✔	✔
Appendicitis, abdominal hernia, cholelithiasis & cholecystitis	540-543, 550-553, 574-575.1, 576.1		✔
Congenital malformations of heart	ICD 8: 746	✔	
Certain causes of perinatal mortality	ICD 8: 760-778	✔	
Health policy indicators			
Malignant neoplasms of trachea, bronchus and lung	162	✔	✔
Liver cirrhosis	571	✔	✔
Motor vehicle accidents	E810-E825	✔	✔
Malignant neoplasms of oesophagus	150		✔
Other			
Suicide and self-inflicted injury, incl. injury undetermined whether accidentally or purposely inflicted	E950-E959, E980-E989		✔
Malignant neoplasms of mammae	174		✔

(1) cerebrovascular disease only; * age range 1993: 0-64; 1996: 21-64

Table 6 Amenable causes of death: Nolte et al.

Cause of death[57]	ICD 9	Age group
Medical care indicators		
Infectious diseases		
Intestinal infections (other than typhoid, diphtheria)	001-009	0-14
Typhoid, diphtheria, tetanus, septicaemia, poliomyelitis, osteomyelitis	001, 002, 032, 037, 038, 045, 730	0-74
Whooping cough	033	0-14
Measles	055	1-14
Tuberculosis	010-018, 137	0-74
Malignant neoplasm of skin	173	0-74
Malignant neoplasm of breast	174	0-74
Malignant neoplasm of cervix uteri	180	0-74
Malignant neoplasm of testis	186	0-74
Hodgkin's disease	201	0-74
Leukaemia	204-208	< 15
Diseases of the thyroid	240-246	0-74
Diabetes mellitus	250	0-49
Rheumatic heart disease	393-398	0-44
Hypertensive disease	401-405	0-74
Cerebrovascular disease	430-438	0-74
All respiratory diseases (excluding pneumonia /influenza)	460-479, 488-519	1-14
Pneumonia/influenza	480-487	0-74
Peptic ulcer	531-533	0-74
Appendicitis	540-543	0-74
Abdominal hernia	550-553	0-74
Cholelithiasis (& cholecystitis)	574-575.1	0-74
Nephritis and nephrosis	580-589	0-74
Benign prostatic hyperplasia	600	0-74
Maternal deaths	630-676	all ages
Perinatal deaths all causes excluding stillbirths	760-779	all ages
Congenital cardiovascular anomalies	745-747	1-14
Ischaemic heart disease*	410-414	0-74
Primary prevention (national health policy) indicators		
Malignant neoplasm of trachea, bronchus, and lung	162	0-74
Cirrhosis of liver	571	0-74
Motor vehicle accidents	E810-825	all ages

* partly medical care indicator, partly primary prevention (national health policy) indicator

are usually outside the direct control of the health services, through healthy public policies ('preventable' conditions). This distinction was made by both Rutstein and colleagues[15] and the EC working group on avoidable deaths.[27] However Westerling was the first to explicitly compare 'treatable' conditions and 'preventable' conditions and to apply this approach empirically and systematically to data from Sweden, using various selections of causes of death, based on the work of both Rutstein and the EC group (Table 5).[14,50,51]

A similar approach was adopted by Benavides and co-workers to analyse avoidable mortality in Valencia, Spain, using indicators proposed by the EC working group and divided into 'primary prevention indicators', i.e. lung cancer, liver cirrhosis, motor vehicle injuries, and 'secondary prevention indicators', consisting of the remaining 14 causes (Table 3).[52]

Using various selections of conditions, mostly based on the EC list of avoidable deaths, this approach was subsequently adopted in studies of avoidable mortality in Lithuania[53], Valencia, Spain[54], Belgium[55], Korea[56] and, with some modification that also took account of Mackenbach's work[47], in Germany and Poland (Table 6).[57]

A slightly different approach was chosen by Simonato et al. who undertook a further differentiation of 'avoidable' causes into (1) those amenable to primary prevention, i.e. health and wider societal policies, (2) those amenable to early detection and treatment and (3) those amenable to improved treatment and medical care (Table 7).[58] These groups were defined as:

1. Causes avoidable through primary prevention, i.e. by reducing the incidence of the disease. This category includes causes whose aetiology is in part attributable to lifestyle factors (such as alcohol and/or tobacco consumption) and/or to occupational risk factors. It also includes deaths from injury and poisoning, which are influenced in part by legal and societal measures such as traffic safety and crime reduction policies.

2. Causes amenable to secondary prevention through early detection and treatment. This group includes causes of death for which "screening modalities have been established" such as cancer of breast and cervix, as well as causes for which death is avoidable through early detection combined with adequate treatment, such as skin cancer.

3. Causes amenable to improved treatment and medical care. This group includes infectious diseases, deaths from which are 'avoidable' largely through antibiotic treatment and immunisation as well as causes that require medical and/or surgical intervention such as hypertension, appendicitis, deaths of which are related to "complex interactions within the health care system, such as accurate diagnosis, transport to hospital, adequate medical and surgical care."

Tobias and Jackson refined this approach further by not classifying each condition as entirely 'avoidable' by either primary or secondary or tertiary prevention but by partitioning causes among these three categories, using an 'expert consensus' method.[59] Thus each condition considered 'avoidable' was assigned relative weights reflecting the scale of its potential preventability within each category. For example, the relative proportions of preventability by measures of primary, secondary or tertiary prevention assigned to hypertensive disease were determined to be 0.3, 0.65 and 0.05, respectively. According to this definition hypertension is thus considered to be largely amenable to secondary prevention measures. Tobias and Jackson also substantially broadened the number of conditions potentially 'avoidable' by reviewing the literature in the light of advances in health care since the early 1980s. Their final list thus included 56 conditions or groups of conditions, 24 of which were considered largely being 'avoidable' by primary prevention (preventing condition to develop), 16 mainly by secondary prevention (early detection and intervention intended to delay progression of disease or recurrence of events) and 16 mainly

Table 7 Amenable causes of death: Simonato et al.

Cause of death[58]	ICD 7	ICD 8	ICD 9
Group 1 Causes avoidable through primary prevention			
Malignant neoplasms of upper airways and digestive tract	140-150, 161	140-150, 161	140-150, 161
Malignant neoplasms of the liver	155	155	155.0
Malignant neoplasms of trachea, bronchus and lung	162-163	162	162
Malignant neoplasms of the bladder	181	188	188
Circulatory disturbances of the brain	330-334	430-438	430-438
Chronic liver disease and cirrhosis	581	571	571
Injury and poisoning	800-999	800-999	800-999
Group 2 Causes avoidable through early detection and treatment			
Malignant neoplasms of the skin (melanoma and non-melanoma)	190-191	172-173	172-173
Malignant neoplasms of the female breast	170	174	174
Malignant neoplasms of the cervix uteri	171	180	180
Malignant neoplasms of the uterus	172-174	182	179, 182
Group 3 Causes avoidable through improved treatment and medical care			
Infectious and parasitic diseases	001-138	001-136	001-139
Malignant neoplasms of the testis	178	186	186
Hodgkin's disease	201	201	201
Leukaemia	204	204-207	204-208
Chronic rheumatic heart disease	410-416	393-398	393-398
Hypertensive disease	440-447	400-404	401-405
Diseases of respiratory system	470-527	460-519	460-519
Gastric and duodenal ulcer	540-541	531-533	531-533
Appendicitis	550-553	540-543	540-543
Abdominal hernia	560-561, 570	550-553, 560	550-553
Cholelithiasis or other gallbladder disorder	584-585	574-575	574-575.1
Maternal mortality	640-689	636-678	630-676

by tertiary prevention (reducing case-fatality by medical or surgical treatment) (Table 8). They also increased the age limit from 65 to 75 to reflect improvements in life expectancy as well as improved cause of death coding for the elderly.

However, in contrast to the 'traditional' concept of avoidable mortality the broader conception used by Tobias and Jackson was intended mainly to "measure the theoretical scope for further population health gain, not what may be considered feasible given current technology, available resources and competing values." Thus the usefulness of this more comprehensive indicator as a measure of the quality of contemporary health care is somewhat limited.

Table 8 Amenable causes of death: Tobias & Jackson

Conditions involved[59]	ICD 9 CM	PAM*	SAM	TAM
Diarrhoeal diseases	001-999	0.7$	0.1	0.2
Tuberculosis	010-018, 137	0.6	0.35	0.05
Diphtheria, whooping cough, tetanus, polio, Hib, measles, rubella	032-033, 037, 045, 320.0, 055-056, 320.0, 771.0, 771.3	0.9	0.05	0.05
HIV/AIDS	042	0.9	0.05	0.05
Hepatitis A, B, C, D, E; primary liver cancer	070, 155	0.7	0.1	0.2
Syphilis, gonorrhoea + other STDs, ectopic pregnancy	090-099, 614.0-614.5, 614.7-616.9, 633	0.8	0.1	0.1
Other infectious: brucellosis + other zoonoses, streptococcus, malaria, meningitis, congenital	023-031, 034-6, 084, 771.1-2, 771.4-9 320, 320.1-9, 770.0,	0.3	0.4	0.3
Lip cancer, melanoma, other skin cancer	140, 172, 173	0.6	0.1	0.3
Stomach cancer	151	0.4	0.2	0.4
Colorectal cancer	153-154	0.4	0.5	0.1
Malignant neoplasm mouth, pharynx, larynx	141, 143-6, 148-9, 161	0.8	0.1	0.1
Malignant neoplasm trachea, bronchus, lung	162	0.95	-	0.05
Breast cancer	174	0.15	0.35	0.5
Cervical cancer	180	0.3	0.5	0.2
Cancer of uterus	179, 182	0.1	0.4	0.5
Cancer of testis	186	-	0.3	0.7
Eye cancer	190	-	-	1
Thyroid cancer	193	0.1	0.2	0.7
Hodgkin's disease	201	-	0.1	0.9
Lymphoid leukaemia	204	0.05	0.05	0.9
Benign cancers	210-234	-	-	1
Goitre, thyrotoxicosis, hypothyroidism	240-242, 244	0.1	0.7	0.2
Congenital hypothyroidism, CAH, PKU, galatosaemia	243, 255.2, 270.1, 271.1	-	0.8	0.2
Diabetes	250	0.3	0.5	0.1
Nutritional deficits including anaemia	260-9, 280, 281	1	-	-
Psychosis, alcoholism, cardiac, gastric or liver damage due to alcohol	291, 303, 305.0, 425.5, 535.3, 571.0-5	0.9	-	0.1
Epilepsy	345	-	0.9	0.1
Otitis media and mastoiditis	381-383	0.1	0.7	0.2
Acute rheumatic fever, heart disease	390-398	0.3	0.6	0.1
Hypertensive disease	401-405, 437.2	0.3	0.65	0.05
Ischaemic heart disease	410-414	0.5	0.25	0.25
Intracerebral haemorrhage or occlusion	431, 433, 434, 436	0.3	0.5	0.2
Respiratory infections including pneumonia and influenza	460-466, 480-487	0.4	0.5	0.1
Chronic bronchitis and emphysema	490-492, 496	0.8	0.1	0.1
Asthma	493	0.1	0.7	0.2
Gastric and duodenal ulcer	531-534	0.05	0.75	0.2
Appendicitis	540-543	-	-	1

Table 8 Amenable causes of death: Tobias & Jackson (*continued*)

Conditions involved[59]	ICD 9 CM	PAM*	SAM	TAM
Intestinal obstruction and hernia	550-553, 560	-	-	1
Gallbladder disease	574-576.9	0.2	-	0.8
Acute renal failure	584	0.1	0.2	0.7
Complications of pregnancy	630-632, 634-676	0.2	0.5	0.3
Skin, bone and joint infections	680-686, 711, 730	0.2	0.5	0.3
Congenital anomalies of brain and spinal cord	740-742	0.6	0.2	0.2
Congenital cardiac, digestive, genito-urinary, muskuloskeletal anomalies	743-746.6, 746.8-747.9, 749-757	0.1	0.2	0.7
Prematurity, low birthweight, respiratory disease from prematurity	764-765, 769, 770.7	0.5	0.1	0.4
Birth trauma and asphyxia	767-768, 770.1, 772.0, 772.3	0.1	0.4	0.5
Other perinatal conditions: respiratory disease, haemolytic disease, jaundice, etc.	766, 769, 770.2-6, 770.8-9, 772.1-2, 772.4-9, 773-779	0.3	0.2	0.5
Sudden infant death	798.0	1	-	-
Road traffic injury	E810-829	0.6	-	0.4
Poisoning	E850-869	0.6	-	0.4
Swimming pool falls and drownings	E883.0, E910.5, E910.6	0.8	-	0.2
Falls from playground equipment, sport injury	E884.0, E884.5, E886.0, EE917.0, E927	0.6	-	0.4
Burns and scalds	E890-899	0.8	-	0.2
Drowning	E910-910.4, E910.7-910.9, E984	0.8	-	0.2
Suicide	E950-959, E980-989	0.6	0.3	0.1
Complications of treatment	E870-879	-	0.2	0.8

* PAM – primary avoidable mortality; SAM – secondary avoidable mortality; TAM – tertiary avoidable mortality
$ proportion in each category

Empirical studies of 'avoidable' mortality

Scope and nature

The literature search identified 72 studies that have empirically applied the concept of avoidable mortality. Two studies that summarised findings of the EC Concerted Action Project on avoidable deaths only, without elaborating on it with additional analyses were excluded from the review.[12,60] Studies were analysed using a structured protocol, extracting information on (1) study region, (2) time period under investigation, (3) aim of study and definition of 'avoidable mortality', (4) causes of death and age group(s) under study, (5) analytical design and (6) main results. This information was drawn together in form of an annotated bibliography (see part III of this report).

As noted earlier, studies vary substantially regarding the selection of 'avoidable' causes but also in terms of methodological approach, study region, time period covered, selection and application of explanatory variables and, more generally, quality. In addition, there is considerable variation regarding terminology. As indicated above, some studies used the expression 'avoidable' deaths to denote mortality from conditions amenable to medical intervention[20,46] while others using this term referred to the more broadly defined concept of medical care as proposed by Rutstein et al.[15,41,56] Buck and Bull used 'preventable' mortality to refer to deaths from causes amenable to medical treatment,[61] while Westerling and others reserved this term for conditions amenable to primary prevention measures.[13,45,53] Westerling also introduced the term 'medical care indicators', which refers specifically to conditions amenable to medical intervention, as opposed to 'health policy indicators', referring to conditions responsive to measures of primary prevention, i.e. wider health policies.[50] Most recent studies tended to adopt this last terminology[54] or some variation, for example using "treatable" or "amenable" mortality to refer to conditions amenable to medical care.[45,53,57] For clarity these meanings will be used in subsequent sections of this review.

The variation in what is actually meant by 'avoidable' mortality also highlights another point that is rarely discussed, namely what is actually meant by 'medical care'. Although most studies that looked at amenable conditions refer to 'medical care', 'medical intervention', 'medical treatment', 'medical management' or 'therapeutic care' only few have provided a precise definition, for example Rutstein et al.[15] and Mackenbach et al.[47] as described in the preceding section. The EC Concerted Action Project on Health Services and 'Avoidable Deaths' refers more broadly to 'health care services', which were interpreted to include primary care, hospital care, community health services and public health programmes[27] while others used terms such as 'health services', 'health care' or 'health care delivery services' more interchangeably with for example 'medical care'.[25,62] Yet others fail to make an explicit link to 'care' or 'services' but more generally refer to 'medical knowledge' or '[medical] technology'.[63] This raises important questions about what 'avoidable' mortality is actually meant to measure, an issue that will be examined in more detail below.

In general, the comparability of studies is rather limited. However two main types of studies can be distinguished: those adopting a cross-sectional approach, by analysing 'avoidable' mortality at a particular point (or period) in time and studies that examine time trends. Using this definition, of 70 studies included in the review 30 were cross-sectional, 31 analysed trends, a further seven undertook both cross-sectional and trend analyses, while one study applied a case control design and one a prospective-observational design. Studies classified as cross-sectional mainly examined geographical variation of 'avoidable' mortality within and/or between regions/countries (n=24) or the distribution of 'avoidable' mortality according to socioeconomic and/or demographic factors such as ethnicity, usually within one region or country (n=9). Four studies examined 'avoidable' mortality at the regional or national level only. Studies that looked at changes in 'avoidable' mortality over time mostly analysed trends at the national and/or regional level (n=15), eleven studies compared trends in different regions or countries, and a further five specifically analysed trends in different socioeconomic and/or ethnic population groups.

Studies have included a wide range of high-income countries, or regions within them, mostly western Europe including Scandinavia and the Mediterranean countries, as well as the USA, Canada, Australia, New Zealand, Japan, Singapore and Korea, whereas five studies looked specifically at (selected) former communist countries of central and eastern Europe. Most studies were set in the 1970s and 1980s, especially those classified as cross-sectional.

Six trend analyses examined changes from the 1950s or early 1960s onwards, usually up to the mid-1980s. Analyses of the more recent period were less frequent (n=10), generally focusing on the first half of the 1990s.

As noted earlier, studies of 'avoidable' mortality generally used this concept as a means to assess the quality of medical/health care. However a number of studies also addressed the question as to whether mortality rates from conditions amenable to medical intervention can indeed be interpreted as an indicator of the quality or effectiveness of medical/health care.[13] Many analyses of geographical variations thus explicitly related amenable mortality to indicators of health services and/or to other factors, mostly socioeconomic indicators and/or indicators of morbidity whereas in analyses of variation by socioeconomic or demographic factors or changes in amenable mortality over time this link is usually more implicit. The following sections will look specifically at these issues and highlight some major findings of the studies being reviewed. More specific information on the studies summarised below is given in the appendix.

Variation between places

In their review of aggregate studies of 'avoidable' mortality Mackenbach et al.[13] summarised the findings of eight studies of geographical variation that had analysed the association between amenable mortality and indicators of health care/services resources and/or other (explanatory) variables.[20,26,32,33,34,64,65,66] They controlled for socio-economic and demographic factors and found that associations with indicators of health care provision were generally rather weak and inconsistent. For example, in their study of regional variation of amenable mortality in The Netherlands, Mackenbach et al. found only few associations that were statistically significant, and often not in the expected direction, for example mortality from tuberculosis was positively associated with the number of hospital beds.[66] In contrast, associations between 'avoidable' mortality and socioeconomic factors were generally found to be stronger and consistently negative.

These associations between 'avoidable' mortality and socio-economic factors are also seen in more recent studies. For example, analysing 'avoidable' mortality by region in Québec, Canada, in the 1980s, Pampalon identified statistically significant geographical variation for three causes considered amenable to medical care, i.e. tuberculosis, hypertensive disease and perinatal mortality.[43] Much of this variation was explained by socioeconomic indicators, mainly low educational level and unemployment. Perinatal mortality alone was also related to an indicator of health services, namely the consultation rate with general practitioners (GPs) although, again, socioeconomic factors explained a substantial larger part of the variation, at 83%, compared with the health services indicator that explained a 'mere' 5%. In contrast, in their cross-country analysis of amenable mortality, analysing 17 developed countries in the early 1970s, Buck and Bull identified significant negative correlations between amenable deaths and public investment in health facilities (Spearman Rho = -0.49).[61] However their analysis did not control for possible confounding through, for example, socioeconomic factors. This was partly taken account of in one other cross-country analysis by Mackenbach who examined the association between amenable mortality and per capita health expenditure in eleven of then EC Member states in 1980-84.[67] His analysis showed that while regional diversity in amenable mortality remained high even after adjustment for gross domestic product (GDP), there was no association between indicators of amenable mortality and the level of health care expenditure. Buck and Bull's study also looked more specifically at regional variation in amenable mortality and its association with indicators of health services in England and Wales in 1974/75-1977/78, using measures of general practitioner training, such as percentage of recent trainees passing exam.[61] They showed that only one of 13 measures was significantly associated with amenable mortality. However, in a multiple regression model that also took account of socioeconomic factors, these indicators explained 10% of the geographical variation in amenable mortality.

Taken together these findings suggest that there is, if any, only little evidence for an association between geographical variation in amenable mortality and differences in the quality or quantity of health services, at least as measured by easily available quantitative data. Rather, geographical variation in amenable mortality seems to be more closely related to socioeconomic conditions[13], which may in turn reflect differences in timely access to effective care. However it is not possible to examine this issue further at an aggregate level.

Variation between social groups

The usual rationale behind studies of variation of amenable mortality by socioeconomic and/or socio-demographic factors is to explore the contribution of health services to inequalities in health, based on the assumption that differences in health status between different social groups in society may be due, in part, to differences in access to and/or quality of health services.

Several studies of racial disparities in amenable mortality, mainly undertaken in the USA, consistently showed considerable differences between African-Americans and white Americans. For example, in their study of amenable mortality in California in 1978, Woolhander and colleagues demonstrated significant excess mortality amongst African-Americans from several amenable conditions such as hypertension and its complications and acute pulmonary infections as well as considerably elevated death rates from cervical cancer, diabetes and peptic ulcer.[68] Similar findings were reported from a study in Texas, showing that in the 1980s standardised mortality ratios for amenable conditions were more than three times higher amongst African-Americans than in the white American population, mainly tuberculosis, hypertension, cervical cancer, appendicitis and asthma.[69] A US study in 1980-1986 also reported substantial racial disparities with death rates from twelve amenable causes 4.5 times higher amongst African-Americans than white Americans.[70] Rates were again found to be highest for tuberculosis (8.9 times), hypertension (6.5 times), asthma (4.4 times) and cervical cancer (2.6 times). These findings were further supported by a study in New York State in 1983 that, using hospital discharge data, calculated age-adjusted case-fatality ratios for a series of amenable conditions.[63] Rates were substantially higher amongst African-Americans compared with white Americans for many amenable conditions, for example vascular complications of heart or brain associated with hypertensive disease (143.3 per 1000 discharges compared with 104.3), cervical cancer (69.4 vs. 55.4), diabetes (81.7 vs. 69.7) or Hodgkin's disease (122.1 vs. 78.1).

This consistent finding of racial inequalities in mortality from amenable conditions in the USA has also been found with disadvantaged population groups elsewhere. For example, three studies looked specifically at the distribution of amenable mortality amongst the native Maori-population compared to the non-Maori majority in New Zealand. Malcolm estimated the potential gain in life expectancy when preventable conditions, i.e. conditions 'avoidable' by primary or secondary prevention were excluded (1985-87).[42] This showed that removal of secondary preventable (i.e. amenable) conditions would result in Maori men gaining an additional 1.2 years in life expectancy compared with one year for non-Maori men (women: 1.7 and 1.0 years), with the 'true' gain for Maori and hence the difference between Maori and non-Maori New Zealanders possibly being even higher due to underestimation of Maori mortality. Tobias and Jackson also reported a considerable ethnic gap in 'avoidable' mortality in New Zealand in 1996-97, with mortality rates from conditions amenable to measures of secondary prevention being about 2.5 times higher amongst Maori people compared with European and other New Zealanders.[59] The results of these two studies further indicate that the gap in amenable mortality between Maori and non-Maori has remained rather stable over time. Indeed, analysing trends in amenable mortality, Malcolm and Salmond showed that between 1968 and 1987 there was only little improvement in the excess mortality of Maori, with the Maori to non-Maori ratio in amenable mortality declining from 2.3-2.5 to 2.0 in both sexes.[71]

Similar findings have also been reported from studies of socioeconomic variations in amenable mortality. In their case-control study of social class differences in amenable mortality in the City of Helsinki, Finland, in 1980-1986, Poikolainen and Eskola demonstrated a significantly elevated risk of premature death for those in the lowest occupational category compared with the highest category, with an odds ratio adjusted for age, sex, marital status and region estimated at 5.8 (95% confidence interval: 6.9-10.6).[72] Other studies, although using different study designs and indicators of socioeconomic status, generally reported similar findings.[56,73,74] The only exception is one study by Westerling and colleagues who found only small differences in amenable mortality between blue and white collar workers (SMR: 107 vs. 95) although there was an almost three-fold difference in mortality from gastric and duodenal ulcer (SMR: 163 vs. 59), which was statistically significant.[51] However they also reported significantly higher death rates amongst those not in work, which were three times those in the working population.

In summary, despite differences in study design, definition of socioeconomic or demographic factors, region and time period covered, these findings suggest a fairly consistent pattern with those classified as being at social disadvantage because of ethnicity or socioeconomic characteristics being at higher risk of death from amenable conditions. Taken together, these findings support the view that health services can contribute to the reduction of health inequalities. This is further illustrated by one study by Mackenbach and colleagues of the potential impact of medical care on the widening of mortality differentials between socio-economic groups between 1931 and 1981 in England and Wales and between 1952 and 1982 in The Netherlands.[75] They showed that, in England and Wales between 1931 and 1961, amenable mortality declined faster than all-cause mortality and that this decline was generally greater in higher social classes. This pattern was found to be less consistent in the period 1961 to 1981 although for half of the conditions considered amenable to medical care the declines were larger in the higher social classes. Based on these findings they concluded that medical care contributed to the observed widening of mortality differences between socioeconomic groups.

Variation over time

In their review of aggregate studies of 'avoidable' mortality mentioned earlier, Mackenbach and colleagues[13] also summarised findings from three studies of time trends in amenable mortality.[24,25,47] These studies reported considerable declines in mortality for most or all conditions considered amenable to medical intervention in recent decades, pointing to the potential impact of medical care. To account for the likely confounding effects of improving socioeconomic conditions and 'spontaneous' declines in the incidence of a number of amenable causes, they compared trends in amenable mortality with trends in mortality from other conditions, generally demonstrating that mortality from amenable causes declined much more rapidly than mortality from so-called 'not amenable' causes. For example, based on the analysis by Mackenbach and co-workers[47], the review estimated that between 1950 and 1984 amenable mortality in The Netherlands declined, on average, by 6 per cent per year in both men and women whereas, among women, mortality from non-amenable conditions fell by a mere 2 per cent per year only, and, among men, did not change at all.

These conclusions receive support from more recent studies of changes in amenable mortality. Table 9 summarises the findings of trend analyses, looking specifically at annual changes in amenable mortality. It only includes studies that have examined mortality rates, mostly age-standardised death rates and provided a summary estimate for all amenable causes and also examined trends in mortality from causes considered not amenable to medical care for comparison (n=16). The figures given in the table are calculated from per cent changes given in the respective publications. The only exceptions were two studies that provided direct estimates of the annual change in amenable mortality.[53,76]

The findings presented in Table 9 generally confirm the findings summarised by Mackenbach et al.[13] For example, examining mortality changes between the mid-1950s and the mid-1970s Charlton and Velez and Boys and co-workers showed that, in western industrialised countries, amenable mortality declined by 2.3% to 3.4% per year while mortality from all other causes fell by a maximum of one per cent per year only.[24,77] Studies looking at changes between the 1960s/1970s and the 1980s/1990s generally reported similar trends with mortality amenable to medical care again falling more rapidly than mortality from other (not amenable) causes, by an annual 3-5% compared with 1-2%.[22,25,54,55,57,71,76,78,79,80,81] Differences in the pace of change between studies are likely to be due, in part, to differences in the selection of causes of death considered amenable to medical care. However these last findings seem to suggest that the decline in amenable mortality accelerated during the 1970s and 1980s compared with the earlier period. This view is supported by the analysis by Boys et al. who showed that the pace of the decline in amenable mortality in, for example, England and Wales increased from 2.7% per year between 1955/59 and 1970/74 to 3.6% per year between 1970/74 and 1985/87.[77] These trends were mainly observed in western industrialised countries. However similar rapid declines were also reported from Singapore where, between 1965/69 and 1990/94, amenable

Table 9 Changes in amenable mortality over time: Summary of results from selected studies of 'avoidable' mortality

			causes amenable to medical care				*causes amenable to health policy*		*all other causes*		*all causes*		
	time period	*country*	*no. causes (age)*	*% of all deaths*	*total change (%)*	*change/ year (%)*	*total change (%)*	*change/ year (%)*	*total change (%)*	*change/ year (%)*	*total change (%)*	*change/ year (%)*	*note*
Boys et al. 1991[77]	1955/59-1970/74	Hungary	22 (0-64)	n.a.	-33.5	-2.2	n.a.	n.a.	-3.6	-0.2	-14.2	-0.9	SDR
		Czechoslovakia			-28.3	-1.9			6.9	0.5	-4.0	-0.3	all other:
		Poland			-42.2	-2.8			-17.7	-1.2	-25.2	-1.7	not amenable
		GDR			-	-			-	-	n.a.	-	incl. IHD
		FRG			-42.5	-2.8			-2.5	-0.2	-14.2	-0.9	
		England & Wales			-40.4	-2.7			1.8	0.1	-10.2	-0.7	
		Canada			-50.7	-3.4			-1.9	-0.1	-14.5	-1.0	
		USA			-46.4	-3.1			4.4	0.3	-8.7	-0.6	
Charlton & Velez 1986[24]	1956-1978	England & Wales	10 (5-64)	1956: 17.3; 1978: 9.6	-51.3	-2.3	n.a.	n.a.	-4.3	-0.2	-12.5	-0.6	SDR
		France		1956: 15.3; 1978: 7.4	-64.0	-2.9			-19.1	-0.9	-26.0	-1.2	
		Italy		1956: 19.7; 1978: 11.3	-57.1	-2.6			-17.0	-0.8	-24.9	-1.1	
		Japan		1956: 33.3; 1978: 19.6	-72.3	-3.3			-43.2	-2.0	-52.8	-2.4	
		Sweden		1956: 15.8; 1978: 7.1	-60.9	-2.8			-2.9	-0.1	-12.4	-0.6	
		USA		1956: 17.8; 1978: 6.3	-67.1	-3.1			-8.7	-0.4	-17.9	-0.8	
Simonato et al. 1998[58]	1955-1994	21 European countries	12 (5-64)	1955/59: 22.0% (m+f)	m -76.3	m -2.2	m -16.6	m -0.5	m -16.6	m -0.5	m -32.6	m -0.9	SDR
				1990/94: 8.9% (f); 7.6% (m)	f -77.9	f -2.2	f -29.1	f -0.8	f -29.1	f -0.8	f -45.1	f -1.3	
Bernat Gil & Rathwell 1989[78]	1960-1984	Spain	13 (5-64)	1960: 19.0; 1984: 8.9	-66.8	-2.8	n.a.	n.a.	-20.0	-0.8	-28.9	-1.2	SDR
Niti & Ng 2001[45]	1965/69-1990/94	Singapore	9 (5-64)	1964/94: 17.1 (m), 19.7 (f)	m -78.2	m -3.1	m -28.5	m -1.1	m -28.5	m -1.1	m -39.7	m -1.6	SDR
					f -67.8	f -2.7	f -34.2	f -1.4	f -34.2	f -1.4	f -42.8	f -1.7	
Poikolainen & Eskola 1986[25]	1969-1981	Finland	21 (0-64)	1969: 8.2 (m), 13.4 (f)	m -63	-5.3	n.a.	n.a.	m -24	m -2.0	m -24	m -2.0	Crude DR/SDR; all other: not amenable excl. violent causes
				1981: n.a.	f -68	-5.7			f -29	f -2.4	f -34	f -2.8	

Table 9 Changes in amenable mortality over time: Summary of results from selected studies of 'avoidable' mortality (*continued*)

			causes amenable to medical care				*causes amenable to health policy*		*all other causes*		*all causes*		
	time period	*country*	*no. causes (age)*	*% of all deaths*	*total change (%)*	*change/ year (%)*	*total change (%)*	*change/ year (%)*	*total change (%)*	*change/ year (%)*	*total change (%)*	*change/ year (%)*	*note*
Mackenbach et al. 1988b[76]	1969-1984	The Netherlands	13 (0-75)	1969: 18.4; 1984: 11.8	n.a.	-4.5	n.a.	n.a.	n.a.	n.a.	n.a.	-1.6	SDR; annual decline estimated by authors
Malcolm & Salmond 1993[71]	1968-1987	New Zealand	15 (0-64)	n.a.									SDR all other: not amenable causes
		Maori			m -75.8	m -3.8	n.a.	n.a.	m -37.1	m -1.9			
					f -72.8	f -3.6			f -46.1	f -2.3			
		Non-Maori			m -61.9	m -3.1			m -22.1	m -1.1			
					f -54.0	f -2.7			f -18.2	f -0.9			
Boys et al. 1991[77]	1970/74-1985/87	Hungary	22 (0-64)	n.a.	-14.7	-1.1	n.a.	n.a.	29.0	1.9	17.0	1.2	SDR
		Czechoslovakia			-28.2	-2.0			4.6	0.3	-3.2	-0.2	all other:
		Poland			-22.6	-1.6			16.5	1.1	7.3	0.5	not amenable
		GDR			-26.5	-1.9			2.9	-	-3.8	-0.3	incl. IHD
		FRG			-61.6	-4.4			-19.0	-1.3	-27.3	-2.0	
		England & Wales			-49.7	-3.6			-15.5	-1.0	-22.0	-1.6	
		Canada			-60.1	-4.3			-22.9	-1.5	-28.4	-2.0	
		USA			-51.2	-3.7			-21.7	-1.4	-26.2	-1.9	
Gaisaus-kiene & Gurevicius 1995[53]	1970-1990	Lithuania	11 (0-64)	1970/90: 11.8 (m), 21.0 (f)	n.a.	m -0.7	n.a.	m 0.9	n.a.	m 0.9	n.a.	m 0.2	SDR; annual decline estimated by authors
						f -0.9		f 1.3		f 1.3		f -0.2	
Hisnanick & Coddington 1995[81]	1972/79-1980/87	USA: Am. Indian/ Alaskan Native	8 (5-75)	1972/87: 7.0	m -57.0	m -7.1	n.a.	n.a.	m -30.6	m -3.8			crude DR
					f -55.5	f -6.9			f -25.5	f -3.2			
Humblet et al. 2000[55]	1974/78-1990/94	Belgium	13 (1-64)	1974/78: 7.3 (m), 20.8 (f)	m -53.0	m -3.3	m -30.8	m -1.9	m -30.8	m -1.9	m -23.9	m -1.5	mortality: YPLL
				1990/94: 4.4 (m); 20.0 (f)	f -29.7	f -1.9	f -26.7	f -1.7	f -26.7	f -1.7	f -26.7	f -1.7	

Table 9 Changes in amenable mortality over time: Summary of results from selected studies of 'avoidable' mortality (*continued*)

			causes amenable to medical care				*causes amenable to health policy*		*all other causes*		*all causes*		
	time period	*country*	*no. causes (age)*	*% of all deaths*	*total change (%)*	*change/ year (%)*	*total change (%)*	*change/ year (%)*	*total change (%)*	*change/ year (%)*	*total change (%)*	*change/ year (%)*	*note*
Lakhani et al. 1986[22]	1974/78-1979/83	England & Wales	10 (0-64)	1974/78: 17.1	-23	-4.6	n.a.	n.a.	-6	-1.2	-9	-1.8	crude DR; all other: not amenable
Marshall et al. 1993[79]	1975/77-1985-87	New Zealand [men only]	12 (15-64)	1975/77: 5.1 1985/87: 4.2	-30	-3.0	n.a.	n.a.	-14	-1.4	-15	-1.5	SDR; all other: not amenable
Kjellstrand et al. 1998[80]	1980-1990	Australia	6	n.a.	-50.7	-5.1	n.a	n.a.	-9.8	-1			SDR
		Canada	(5-64)		-37.4	-3.7			-13.7	-1.4			
		France			-36.5	-3.7			-9.6	-1.0			
		Germany (west)			-29.3	-2.9			-6.3	-0.6			
		Italy			-33.3	-3.3			-5.9	-0.6			
		Japan			-31.2	-3.1			+5.4	+0.5			
		New Zealand			-20.2	-2.0			-5.1	-0.5			
		Sweden			-38.6	-3.9			-14.8	-1.5			
		UK			-40.1	-4.0			-19.8	-2.0			
		USA			-26.9	-2.7			-10.3	-0.1			
		all			-34.4	-3.4			-9.0	-0.9			
Nolte et al. 2002[57]	1980-1988	west Germany	29 (<75)	1980:14.9 (m), 26.8 (f)	m -37.7	m -4.7	m -17.4	m -2.2	m -10.3	m -1.3	m -17.6	m -2.2	SDR
				1988:11.2 (m), 24.3 (f)	f -25.7	f -3.2	f -8	f -1.0	f -16.5	f -2.1	f -18	f -2.3	all other: not amenable excl. IHD
		east Germany		1980:18.8 (m), 29.8 (f)	m -15.6	m -2.0	m 0	m 0.0	m -6.1	m -0.8	m -5.8	m -0.7	
				1988:15.9 (m), 28.3 (f)	f -13.9	f -1.7	f 17.4	f 2.2	f -11.6	f -1.5	f -9.6	f -1.2	
	1983-1988	Poland		1983:16.5 (m), 30.0 (f)	m -5.9	m -1.2	m +5.7	m 1.1	m 2.3	m 0.5	m +3.8	m 0.8	
				1988:15.0 (m), 28.4 (f)	f -6	f -1.2	f +5.8	f 1.2	f -1.6	f -0.3	f -0.9	f -0.2	
	1992-1997	west Germany		1992:10.5 (m), 23.7 (f)	m -8.5	m -1.7	m -8.8	m -1.8	m -6.7	m -0.8	m -9	m -1.8	
				1997:10.6 (m), 23.4 (f)	f -8.6	f -1.7	f -2.3	f -0.5	f -7.5	f -0.9	f -7.7	f -1.5	
		east Germany		1992:12.5 (m), 24.5 (f)	m -17	m -3.4	m -14.3	m -2.9	m -18.2	m -2.3	m -17.7	m -3.5	
				1997:12.6 (m), 23.2 (f)	f -24.4	f -4.9	f -9.6	f -1.9	f -20.8	f -2.6	f -20.6	f -4.1	
	1991-1996	Poland		1991:14.0 (m), 26.8 (f)	m -0.4	m -0.1	m -8.8	m -1.8	m -9.9	m -2.0	m -12	m -2.4	
				1996:15.8 (m), 27.9 (f)	f -8.3	f -1.7	f -2.6	f -0.5	f -13.6	f -2.7	f -11.9	f -2.4	

mortality among men fell by 3.1% per year (women: 2.7%) compared with mortality from all other causes, at 1.1% year (1.4%).[45] Comparable trends were also reported from former communist countries of central and eastern Europe, although with declines at a lower rate, with amenable mortality falling by about 1-2 per cent per year between the mid-1970s and mid-1980s while non-amenable mortality remained more or less stable or even increased as, for example, in Hungary, Poland and Lithuania.[53,77]

A more recent study that looked specifically at changes in amenable mortality in east Germany before and after the political transition in 1990 demonstrated a substantial acceleration in the decline in amenable mortality, from 1.7-2 per cent per year between 1980 and 1988 to 3.4-4.9 per cent per year between 1992 and 1997.[57] There was also acceleration in the decline of non-amenable mortality but at a lower level, from 0.8-1.5% per year to 2.3-2.6% per year. This was not, however, observed in Poland. In fact, non-amenable mortality seemed to have fallen more rapidly in the 1990s, after the political transition, than in the 1980s when the communist system was still in place, and the decline was also at a faster rate than amenable mortality, at 2-2.7 per cent per year between 1991 and 1996 compared with 0.1-1.7 per cent per year. These differential trends were largely attributed to the slow pace of change in health care in Poland in the 1990s compared with the very rapid changes observed in east Germany after its unification with west Germany in October 1990.

In summary, analysis of changes in amenable mortality published thus far paint a rather consistent pattern of substantial declines in amenable mortality that have generally been much more rapid than declines in mortality from other causes. Due to these changes, the number of amenable deaths as proportion of all deaths has fallen considerably in all countries under study, again with some variation between countries, largely because of the selection of causes of death included. These findings suggest that "at least part of the mortality decline from amenable conditions is due to improvements in health care."[13]

Conceptual problems

Whilst many authors who have used the concept of 'avoidable' mortality have highlighted its potential value as a measure to assess the quality or effectiveness of health care it has also faced considerable criticism, in particular because of its apparent lack of association with measures of health care provision, as noted above. The following sections will briefly recap on some of the main limitations that have been identified, ordered according to major themes emerging from the literature, although some overlap between sections will be inevitable.

Relationship to health care inputs

As noted earlier, there is as yet little evidence for an association between observed geographical variations in amenable mortality and other measures of health care provision, findings that have elicited strong criticism as to the actual usefulness of 'avoidable' mortality as a measure of the quality or effectiveness of health care.[64] Mackenbach and co-workers found only few "possibly meaningful relationships" between amenable mortality and medical supply characteristics such as general practitioner density or number of hospital beds.[66] Kunst et al. also reported that levels of health care supply added "little to the explanation of regional differences" in mortality from selected 'avoidable' conditions in EC countries in the 1970s.[34] In particular the observed lack of specific intercorrelations between causes of death that broadly reflect the same type of medical care, for example appendicitis and hernia, seemed to suggest that differences were not determined by a common medical care factor. They thus concluded that the supply of health care within EC countries is likely to be above a level at which an effect on case fatality would be seen and other factors, such as inter-regional patient flows and random variation could account for observed differences. However as with Mackenbach et al.[66] they also concluded that the level of health care supply per se was perhaps not an adequate measure as it merely reflects quantity rather than quality of care.[34]

Indeed, most studies identified in the present review have looked mainly at resources or the supply of health services, using measures such as health expenditure (e.g. % of GDP spent on health)[26,61], number of health care professionals (per defined population, per capita, per patient)[26,34], proportion of specialists[33], number of hospital beds[34,43] or presence of regional, acute and/or university hospital.[33] Only few studies also looked at some process indicators such as hospitalisation rates[43], consultation rates with general practitioners and/or specialist consultations[32] or acceptance rates for dialysis/renal transplantation[80] although associations with amenable mortality using these measures were not consistent.

The lack of a demonstrable association with health care resources is, however, not entirely surprising. First, available data reflect only what is measurable and not necessarily what is important. Second, any relationship between quantity and quality is likely to be inexact. Third, geographical level of analysis may be insufficiently detailed to identify any real differences. Finally, there may be unspecified lags between changes in resources and changes in mortality. However, the rather more frequently observed association with adverse socioeconomic factors has focused attention to timely access to medical care. Consequently, Mackenbach et al. suggested that further studies at the population level should use indicators of more specific aspects of medical care delivery, perhaps with further insights to be gained by analysing how supply is organised, whether it conforms to quality standards, and how accessible it is to the population.[13]

However, whilst direct evidence in the form of a clear association between amenable mortality and measures of health service provision may be lacking in western Europe, there is growing, albeit indirect, evidence from studies from the former communist countries of central and eastern Europe in support of a link between resources and outcomes. The scale of the gap in performance between the two parts of Europe in the 1980s is likely to have been very much greater than between regions of western European countries. It has been estimated that higher death rates from amenable causes accounted for 24% of the east-west gap in Europe of 4.2 years in male life expectancy between birth and age 75 in 1988.[82] In women, the corresponding figure was 39% (gap: 2.3 years). These differences have been explained, in part, by the relative isolation of those countries from many modern health care developments. This is illustrated by the marked reduction in deaths from testicular cancer in the former German Democratic Republic (GDR) when modern chemotherapeutic agents became available after unification.[83] Other evidence suggests that shortages or inadequacies in health care may have led to less effective treatment of certain conditions, with management of hypertension and treatment of congenital heart anomalies in the GDR being cited specifically.[84-86]

A related study showed that just after German unification in 1992, when the health care system in east Germany was still in a major process of rebuilding, about 16% of the two year east-west gap in male life expectancy between birth and age 75 was attributable to conditions amenable to health care.[57] In women, differences in amenable mortality contributed 26% to the 0.8 year life expectancy gap in 1992. By 1997, the east-west gap in life expectancy in Germany had narrowed considerably, largely due to falling death rates in east Germany particularly among those aged 55 years and older.[87] The contribution of amenable conditions to the remaining health gap did not, however, change, suggesting that one reason for east Germany still lagging behind the west is a difference in the effectiveness of health care.[57] However large improvements in neonatal mortality in east Germany since 1990 may be considered to be at least partly due to improvements in the quality of perinatal care,[88] as was also seen in the Czech Republic.[89]

In contrast, some countries of the former Soviet Union experienced a substantial deterioration in the quality of health care, with a noticeable impact on aggregate mortality rates, although care is needed to separate the effects of collapse of the health care system from wider societal problems. One example is the observation of an eight-fold rise in deaths from diabetes among young people in the Ukraine since 1990, largely due to individuals experiencing a disruption in supplies of insulin and difficulties in obtaining specialised care when complications arose.[90] This example illustrates the usefulness of the concept of 'avoidable' mortality as an indicator of potential problems at the population level possibly related to health care that may then be investigated further by in depth studies.

Interpreting trends in deaths from amenable mortality over time

Findings from longitudinal studies support the view that declining mortality from amenable conditions in (western) industrialised countries is likely to reflect increased effectiveness of health care. However, as noted earlier, declines in 'avoidable' mortality may have been confounded by simultaneous changes in disease incidence. The challenge of disentangling these two factors is well illustrated by the case of tuberculosis and some other infectious diseases where observed declines in incidence in the early 20th century were largely attributed to improving living conditions. McKee and Rajaratnam noted the potential impact of cohort effects on observed falls in death rates from peptic ulcer, considered amenable to medical care.[91] This was based on findings in west Germany and Switzerland, demonstrating that a decline in mortality from peptic ulcer between 1952 and 1980 among the under 65s was matched by an increase among the elderly.[92,93] This was largely attributed to exposure to aetiological factors affecting the cohort in the past, with the improvements seen in younger people possibly linked to declining rates of early infection with *Helicobacter pylori*, reflecting improving social conditions.[94] However a more recent analysis of trends in peptic ulcer mortality in Europe showed that much of the decline between 1955 and 1989, averaging 56%, occurred between 1974 and 1985.[95] While the earlier decline in western Europe was mainly related to the cohort effect mentioned above, the more recent falls were interpreted as largely reflecting advances in treatment, exerting an effect especially since the mid-1970s due to the introduction of H2-receptor antagonists.

Most studies of amenable mortality over time have also reported substantial falls in mortality from cerebrovascular disease[20,37,96] although some authors did not consider this condition as amenable to medical intervention.[26] This discrepancy in part reflects the continuing controversy about whether declining death rates from this condition can actually be interpreted as an effect of medical care or rather reflect a spontaneous decline in incidence, perhaps reflecting the delayed impact of factors acting in utero or early childhood.[97] Thus, in western industrialised countries mortality rates have been declining particularly since the 1960s for reasons not fully understood.[98,99] However there is now considerable evidence of declining case-fatality rates, pointing to the potential impact of medical interventions (see Box 2).[98,100]

Box 2 The decline in stroke mortality and its explanations

Improved survival after stroke is likely to have accounted for much of the decline in stroke mortality in recent decades.[99] Reductions in case fatality have been demonstrated in a variety of settings[100,101,102] although findings are not consistent across geographical areas.[103]

There are several possible reasons for the observed increase in survival rates including, among others, advances in treatment and management of acute stroke[102,104,105], improvements in supportive and rehabilitative care[106,107], improved diagnostic procedures detecting milder forms of stroke[108], and lower severity of stroke.[100,109] Differences in treatment and/or management of stroke have also been put forward to explain geographical variation in stroke survival[110], at least in part.[111,112]

One other reason for the decline in stroke mortality is, of course, declining incidence, although there are some inconsistencies.[99] Thus, falls in stroke incidence have been reported in a number of regions, for example Perth/Australia[113] and Finland[114] during the 1980s and early 1990s, but not in others.[100,109,115] Some studies have noted an actual increase in incidence rates such as in Rochester/Minnesota[108] and northern Sweden (women)[116] but this seems partly to have been due to changes in diagnostic practice, with greater availability of diagnostic procedures such as radiological imaging and the possible detection of milder cases of stroke.

Notwithstanding these exceptions, the frequently observed downward trend in stroke incidence rates has been associated largely with improvements in underlying risk factors, especially high blood pressure which is one of the factors most closely associated with stroke. These have been explained, largely, by pharmacological treatment of high blood pressure or reduced salt intake.

Treatment was first considered an implausible explanation for declining mortality, mainly because effective treatment had not been available until the 1960s whereas falls in stroke mortality had been observed since the beginning of the 20th century.[99] It was however acknowledged that treatment of hypertension may have contributed to the accelerated decline in stroke mortality beginning around 1970 although, again, its explanatory power was considered relatively modest, mainly because of the perceived limited potential of the then available antihypertensive treatments to exert a significant impact at the population level.[99,117] Conversely, in their study of amenable mortality in Finland, Poikolainen and Eskola observed a rapid decline in mortality from hypertension between 1969 and 1981, which was linked to an increase in pharmacological treatment. This was estimated to have prevented approximately 500-800 deaths per year in the middle-aged population in Finland during the 1970s.[25] However other evidence from Finland suggests a considerable contribution of changes in dietary habits since the late 1970s, mainly reduced salt intake but also increased intake of polyunsaturated fats.[118]

Recent findings from the WHO MONICA Project demonstrated a significant decline in mean systolic blood pressure levels among the middle-aged in populations in 21, mainly western industrialised countries between 1979 and 1996.[119] These declines showed a strong association with stroke event rates in women, explaining 38% of the variation in event rate trends in 15 populations, taking account of a 3-4 year time lag.[120] However no such association was seen in men.

Taken together these findings indicate that the decline in stroke mortality is still far from being "fully explained". However evidence assembled so far points to the potential impact of health care on stroke mortality, both in terms of increasing survival after stroke and reducing incidence, by means of better treatment of high blood pressure. Thus, one study of 'avoidable' mortality attributed 70% of the potential avoidability of stroke to measures of secondary (antihypertensive treatment) and tertiary prevention (stroke units, rehabilitation, surgery) whilst the remaining 30% were attributed to primary preventive measures, mainly addressing smoking, diet, physical activities.[59]

To address the question of whether and to what extent observed changes in mortality can actually be attributed to specific interventions, Mackenbach and colleagues examined how changes in deaths from particular causes related to when various interventions were introduced.[47] They were able to show that the impacts of specific treatments were observable as accelerating falls in mortality from the conditions they were intended to treat. Based on this analysis they further calculated that in The Netherlands between 1950 and

1984, changes in deaths from amenable causes added a total of 2.9 years to male life expectancy at birth (women: 3.9 years) to what would otherwise have occurred. A recent update of this analysis estimated that, between 1984 and 1995, continuing declines in amenable mortality added a further 0.23 years to male life expectancy at birth (women: 0.41 years).[49] Moreover, considering conditions for which there had been important medical advances in the latter period the gain in life expectancy attributable to falling amenable mortality would equal 1.1 years in men and 0.8 years in women.

In summary, when interpreting trends in mortality, whether amenable or otherwise, a degree of caution is required because of factors such as changing disease incidence, which may reflect changes in risk factors acting over prolonged periods. This raises the issue of attribution of health outcomes to changes in health care, an issue that is examined in the next section.

Selection of 'avoidable' conditions and the attribution of health outcomes

Clearly any list of indicators of 'avoidable' mortality used is, to some extent, arbitrary as a death from any cause is typically the final event in a complex chain of events. As noted earlier the decision as to whether a particular cause of death be classified as 'avoidable' or not depends upon the definition of medical/health care selected. The choice of category is essentially based on a judgement about the relative effectiveness of different interventions that might prevent death. This, however, requires a clear definition of what types of intervention should be studied in relation to a particular cause of death as well as an assessment of the relevant evidence of the possibility of influencing mortality by means of that intervention. Thus, Walsworth-Bell and Allen questioned the inclusion of some 'avoidable' conditions as performance indicators for health services.[121] They analysed eight of fourteen conditions considered amenable in a selected area in England and Wales in 1981-1983 that Charlton et al.[20] had identified as performing poorly in terms of amenable mortality and, hence, medical care. Based on an analysis of case notes for each death from these conditions they found "convincing" cases for 'avoidability' for hypertension and cancer of the cervix only, identifying health care related factors that may, in most cases, have altered the final outcome. For most other causes there was only little evidence of inappropriate care and, hence, scope for averting death. The authors thus concluded that only deaths from hypertension and cervical cancer appeared useful indicators for assessing the quality of medical care.

However the advocates of the original concept had accepted the limited usefulness of analysis of aggregate data as a means of assessing quality of care. Rutstein and Charlton et al. emphasised the need to supplement aggregate analyses with more detailed local enquiries (Box 3).[21,122] Holland and Breeze further stressed that 'avoidable' deaths should not be interpreted as absolute measures of outcome and that they "do not provide definitive evidence that a particular service is wrong."[123] Westerling also noted the risk of 'false warning signals' that may be produced especially by small area analyses of amenable mortality, due to random variation.[50] In line with Rutstein[122], Charlton et al.[21] and others he thus suggested using indicators of avoidable mortality for monitoring but limiting them to acting as a starting point for in-depth analysis.

Box 3 Confidential enquiries

Building on the findings by Charlton et al.[20], Holland and Breeze reported on two District Health Authorities (DHA) in England and Wales that were identified as having high standardised mortality ratios (SMRs) for certain avoidable deaths.[123] Both DHAs looked, in detail, into deaths from cervical cancer using patient records from local GPs and hospitals for the period 1979-1984. As a result of this enquiry, DHA 1 identified shortcomings in the screening system as a major explanation for the observed elevated death rate from cervical cancer, in particular failures in following up abnormalities that were suspicious. DHA 2, in contrast, did not find shortcomings in services as such but noted that the major obstacle in curbing cervical cancer death rates was low uptake of screening services. This was believed to reflect gaps in knowledge and other individual factors influencing health seeking behaviour although poor accessibility and acceptability of services may have been important as well, aspects that can be interpreted as a failure of the screening process to reach high risk individuals.

Similarly, differences in levels of maternal mortality between European countries as highlighted for example in the EC Atlas of 'Avoidable Death'[28] have prompted the formation of the European Concerted Action on 'Mothers' Mortality and Severe morbidity' (MOMS) .[124] Their findings suggest that the higher level of maternal mortality rates in France compared to its European neighbours may, in part, be attributed to substandard care related to obstetric haemorrhage[125,126], reinforcing similar findings from an earlier study on this topic.[127] The French team took this observation forward in a subsequent analysis that looked more specifically into morbidity related to obstetric haemorrhage and showed that up to one-third of patients received substandard or inappropriate care. This was attributed mainly to organisational features, thus highlighting the need for re-organisation of obstetric services in the areas under study.

The changing concept of avoidability

Importantly, most studies of amenable mortality were set in the 1970s and 1980s, often using a shortened version of Rutstein's list[15] or some modification of the lists by Charlton et al.[20] and/or the EC group.[28] These reflect consensus about what was considered achievable by medical care at that time. However there have been substantial advances in the scope and quality of health care since then, so that some causes of death previously considered not being amenable can now be treated effectively. At the same time, progress in health care may have made questionable the value of some conditions, previously considered as being relatively 'robust' indicators of the quality of health care, such as perinatal mortality (Box 4).

Box 4 The changing meaning of perinatal mortality

Studies of 'avoidable' mortality usually consider perinatal mortality as an important indicator of the quality of health care.[15,20,28] This indicator has, however, been criticised.[128] As industrialised countries in particular reach the limits of improvements in perinatal mortality rates are increasingly based on very small numbers, which are "very dependent on precise definitions of terms and variations in local practices and circumstances of health care and registration systems."[129] Also, comparisons between countries are problematic because of variations in definitions used and, in industrialised countries, the declining subset of perinatal deaths that are actually amenable to medical care. For example, advances in obstetric practice and neonatal care have led to improved survival of very preterm infants, resulting in (varying) redefinitions of viability criteria. Outcomes are also affected by attitudes to viability of preterm infants[130] and thus to the appropriateness of strenuous efforts to save very ill newborn babies rather than what may be seen as a more humane decision to withdraw therapy.[131] Legislation and guidelines concerning end-of-life decisions vary among countries, from strong protection of human life in some to active intervention to end life in others, such as The Netherlands.[132]

A related problem is variation in actual registration procedures and practices, which may be considerable between countries, reflecting different legal definitions of the vital events to be declared. One example is the delay permitted for registration of births and deaths, ranging from three up to 42 days within western Europe.[129] This is especially problematic for small and preterm births with deaths occurring during the first day of life most likely to be under registered where permitted delays are longest.

Congenital anomalies are an important factor contributing to perinatal mortality. However improved ability of prenatal ultrasound screening to recognise congenital anomalies has been shown to have affected perinatal mortality because of termination of pregnancy following prenatal screening, thus shifting deaths of malformed fetuses from a registered fetal or infant death to an induced abortion.[128,129]

This phenomenon increasingly explains international variation in infant deaths due to congenital anomalies[133] with, for example, a high rate (44%) in Ireland, which has limited prenatal screening and legal prohibition of induced abortion, compared with France (23%), where there is routine prenatal screening linked to ready access to induced abortion throughout gestation, although the total number of deaths (aborted plus delivered) is actually higher in France.[134]

For these reasons the use of perinatal mortality as an indicator of the quality of health services in international comparisons may be misleading unless these factors are being taken into account, for example by applying common definitions. However evidence from perinatal audits undertaken in a variety of settings suggests that notwithstanding the improvements in antenatal and obstetric care achieved in western industrialised countries in recent decades, current perinatal mortality could be reduced by up to 25% by further improvements in quality of care.[129] This implies that, as long as care is taken to ensure comparisons are valid, perinatal mortality can still serve as a meaningful outcome indicator in international comparisons. This conclusion receives further support from findings of a recent international audit of perinatal deaths in regions of ten European countries (EuroNatal audit), which showed that differences in perinatal mortality rates may, in part, be explained by differences in the quality of antenatal and perinatal care.[135]

Yet few studies analysing more recent periods have taken account of these changes. Thus, as noted above, Mackenbach expanded his original list of amenable conditions to include ischaemic heart disease, as the introduction of thrombolytic therapy had led to improved survival of patients; rectal cancer because of the introduction of more effective combinations of surgery and radiotherapy; and hip fracture, mortality from which has benefited from more aggressive surgical treatment of elderly patients.[49] One other example is a study by McColl and Gulliford who developed twelve outcome indicators to assess the effectiveness of (local) health services in addition to selected 'avoidable death' indicators as derived from the work by Charlton et al.[20,136] However their approach differed from the concept of 'avoidable' mortality in that they also included indicators of morbidity as well as process oriented indicators such as immunisation rates. Tobias and Jackson went further by updating Charlton's original list to include 56 conditions or groups of conditions, so substantially broadening the concept of 'avoidable' mortality.[59] As noted above, their study also categorised each 'avoidable' cause of death according to the level of intervention involved, i.e. primary, secondary or tertiary intervention. This highlights one intrinsic problem of 'avoidable' mortality, namely the attribution of health outcomes to specific elements of health care.

This is especially apparent in the case of ischaemic heart disease (IHD). The contribution of medical care to the decline in ischaemic heart disease mortality remains controversial although accumulating evidence suggests its impact to be considerable. Beaglehole, for example, calculated that 42% of the decline in deaths from cardiovascular disease in New Zealand between 1974 and 1981 could be attributed to advances in medical care.[137] Similarly, a study in The Netherlands estimated the potential contribution of specific medical interventions (treatment in coronary care units, post-infarction treatment and coronary bypass grafting) to the observed decline in IHD mortality between 1978 and 1985 at 46%, while another 44% were attributed to primary prevention efforts such as smoking cessation, strategies to reduce cholesterol levels and treatment of hypertension.[138] Using a computer-simulated state-transition model, Hunink et al. estimated that about 25% of the decline in IHD mortality in the USA between 1980 and 1990 could be explained by primary prevention whereas another 72% was due to secondary reduction in risk factors or improvements in treatment of patients with IHD.[139] Including a variety of measures of primary (e.g. treatment of hypertension) and secondary prevention (e.g. treatment following myocardial infarction) Capewell et al. calculated that 40% of the decline in coronary heart disease mortality in Scotland between 1975 and 1994 could be attributed to medical care.[140] This was further supported by another study in Auckland, New Zealand that, taking account of medical and surgical treatments administered to patients with ischaemic heart disease and trends in cardiovascular risk factors in the population and, in particular, smoking, cholesterol levels and hypertension, estimated that 46% of an observed decline in IHD mortality of 23.4% between 1982 and 1993 could be attributed to treatment while 54% was attributed to risk factor reductions.[141] This general picture receives further support from the WHO MONICA project, linking changes in coronary care and secondary prevention practices to the decline in adverse coronary outcomes between the mid-1980s and the mid-1990s.[142]

These findings suggest that a considerable proportion of IHD may be amenable to medical care. Consequently, Tobias and Jackson have assigned 25% of the potential preventability to measures of secondary prevention such as treatment of hypertension and high cholesterol and a further 25% to tertiary prevention measures, mainly treatment of acute episodes and surgery to unblock coronary arteries (see also Box 2).[59] The estimates of the quantitative attribution of health outcomes to specific components of health care were based on an expert consensus process "in the absence of any more objective measure for assigning the weights." [59] Whilst, as the authors concluded, further research on this area is certainly warranted it appears questionable whether it is feasible to assess the precise impact of particular interventions on some conditions, given the multifactorial nature of many chronic diseases and the phases involved in developing the actual condition. One might even question whether this is actually desirable because such estimates would suggest a degree of accuracy that is unlikely to be achievable, due to the nature of the approach and the quality of data available.

Treatment or prevention

As noted earlier, various authors have distinguished conditions where death can be averted by prevention ('preventable') or by treatment ('amenable', 'treatable'). This concept can be confusing so some clarification is required. Amenable conditions are defined as those from which it is reasonable to expect death to be averted even after the condition has developed. This covers diseases such as appendicitis and hypertension, where the clinical nature of the intervention is apparent. It also includes causes of death susceptible to secondary prevention through early detection and effective treatment, such as cervical cancer, for which effective screening programmes exist, and such as tuberculosis where, although the acquisition of disease is mainly driven by socio-economic conditions, timely treatment is effective in preventing mortality.

Preventable conditions typically include those for which there are effective means of preventing the condition from occurring. These include causes whose aetiology is, to a considerable extent, related to lifestyle factors, most importantly the use of alcohol and tobacco (lung cancer and liver cirrhosis). This group also includes deaths amenable to legal measures such as traffic safety (speed limits, use of seat belts and motorcycle helmets).

Where a condition is both preventable and amenable to treatment, then the amenability will prevail. Thus, 'preventable' conditions, in this context, are actually a sub-set of those that might otherwise be considered as being able to be prevented by public health measures and are characterised by their relative lack of effective treatment once they have developed.

Clearly some conditions have features that place them on the interface between these categories. Thus, declining mortality from cardiovascular and cerebrovascular diseases may to a substantial part have been due to changes in diet and thus 'preventable', while improvements in mortality from traffic accidents may also have been impacted by substantial improvements in emergency services, and thus 'treatable' (similarly: HIV/AIDS).

A somewhat extreme illustration of this last example is the finding of a recent study on the impact of medical care on death rates from homicide. Based on the observation that since the 1960s the lethality of serious criminal assault in the USA has dropped substantially despite a simultaneous increase in assault rates, Harris et al. examined time-series data on criminological data on murder, manslaughter and assault as well as health data and data on medical resources and facilities.[143] They estimated that contemporary US homicide rates would be up to five times higher than they would have been in the absence of advances in medical technology and related health care support.

In summary, some of the criticisms of amenable mortality have been based on a false premise, proposing that it should deliver more than it was ever intended to. Measures of amenable mortality can rarely, if ever, confirm the presence and nature of a problem. Instead, they can act as an indicator of possible concern that should be investigated further. In some cases there will be straightforward explanations, such as changing disease incidence, but often problems related to the organisation or delivery of health care will be identified. However when applying the concept of amenable mortality today it is important to update the list of causes that are included to take account of recent advances in health care. It is also important to be aware that the nature of attribution of an outcome to a particular aspect of health care is intrinsically problematic because of the multi-factorial nature of most outcomes. As a consequence, when interpreting findings a degree of judgement must be applied, based on an understanding of the natural history and scope for prevention and treatment of the condition in question.

Contribution of amenable conditions to overall mortality

Another criticism addresses the observation that conditions amenable to medical intervention form only a small proportion of total mortality and analyses of trends are thus likely to overemphasise the overall impact of health services.[144] For example, applying the concept of 'avoidable' mortality as used by the EC Concerted Action Project to Sweden in 1974-78 and 1980-84, Westerling and Smedby showed that ten out of 14 causes of death that were considered indicators for the quality of medical care intervention occurred, on average, less than 50 times per year[37], in many cases reflecting the low level of mortality in

Sweden. At the sub-national level, even when aggregating data over periods as long as five years, expected rates would be small for most conditions. The authors thus concluded that these indicators were of limited use for further studies on quality of health care in Sweden and other countries where overall mortality is now very low.

This criticism arises largely because the original advocates of this concept adopted the somewhat arbitrary criterion that only deaths occurring under the age of 65 could be considered amenable. This is inconsistent with life expectancies at birth in the high 70s or low 80s in many industrialised countries and was addressed by Mackenbach et al. by increasing the age limit to 75.[47] This criticism also ignores the enormous changes in the scope of health care, especially since the 1980s.

Low age limits seem no longer justified in the light of new evidence regarding, for example, hypertension and stroke. Two large studies, the Systolic Hypertension in the Elderly Program (SHEP) and the Systolic Hypertension in Europe study (Syst-Eur), were able to show the benefits of antihypertensive drug treatment for elderly patients with isolated systolic hypertension (ISH) with respect to stroke and other major cardiovascular events.[145,146] The SHEP study demonstrated that, in a cohort of patients over 60 years of age (mean age: 72 years), treatment of ISH reduced the total risk of stroke by 36%, the incidence of cardiovascular disease in general by 32% and of coronary heart disease by 25%.[147] Setting an age limit at 65 years for the 'avoidability' of mortality from hypertension and stroke is likely therefore to underestimate the 'true' impact of health care.

Similarly, evidence from England and Wales of improved survival from certain cancers during the 1990s, such as female breast cancer, cancer of the colon and rectum, the bladder and malignant melanoma point to the potential for reducing mortality from these causes at least up to age 75.[148] Improved survival from female breast cancer was largely attributed to a combination of earlier diagnosis and the introduction of a breast screening program as well as improvements in treatment.[149,150] However studies on cancer survival continue to stimulate intense debates on whether improved survival indeed reflects advances in treatment or rather obscures increased detection of early, "survivable" tumours and related methodological problems.[151,152]

In summary, the choice of an upper age limit of 65 is no longer justified because of the increase in life expectancy since the first studies were undertaken.

Underlying disease incidence and disease severity at presentation

An intrinsic problem with the concept of 'avoidable' mortality is that it takes no account of differences in the underlying incidence of disease, or of the severity of disease at presentation. The latter is a function of health seeking behaviour and thus is partly outside the scope of health services. However, it may also reflect access to care and should therefore, at least in part, be amenable to health services. As the incidence of disease will vary between places and over time, reflecting changes in the determinants of disease, some of which may only exert their effects after many years, superficial comparisons of 'avoidable' mortality' may be quite misleading.

Where studies have taken account of underlying disease incidence, usually using hospital discharge data as proxy for incidence, they have unsurprisingly shown a positive correlation between incidence and mortality for a number of amenable conditions.[62,65] In these studies differences in incidence have generally explained the greatest part of observed variation in mortality between regions from selected amenable conditions although significant heterogeneity remained even when this was taken into account. The only exception was cervical cancer in the Netherlands where what had been a significant regional variation disappeared once variation in incidence rates had been accounted for.[62] A study in Sweden looked at whether the proportion of deaths from selected causes occurring outside hospital could explain regional variation in mortality from these causes, assuming that for certain ‘avoidable’ conditions acute medical management may have an important impact on the outcome.[153] However it found little evidence that this was the case. The only exceptions were for diabetes and gastric ulcer in some predominantly isolated regions, where high death rates outside hospital co-existed with high total death rates, indicating the need for further in-depth studies in those areas.

In summary, it would be desirable to take disease incidence into account but this is often not possible. However, it has been shown that variations in amenable mortality cannot simply be explained by differences in disease incidence.

Other limitations

Cause of death certification and coding

A further criticism of the concept of ‘avoidable mortality’ arises from the observation that differences may be due, at least in part, to differences in diagnostic patterns, death certification or coding of cause of death. This problem is common to all analyses that employ geographical and/or temporal analyses of mortality data. However this must be set against the advantages of mortality statistics, as they are routinely available in many countries and as death is a unique event, in terms of its finality, so it is clearly defined.[154] There are, of course, some important caveats regarding the quality of recording of causes in the official statistics, which limits their suitability for epidemiological analysis. Thus, mortality data inevitably underestimate the burden of disease attributable to low-fatality conditions, such as mental illness, or many chronic disorders that may rarely be the immediate cause of death but which do contribute to mortality, such as diabetes.[154,155]

Further problems arise from the different steps involved in the complex sequence of events that leads to allocation of a code for cause of death.[156,157] It has been argued that the WHO rules for selecting the principal cause of death are open to varying interpretations and are likely to pose considerable problems in certifying deaths at old age when multiple conditions complicate the definition of a single underlying cause of death.[158] In addition, diagnostic habits and preferences of certifying doctors are likely to vary depending on diagnostic techniques available, cultural norms, or even professional training. Simple inaccuracies in completion of death certificates, such as errors in reporting the sequence of events or illegible statements may also reduce data quality. Validity of the cause of death statistics may also be affected by the process of assigning the ICD code to the statements given on the death certificate. Problems of comparability may also arise from differences in the translation of ICD as has been observed for the German versions of ICD-8 and ICD-9 in use in west Germany and the former GDR.[159] Thus, cause-specific data are at risk of misclassification from a variety of sources. This last point was emphasised by Carr-Hill et al. who pointed to evidence suggesting a correlation between quality of medical records as source of cause of death and quality of medical care.[64]

In summary, when interpreting data on amenable mortality, as with any studies using data on cause of death, it is important to be aware of potential problems with disease classification and coding.

Focus on mortality

Holland and Breeze further noted that "while careful examination of mortality from specific causes can provide information on the outcome and effectiveness of health services, mortality is not always an appropriate indicator."[123] They noted that mortality is at best an incomplete measure of health service performance and is irrelevant for those services that are focused primarily on relieving pain and improving quality of life.

However reliable data on morbidity are still scarce and although progress has been made in terms of setting up disease registries other than the more widely established cancer registries, for example for conditions such as diabetes, myocardial infarction or stroke, these often cover only some regions in a country. In contrast, routinely collected health service utilisation data such as inpatient data or consultations of general practitioners and/or specialists usually cover an entire region or country. But whilst potentially useful, utilisation data, especially consultation rates, usually mainly reflect health care needs of those who (actively) seek care and not necessarily those in need of care, which is largely socially determined.

Buck and colleagues also pointed to the importance of non-health outcomes of health care.[160] These would include, amongst others, the potential impact on the general well-being (of society) of the redistributional effects of health care. Another issue is the intrinsic value of the health care process itself (process utility), which is the potential benefit to patients of being able to hand over responsibility for health care decision making - and any potential risk related to that decision - to an agent, i.e. the doctor, so relieving themselves of responsibility for a difficult decision and gaining the reassurance that results from the transfer of expert information. A related benefit of organised health care, where this involves an element of redistribution, is alleviation of the risk of impoverishment as a consequence of disease.[160]

Negative consequences of medical care

One final point that is rarely addressed in studies of 'avoidable' mortality is the potential negative impact of medical care. This may be because, notwithstanding the work of Illich, the concept of iatrogenesis has only relatively recently risen high on the policy agenda. However it is now clearly recognised as a matter of concern, with a recent study estimating that the annual number of deaths resulting from medical errors in the USA as up to 98,000 per year.[161] Similarly, in the UK, the Bristol Inquiry into the management of care of children receiving heart surgery[162] has contributed to a growing "error prevention movement"[163] as to reduce medical errors and their impact.[164] Rutstein et al. did include surgical and medical complications and misadventures, nosocomial infections and iatrogenic disease in their list of unnecessary deaths.[15] However, the only study of 'avoidable' mortality that has included deaths related to medical error published so far is the analysis by Tobias and Jackson in New Zealand.[59]

Alternative approaches to assess the contribution of medical care to population health

Given the limitations of the concept of 'avoidable' mortality, it is necessary to examine proposed alternative approaches to assessing the quality of health care at a population level. Buck and colleagues reviewed various approaches to assessing the societal contribution of health care.[160] In addition to 'avoidable' mortality, they identified two other empirical approaches, the inventory approach and the production function approach.

The inventory approach

The inventory approach refers to analyses that looked at individual health services, identifying the relevant population at whom they are aimed and quantified the associated burden of disease. Examples include early work by McKinley and McKinley, who examined the effect of chemotherapeutical and prophylactic interventions on the mortality decline in the United States since 1900.[6] Based on their analysis of the date of the introduction of each intervention in relation to the decline in death rates from various infectious diseases they estimated that 3.5% of the fall in infectious disease mortality since 1900 could be attributed to medical interventions. Although criticised by others[165], this estimate compares very well with one study by Mackenbach mentioned earlier who calculated that of the total decline of infectious disease mortality in The Netherlands between 1875/79 and 1970 between 1.6 and 4.8% can be attributed to medical care.[8]

Other studies employing the inventory approach include the work by Bunker and co-workers[166,167] as identified by Buck et al. and, more recently, Wright and Weinstein.[168] Both groups adopted an essentially similar approach, i.e. using published evidence on the effectiveness of specific preventive and curative health services to estimate the potential gain in life expectancy. Thus, examining the impact of 13 (clinical) preventive services such as cervical cancer screening and 13 curative services, e.g. treatment of cervical cancer, Bunker et al. arrive at an estimate of 1.5 years gain for preventive services with a potential further gain of 7-8 months, while the gain for curative services was estimated at 3.5 to four years (potential further gain: 1-1.5 years).[166] Taken together these calculations suggest that about five years (or 17%) of a total gain in life expectancy of 30 years in the USA during the 20th century may be attributed to clinical preventive and curative services.[167]

The analysis by Wright and Weinstein looked more explicitly at specific interventions and target populations, thus estimating that, for example, in 35-year olds with highly elevated blood cholesterol levels of > 300 mg/dl the reduction of cholesterol to 200 mg/dl would result in a life expectancy gain of 50-76 months in that particular group.[168] In comparison, targeting 35-year olds at average risk by helping them to quit smoking was estimated to increase life expectancy by eight to ten months.

One limitation of these kinds of analyses is that they largely assume that health gains as reported in clinical trials translate directly into health gains at the population level. This is not necessarily the case.[169] For example, evidence from randomised controlled trials shows that the pharmacological treatment of high blood pressure reduces the risk of stroke. Yet the application of this knowledge in primary care is hampered by a number of problems, for example inaccuracies in the detection of people most likely to benefit from the treatment or poor adherence to treatment by patients as well as poor adherence to established management guidelines by professionals. Thus, assuming that hypertension treatment reduces the stroke risk by 42%, that half of the hypertensive population are detected and of those half are on treatment with only 50% being well controlled, Ebrahim calculated that the efficacy of 42% will be reduced to 5% community effectiveness.[170]

More importantly, the approach chosen in the two sets of studies is intrinsically selective in that they identify specific services that do not encompass the full scope of health services. For example, the impact of a screening service for, for example, detecting the precursors of cervical cancer will largely depend on how the actual screening programme is organized, i.e. whether it is proactive and a defined population (e.g. community) is offered screening by invitation, or opportunistic, which is restricted to patients who consult a health practitioner usually for reasons other than screening. Also, by analysing each service individually, they overlook possible interaction between services.[160] One other drawback of this approach relates to the focus on mortality, similar to studies of 'avoidable' mortality. Bunker and colleagues tried to overcome this limitation by further assessing the potential impact of medical care on quality of life.[166] Again using published evidence on the effects of specific treatments for a certain illness or condition but in the absence of formal quantitative measures, they looked at an indicator "magnitude of relief in treated patients", subsequently translated into "potential years of relief per 100 population."[167] Looking at 19 conditions as diverse as unipolar depression, terminal cancer (severe pain) and cataract it was thus estimated that an individual has, on average, been relieved (from pain, by restoring function, by preventing complications) from about five years of poor quality as a result of medical care. Although providing different and potentially useful results, the underlying approach is similar to the analysis of gains in life expectancy and thus subject to the same methodological limitations.

Finally, the inventory approach was also adopted in a recent study by Cutler and McClellan, although from a slightly different angle that applied an economics perspective to the estimated impact of technological advances in medical care on selected conditions.[171] For example, looking specifically at survival from heart attacks amongst Medicare beneficiaries in the period 1984 to 1998 and changes in treatment and associated costs they estimate that for every $1 spent on treatment there had been a health gain of $7. They thus concluded that "(T)echnology increases spending, but the health benefits more than justify the added costs."[171] Similar net benefits were estimated for low-birthweight infants, where a twelve-year increase in life expectancy between 1950 and 1990, valued at $240,000, was found to substantially outweigh the associated cost increase of advances in medical and non-medical treatment of $40,000 during the same period. Improved treatment of depression and cataract was also found to achieve net benefits when monetary values were applied to improvements in quality of life, i.e. reduction in time spent depressed or improved vision.

By also looking at cost of treatment these analyses certainly add a further important dimension to assessing the contribution of health care to population health. One major limitation of this last kind of analysis is, however, that it only provides information about the potential health gain of those who have access to care.

The production function approach

The production function approach describes "the production of health in terms of a function of possible explanatory variables."[160] There is an abundance of research, mostly from a (health) economics perspective that has adopted this approach, usually examining factors indicative of health care ('health care input') and other explanatory variables for their impact on some health measure ('health care output') through regression analysis. As with the previously described studies that have looked more specifically at the association between selected health care indicators and amenable mortality, these studies have produced mixed findings. Thus, one early study by Cochrane and co-workers demonstrated in a cross-sectional analysis that included 18 developed countries that, contrary to the expectations, health care indices were not negatively associated with (age-specific) mortality rates and moreover, a higher number of doctors per head was positively related to mortality at young ages.[172] In contrast, gross national product (GNP) per capita showed a strong and consistent negative association with mortality. Others have also failed to identify strong and consistent relationships between health care indicators such as health care expenditure and health outcomes, usually (infant) mortality or life expectancy, after controlling for other factors, whereas socioeconomic factors were found to be powerful determinants of health outcomes.[173,174,175]

However, more recently Cremieux et al. showed that in within Canada lower health care spending was associated with an increase in infant mortality and a decline in life expectancy, and that this relationship was independent of a number of (socio)economic and lifestyle variables.[176] More specifically, they estimated that a 10% reduction in health care spending was associated with higher infant mortality of about 0.5% and lower life expectancy of 6 months in men and 3 months in women. Also, in a recent cross-country analysis that examined the determinants of health outcomes in 21 OECD countries, Or identified a significant negative relationship between health expenditure and premature mortality among women as measured in Potential Years of Life Lost (PYLL).[177] However, for men this association was, although negative, less strong and as with other studies, the impact of wider environmental factors, especially socioeconomic indices, was found to be more important than health care inputs. This was especially pronounced in a related analysis that assessed the relative importance of medical and non-medical factors to the decline in premature mortality in OECD countries between 1970 and 1992. It showed that of an overall decline in premature mortality in all 21 OECD countries of 61.9% among women (men: 52.7%), 13.5% (2.9%) was accounted for by rising in health care expenditures whereas the rise in the employment share of white-collar workers accounted for 29.5% (27.1%).

A subsequent analysis by the same author broadened the spectrum of health outcome indicators and also took account of non-monetary health care input variables, i.e. number of doctors per capita, as well as type of reimbursement (salary, fee-for-service, capitation) and a measure of access to services (gatekeeper).[178] It showed a strong negative and statistically significant association between the number of doctors and premature and infant mortality as well as life expectancy at age 65, suggesting that a ten per cent increase in doctors - all else being equal - would result in a reduction in premature mortality of almost 4% in women and 3% in men. Only the association with occupational status was stronger whereas for men GPD was an equally strong determinant. There was also evidence that a larger share of public financing of health care was associated with lower rates of premature and infant mortality, whereas the characteristics of the health care system, i.e. funding mechanisms appeared to be less important. This last point was addressed in an analysis by Elola and colleagues who examined the association between health care systems and selected health outcomes, namely premature mortality (potential years of life lost, PYLL) and infant mortality in 17 western European countries.[179] They distinguished two basic forms of health care systems: national health services (e.g. UK, Denmark, Ireland, Italy, Spain) and social security systems (e.g. Germany, Austria, Netherlands). Controlling for socioeconomic indicators such as Gini-coefficient their regression model predicted that countries with national health services systems would have lower infant mortality rates at similar levels of GDP and health care expenditures than social security systems.

However while these last findings point to a role of health care for health that may be greater than previously assumed, studies reported so far are subject to a number of methodological problems. Apart from obvious limitations arising from data availability and reliability, both in terms of health care resources and health outcomes, with models driven largely by data availability, one major weakness relates to the cross-sectional nature of many these analyses. The contribution of health care to population health is likely to operate over a period of time, with potentially considerable time lags between intervention and outcome. Yet, the usual approach is to associate contemporary inputs with current outcomes. This was illustrated in an analysis by Gravelle and Backhouse who re-examined the work by Cochrane et al.[172] and, by lagging the explanatory variables were able to show that past inputs are more significant in determining mortality than current ones.[180] A related problem is that of causality a cross-sectional design is ill-equipped to address adequately. Finally, Gravelle and Blackhouse also highlighted the general problem of analyses operating at the aggregate level within or between countries or regions as they are likely to miss important relationships at the sub-national or regional level.[180] Finally, these models often lack any theoretical basis that might indicate what causal pathways existed.

Future directions

This review has traced the evolution of the concept of "avoidable mortality" from its inception in the 1970s. 'Avoidable' mortality was never intended to be more than an indicator of potential weaknesses in health care that can then be investigated in more depth. Notable examples include the studies that observed high death rates from cervical cancer and from hypertension in English districts that, on further investigation, led to the identification of shortcomings in health care[12], or the study of diabetes in Ukraine where a rapidly increasing death rate, that had not been identified by those responsible for reporting on official statistics, led to the identification of a serious breakdown in the delivery of health care.[90] In contrast, many of the critics of 'avoidable' or, more specifically, amenable mortality have asked that it do something it was not intended to do, to be a definitive source of evidence of differences in effectiveness of health care. Similarly, it is not unexpected that studies seeking to link amenable mortality with health care resources have failed to do so, especially when undertaken within countries, although it is notable that where gross differences exist, as between western and eastern Europe, the gap in amenable mortality is especially high. Thus, Holland's statement that "[A]voidable deaths provide a valuable measure of quality. [...] It has a valuable part to play in observing changes in performance over time. The methodology can be applicable to other areas of concern, for example alerting managers to variations in mortality within regions. [...] This technique can provide indicators of areas where future research is necessary" remains valid.[181] For these reasons, it seems reasonable to continue and extend the extensive body of research that has already been undertaken to look at amenable mortality, updating the list of conditions included to reflect the changing scope of health care and extending the age limit to reflect increasing expectation of life. However it must be recognised that the concept of amenable mortality does have important limitations, relating to comparability of data, attribution of causes, and coverage of the range of health outcomes.

Comparisons of health system performance are now firmly on the international policy agenda, especially since the publication of the 2000 World Health Report. Incorporation of the concept of amenable mortality into the methodology used to generate the rankings of health systems in that report would be an advance on the current situation. In contrast, neither the inventory or production function approaches offer any benefit in this context. However, this would not address one of the major criticisms of such comparisons, that they do not indicate what needs to be done when faced with evidence of sub-optimal performance. This requires a more detailed analysis of the specific issues facing health (care) systems.

One approach that shows promise is the concept of tracer conditions, in which selected amenable causes are the focus of careful study of the responses of health systems. This was proposed by the US Institute of Medicine (IoM) in the late 1960s as a means to evaluate health policies.[182] A similar approach was adopted by British researchers at St. Thomas Hospital, London, at around the same time to assess the provision of health services in the London Borough of Lambeth.[183] The tracer concept as described by the IoM was borrowed from natural sciences and translated for use within the health care delivery system. It was based on the idea that certain tracer conditions or diseases would make it possible to examine how the health care delivery was functioning, and so assess its quality. The tracer conditions would have to be discrete and identifiable health problems and offer a means to provide insight into how particular parts of the system work - not in isolation but in relation to each other. The criteria proposed to provide a "rational and uniform basis" for the selection of tracers were as follows:

- the health problem should have a definitive functional impact (i.e. treatment was necessary and without appropriate treatment a functional impairment would result);
- it should be relatively well defined and easy to diagnose;

- prevalence rates should be high enough to permit collection of adequate data from a limited population sample;
- the the natural history of the condition should vary with utilisation and effectiveness of medical care;
- techniques of medical management of the condition should be well defined for at least one of the following processes: prevention, diagnosis, treatment, rehabilitation;
- there should be sufficient understanding of non-medical factors on tracer condition (requiring a good understanding of the epidemiology of the tracer).

The IoM team defined a battery of 6 tracers rather than only one to enable evaluation of (ambulatory) care received by a cross-section of the population (both sexes, different age groups). They further categorised health service delivery into 5 major elements: *prevention, screening, evaluation* (history and physical evaluation; laboratory; other testing), *management* (chemotherapy; health counselling; speciality referral; hospitalisation) and *follow-up* case.

In summary, building on the evidence assembled it is possible to conceive of a means of assessing performance of health care systems that has two stages. The first involves a broad assessment of health outcomes that might identify topics deserving further attention. The second stage involves an in-depth assessment of how the system deals with any issues of potential concern identified in the first stage.

PART II: AVOIDABLE MORTALITY IN THE EUROPEAN UNION

Introduction

The review of the concept of ‘avoidable mortality’ in the first part of this report indicates that, notwithstanding its many limitations, this concept has provided a means to examine the quality of health care provided by a health care system and to identify topics for further in-depth investigation.

The second part of this report looks at its continuing potential to do so, building on what has been done before and updating the list of conditions considered amenable to health care in the light of more recent advances in medical knowledge and technology and extending the age limit to reflect increasing expectation of life. This revised concept is then applied to routinely available data from selected countries in the European Union to investigate the potential impact of health care on changing life expectancy and mortality in the 1980s and 1990s.

Methods

Data

Mortality data were extracted from the World Health Organization mortality files for the years 1980, 1989, 1990 and 1998.[184] Data include deaths in each year, using the 8th (abbreviated A-list), 9th (abbreviated basic tabulation list) and/or 10th revision of the International Classification of Diseases (ICD) by sex and 5-year age band (with infant deaths listed separately). Data for west Germany were only available to 1990 from this source; additional data were thus obtained from the Statistical Office Germany.[185] However, from 1998 data collection at the federal level in Germany no longer distinguishes between the former east and west but provides data at the level of federal states; as a consequence separate data for east and west Berlin are no longer available and the pre- and post 1998 ‘west’ (or ‘east’) are thus not strictly comparable. Thus, for consistency, the year 1997 was chosen as the most recent year for west Germany. As with WHO, data included deaths by sex and 5-year age band but using the detailed list of ICD9. Population numbers by sex and age were obtained from the same sources.

The analysis was limited to the larger member states of the European Union. It thus looks at changes in amenable mortality in Austria, Denmark, Finland, France, Greece, west

Germany, Italy, the Netherlands, Portugal, Spain, Sweden and the United Kingdom. Belgium was not included as most recent data were only available for 1995. This is because mortality statistics are collected at the community level in Belgium and the community of Brussels has experienced long standing problems in implementing effective reporting systems.

Selection of causes of death

The selection of causes of death considered amenable to health care was based on our earlier analysis of 'avoidable' mortality[57] but took account of recent work by Tobias and Jackson[59] who provided an update of the list proposed by Charlton et al.[20], and by Mackenbach[49] (Table 10). We thus included colorectal cancer where there is evidence from randomised controlled trials on the impact on survival of intensive follow-up after curative resection for colorectal cancer.[186] Increasing evidence also points to the potential benefits of screening for colorectal cancer for curbing mortality from this condition, although there is still a lack of consensus on the effectiveness of population screening.[187,188] We also included epilepsy as a recent inquiry identified sub-optimal management of this condition in the UK, which was related to an increased risk of premature death.[189]

As with the European Community Atlas of 'Avoidable Death'[28], we included 'malignant neoplasm of uterus, part unspecified' (ICD-9 179) and of 'body of uterus' (ICD-9 182) in addition to cancer of cervix uteri (ICD-9 180), as it has been reported that due to variation in death certification and coding practices[157] some countries could allocate cervical cancer to any of these categories. A recent study confirmed that this is still largely the case. Thus, Levi and colleagues demonstrated that 20-65% of deaths from uterine cancer in many of the larger EU countries are still being certified as 'uterus, unspecified'.[190] They therefore recommended that when analysing cervical cancer mortality across Europe to also include ICD-9 179 and 182 for ages under 45 as most deaths from uterine cancer at that age arise from cancer of cervix uteri.

However, unlike Tobias and Jackson[59] we did not include stomach cancer. The decline in stomach cancer mortality during the past century has largely been due to declining incidence, associated primarily with declining prevalence of infection with *H. pylori*,[191] although with the effects also modulated by changing dietary patterns such as increased fruit and vegetable consumption and decreasing salt intake, rather than improvements in survival of those with cancer, which still remains poor.[192] However we recognise that this may be controversial as there is variation in survival after diagnosis of stomach cancer between European countries, with for example England, Scotland and Poland somewhat lower than the average European five-year survival rate whereas survival was found to be significantly higher in Germany, Austria, France, Spain and Italy, with this mainly being attributed to variation in stage at presentation, and, in a some cases, to differences in the quality of care. In contrast, there is a large difference in survival from stomach cancer in Japan, where survival is reported to be much higher than in Europe, at 47% vs. 21%.[192] This has been linked to more widespread use of endoscopy and development of mass screening, centralised management of designated, highly experienced and skilled surgeons, as well as the younger age at disease presentation in Japan.[193] However this takes place in a country where the incidence of stomach cancer is very much higher than in any western European country except Portugal and thus the costs and benefits of such a programme are unlikely to apply in the rather different European setting. On balance, therefore, it was decided not to include stomach cancer in this study.

A recent analysis of cancer mortality trends in the European Union between 1988 and 1997 showed a small decline in prostate cancer mortality especially after 1995 with appreciable advances in survival being observed in the last few years that was attributed, in part, to therapy including screening and thus early diagnosis as well as hormonal treatment.[194] However the impact of screening on mortality from prostate cancer is still uncertain[195], especially as to whether the early detection of prostate cancer does indeed prolong life, mainly because many cancers are indolent and remain asymptomatic at the time of death from another cause.[196] Prostate cancer was thus not included in our analysis.

Finally, although asthma has been considered amenable to health care[20,28,197] we did not include this condition, simply because the data format available, using the abbreviated form of ICD-8 and ICD-9, did not make it possible to extract deaths from this condition.

As with our earlier work, the conditions selected in the present analysis were considered indicators of the impact of health care, i.e. secondary prevention or medical treatment, thus *amenable* conditions. As with the EC working group on 'avoidable deaths' we interpret health care (services) as to include primary care, hospital care, and collective health services such as screening and public health programmes, e.g. immunisation. The conditions were chosen on the basis of having identifiable effective interventions and health care providers. They were, however, not intended to cover all causes that are possibly treatable. Rather, it was assumed that while not all deaths from these causes would be 'avoidable', health services could contribute substantially to minimising mortality.

To calculate the contribution of amenable conditions to changes in life expectancy, single causes and cause groups were combined, with one exception. Ischaemic heart disease (IHD) was treated separately as (1) the precise contribution of health care to reductions in deaths from this condition is unresolved[142], (2) IHD may be understood as an indicator of health care but also of health policy, and, most importantly, (3) the very large number of deaths involved means that any changes will obscure the impact of health care on diseases other than IHD. Three cause groups were thus analysed: amenable conditions, IHD and 'other causes', comprising the remaining causes of death.

As in our earlier work, an age-limit was set at 75 years as 'avoidability' of death and reliability of death certification become increasingly questionable at older ages. We recognise, however, that any upper age limit is essentially arbitrary, but this value is consistent with life expectancy at birth in many western European countries. However the logic of this would suggest a higher upper limit for women. We recognise this as an important issue for debate but we do not feel that it has yet been resolved.

Different age limits were set for diabetes mellitus (< 50) because the preventability of deaths at older ages from diabetes, and in particular the effectiveness of good diabetic control in reducing vascular complications, remain controversial. For some other causes a limit of <15

Table 10 Causes of death considered amenable to health care

Name of group	Age	ICD8	ICD9	ICD10
1 Intestinal infections[30]	0-14	000-009	001-009	A00-A09
2 Tuberculosis[20,28]	0-74	010-019	010-018, 137	A15-A19, B90
3 Other infectious (Diphtheria, Tetanus, Poliomyelitis)[28]	0-74	032, 037, 040-043	032, 037, 045	A36, A35,A80
4 Whooping cough[28]	0-14	033	033	A37
5 Septicaemia[47‡]	0-74	038	038	A40-A41
6 Measles[28]	1-14	055	055	B05
7 Malignant neoplasm of colon[(‡)] and rectum[49,59, 186,187,188]	0-74	153-154	153-154	C18-C21
8 Malignant neoplasm of skin[30,47(‡)]	0-74	173	173	C44
9 Malignant neoplasm of breast[30,136]	0-74	174	174	C50
10 Malignant neoplasm of cervix uteri[28]	0-74	180	180	C53
11 Malignant neoplasm of cervix uteri and body of the uterus[28,190]	0-44	182	179, 182	C54, C55
12 Malignant neoplasm of testis[30,47,(‡)]	0-74	186	186	C62
13 Hodgkin's disease[28,199,200(‡)]	0-74	201	201	C81
14 Leukaemia[30,47]	0-44	204-207	204-208	C91-C95
15 Diseases of the thyroid[47]	0-74	240-246	240-246	E00-E07
16 Diabetes mellitus[47,136]	0-49	250	250	E10-E14
17 Epilepsy[59,189]	0-74	345	345	G40-G41
18 Chronic rheumatic heart disease[28(‡)]	0-74	393-396	393-398	I05-I09
19 Hypertensive disease[28]	0-74	400-404	401-405	I10-I13, I15
20 Ischaemic heart disease[30]	0-74	410-414	410-414	I20-I25
21 Cerebrovascular disease[28]	0-74	430-438	430-438	I60-I69
22 All respiratory diseases (excl. pneumonia/influenza)[28]	1-14	460-466, 490-519	460-479, 488-519	J00-J09, J20-J99
23 Influenza[28]	0-74	470-474	487	J10-J11
24 Pneumonia[28]	0-74	480-486	480-486	J12-J18
25 Peptic ulcer [30,47,136]	0-74	531-533	531-533	K25-K27
26 Appendicitis[28]	0-74	540-543	540-543	K35-K38
27 Abdominal hernia[28]	0-74	550-553	550-553	K40-K46
28 Cholelithiasis & cholecystitis[28]	0-74	574-575	574-575.1	K80-K81
29 Nephritis and nephrosis[47]	0-74	580-584	580-589	N00-N07, N17-N19 N25-N27
30 Benign prostatic hyperplasia[47]	0-74	600	600	N40
31 Maternal deaths[28]	All	630-678	630-676	O00-O99
32 Congenital cardiovascular anomalies[30]	0-74	746-747	745-747	Q20-Q28
33 Perinatal deaths, all causes excluding stillbirths[28]	All	760-779	760-779	P00-P96, A33, A34
34 Misadventures to patients during surgical and medical care[59 (‡)]	All		E870-E876, E878-E879	Y60-Y69, Y83-Y84

(‡) condition not included as 'amenable condition' in Denmark, Finland and Sweden (see text) was set (intestinal infectious diseases, whooping cough, measles, childhood respiratory diseases) as deaths other than in childhood from these causes are likely to reflect some other disease process. However, unlike in our earlier study, the age limit for leukaemia was extended to 44 years. This is mainly because of a recent study that has reported substantial improvements in mortality from leukaemia in European Union countries.[202] It showed that between 1960/64 and 1995/97 death rates among children declined by over 70% and among those aged 15-44 rates fell by about 40% in men and 45% in women. This was largely attributed to advances in treatment.

For countries that used the 8th revision of ICD the selection of amenable causes of death had to be modified slightly. This was the case for Sweden (ICD8: 1980), Finland (1980) and Denmark (1980, 1990). The data were presented according to the abbreviated version of ICD-8 (A-list). The A-list does not, however, make it possible to extract some conditions shown in Table 10.These included septicaemia, cancer of colon, cancer of skin other than melanoma, cancer of testis, Hodgkin's disease and misadventures during surgical/medical care. For consistency, these conditions were thus excluded from the analysis of amenable mortality in Sweden, Finland and Denmark. There were also some differences between ICD-9 and ICD-10 that could affect intra-country comparisons involving The Netherlands and Sweden, which changed from ICD-9 to ICD-10 in 1995 and 1996 respectively. For example, the ICD-10 codes for cerebrovascular diseases do not include a diagnosis equivalent to ICD-9 435 ("transient cerebral ischaemia")[203] although this is not expected to cause problems because of the small numbers involved compared with the total number of deaths from cerebrovascular disease. Similarly, the ICD-10 classification for perinatal causes (P00-P096) does not include tetanus neonatorum, which has been reclassified as A33; however, the equivalent ICD-9 code 771.3 is not identifiable as a single category in the ICD-9 basic tabulation list. But again numbers involved in western Europe will be non-existent or negligible and are not expected to causes any problems. There were, however, some inconsistencies in the reported number of deaths from chronic rheumatic heart disease in Denmark, Finland and Sweden, with some unusually high fluctuations coinciding with the change from ICD-8 to ICD-9 or ICD-10. This condition was thus excluded from the analysis of amenable mortality in the three Nordic countries.

Analysis

The contribution of health care to changes in mortality trends in EU countries was estimated by decomposing life expectancy by age and cause of death. This enables separation of differences between life expectancies into contributions according to age and cause of death, expressed in years gained or lost. Because of the age limit noted earlier, the analyses were based on 'temporary' (or 'partial') life expectancy between birth and age 75 [$e_{(0-75)}$] rather than life expectancy at birth. Life expectancy was calculated using life table techniques as proposed by Chiang.[204] This gives slightly lower estimates than those reported in the World Health Organisation's Health for All database, which uses a different method (Wiesler's method) (Remis Prokhorskas, personal communication). Decomposition of differences in life expectancy was undertaken using methods developed independently by Andreev[205], Arriaga[206], and Pressat.[207] Analyses were undertaken using Microsoft Excel.

To examine changes in amenable mortality and their impact on changing temporary life expectancy, we compared two periods, 1980 to 1989 and 1990 to 1998 as for most countries most recent data were available to 1998 only.

Age-standardised mortality rates by sex were calculated for all conditions and for all ages (0-74) by direct standardisation to the European standard population.[208]

Results

Trends in life expectancy at birth

In 1980, life expectancy at birth was highest among Greek men and Dutch women but the order changed from 1989 onwards with Swedish men and French women experiencing on average the longest lifespan in 1998, at 76.8 and 82.6 years, respectively (Table 11). In contrast, life expectancy was consistently lowest in Portugal, for both men and women, at 71.6 and 78.9 years (1998), respectively. Although improving everywhere between 1980 and 1998 the pace of change differed between the two periods and between countries. The largest improvements were seen in Austria, Italy, west Germany, the UK (men), Finland (men) and Portugal (women).

These changes meant that a female life expectancy gap of 4.8 years between the 'best' and the 'worst' country in 1980 had narrowed to 3.7 years in 1998. While initially also declining among men, from 5.6 years in 1980 to 4.1 in 1989, the mortality differential has been increasing again, to 5.2 years between Portugal and Sweden in 1998.

Looking at life expectancy between birth and age 75, the picture is somewhat similar, at least for men, with figures consistently lowest in Portugal and highest in Sweden (Table 12). For women, from 1989, temporary life expectancy was lowest in Denmark, with Portugal coming a close second while the highest figures were again seen in Sweden. In 1998, however, life expectancy was highest among Spanish women although differences between countries were small.

As with life expectancy at birth, size and pace of improvements in temporary life expectancy differed between the two periods and between countries. In the 1980s, the largest improvements were seen in Portugal, Austria and west Germany (Table 12). In the 1990s this pattern had changed somewhat, at least for men, with the largest improvements now seen in Finland, Denmark and Austria, whereas among women, increases were again highest in Austria and Portugal but also in Finland.

Among men, much of the observed changes in life expectancy at birth between 1980 and 1998 were due to mortality declines among the under 75s, accounting for 55% (Greece, Sweden, UK) to 71% (Portugal) of the overall change. In women, this proportion was considerably less, accounting for 32% (Finland) to 52% (Portugal). It is important to keep this in mind when interpreting the following figures on changes in temporary life expectancy.

Amenable mortality in the 1980s and 1990s

For clarity, subsequent sections will examine changes in amenable mortality in the 1980s and 1990s on a country by country basis. Table 14 at the end of this chapter gives an

Table 11 Life expectancy at birth in selected European countries in 1980, 1989, 1990 and 1998 (in years)

	1980		1989		1990		1998		1980-89 change		1990-98 change	
	m	f	m	f	m	f	m	f	m	f	m	f
Austria	68.96	76.05	71.97	78.77	72.37	79.00	74.74	80.98	3.01	2.72	2.37	1.98
Denmark	71.15	77.27	72.13	77.90	72.15	77.87	74.11	79.08	0.98	0.63	1.96	1.21
Finland	69.18	77.93	70.86	78.98	70.93	78.94	73.56	80.99	1.68	1.05	2.63	2.05
France	70.68	78.97	72.99	81.34	73.31	81.67	74.90	82.55	2.31	2.37	1.59	0.88
Germany west	69.88	76.69	72.55	79.08	72.69	79.11	74.47	80.63	2.67	2.39	1.78	1.52
Greece	73.02	77.51	74.49	79.41	74.68	79.51	75.65	80.69	1.47	1.90	0.97	1.18
Italy	70.98	77.63	73.59	80.27	73.68	80.37	75.73	82.09	2.61	2.64	2.05	1.72
Netherlands	72.47	79.36	73.65	80.03	73.81	80.21	75.18	80.75	1.18	0.67	1.37	0.54
Portugal	67.44	74.56	70.64	77.70	70.38	77.35	71.63	78.85	3.20	3.14	1.25	1.50
Spain	72.41	78.57	73.36	80.41	73.31	80.44	75.00	82.17	0.95	1.84	1.69	1.73
Sweden	72.75	78.94	74.78	80.69	74.80	80.50	76.82	82.03	2.03	1.75	2.02	1.53
UK	70.40	76.47	72.63	78.14	72.95	78.60	74.87	79.85	2.23	1.67	1.92	1.25

Table 12 Life expectancy between birth and age 75 in selected European countries in 1980, 1989, 1990 and 1998 (in years)

	1980		1989		1990		1998		change 1980-89		change 1990-98	
	m	f	m	f	m	f	m	f	m	f	m	f
Austria	65.64	69.92	67.59	71.15	67.85	71.22	69.17	71.97	1.95	1.23	1.32	0.76
Denmark	67.25	70.09	67.77	70.34	67.91	70.43	69.11	71.09	0.52	0.25	1.21	0.66
Finland	66.05	71.04	66.90	71.37	67.00	71.31	68.61	72.02	0.86	0.33	1.61	0.71
France	66.49	70.75	67.66	71.54	67.80	71.68	68.85	72.06	1.17	0.79	1.05	0.38
Germany west	66.43	70.14	68.15	71.23	68.24	71.28	69.12	71.78	1.73	1.09	0.89	0.50
Greece	67.93	70.58	68.87	71.58	69.05	71.61	69.36	72.05	0.94	1.00	0.31	0.44
Italy	66.98	70.54	68.59	71.61	68.62	71.69	69.77	72.20	1.62	1.07	1.16	0.51
Netherlands	68.14	71.14	69.05	71.44	69.09	71.50	69.88	71.83	0.91	0.30	0.79	0.31
Portugal	64.34	69.09	66.49	70.50	66.39	70.52	67.33	71.30	2.14	1.42	0.93	0.78
Spain	67.72	70.95	68.08	71.65	68.11	71.68	69.24	72.37	0.37	0.71	1.13	0.68
Sweden	68.28	71.18	69.34	71.75	69.45	71.71	70.52	72.27	1.06	0.57	1.08	0.57
UK	67.04	69.96	68.36	70.76	68.46	70.89	69.49	71.49	1.32	0.80	1.04	0.60

overview on levels of mortality from selected causes and cause groups in each country for ages 0 to 74 by sex for the years 1980, 1990 and 1998. The numbers subsequent figures are based on are given in Table 15 and Table 16.

Austria

Figure 3 illustrates how different causes of death contributed to changes in temporary life expectancy in Austria between 1980 and 1989 and between 1990 and 1998. The sum of values, negative and positive, represents the change in life expectancy between birth and age 75 in years (delta e $_{(0\text{-}75)}$). Bars extending below the horizontal axis indicate that mortality rates in the age group concerned actually increased and thus contributed negatively to the overall change in temporary life expectancy, while bars above the axis indicate that mortality rates in an age group fell and therefore contributed positively.

This shows that in Austria, in the 1980s, improvements in amenable mortality made substantial positive contributions to the overall increase in temporary life expectancy, accounting for 40-44% in men and women. About 20% of this improvement was due to a decline in infant mortality, with another 13-16% attributable to declining mortality among those aged 40+. If ischaemic heart disease was to be included with amenable conditions, their impact on life expectancy would be somewhat higher, contributing 1.14 years in men and 0.65 of a year in women.

However, declining mortality from 'other causes' made the largest contribution, at almost 50% in both sexes, largely because of declining mortality among the young and middle-aged (15-64 years).

In the 1990s, changes in amenable causes made a smaller contribution to the changes in life expectancy than they had in the 1980s, especially among men, where falling amenable mortality now accounted for 19% of the overall increase of 1.32 years (Figure 3). However, unlike in the 1980s, much of the improvement in amenable mortality was now due to declining death rates among the middle-aged. For women, falling amenable mortality remained an important contributor, still accounting for almost 40% of the increase in life expectancy. As with men, this was largely due to fewer deaths among the middle-aged although falling infant mortality remained an important contributor.

Although declining IHD mortality also contributed to the overall improvement in temporary life expectancy, its impact was somewhat less than in the 1980s, accounting for less than 10% in both sexes. Consequently falling mortality from other conditions became more important, in relative terms, in explaining improvements in temporary life expectancy in the 1990s in both sexes, but especially so in men, accounting for almost three quarters of the change, again, mostly because of declining death rates among the middle-aged.

Denmark

Unlike Austria, changes in temporary life expectancy in Denmark in the 1980s were much less, especially among women, at 0.25 of a year (Table 12). Figure 4 shows that the underlying mortality pattern also differed quite considerably from that seen in Austria. Among men, falling mortality from amenable conditions contributed only 17% to the overall increase in life expectancy of 0.52 of a year. However, adding the decline in death rates from IHD, the relative impact of amenable causes increased to almost 90%, indicating that much of the improvement in temporary life expectancy among Danish men in the 1980s was actually due to falling IHD mortality. There was also considerable decline in mortality from 'other causes' at younger ages. Its relative impact was, however, counterbalanced by an actual increase in deaths from these causes at ages 50+.

Figure 3 Age- and cause specific contributions to changes in temporary life expectancy in Austria: 1980-1989 and 1990-1998

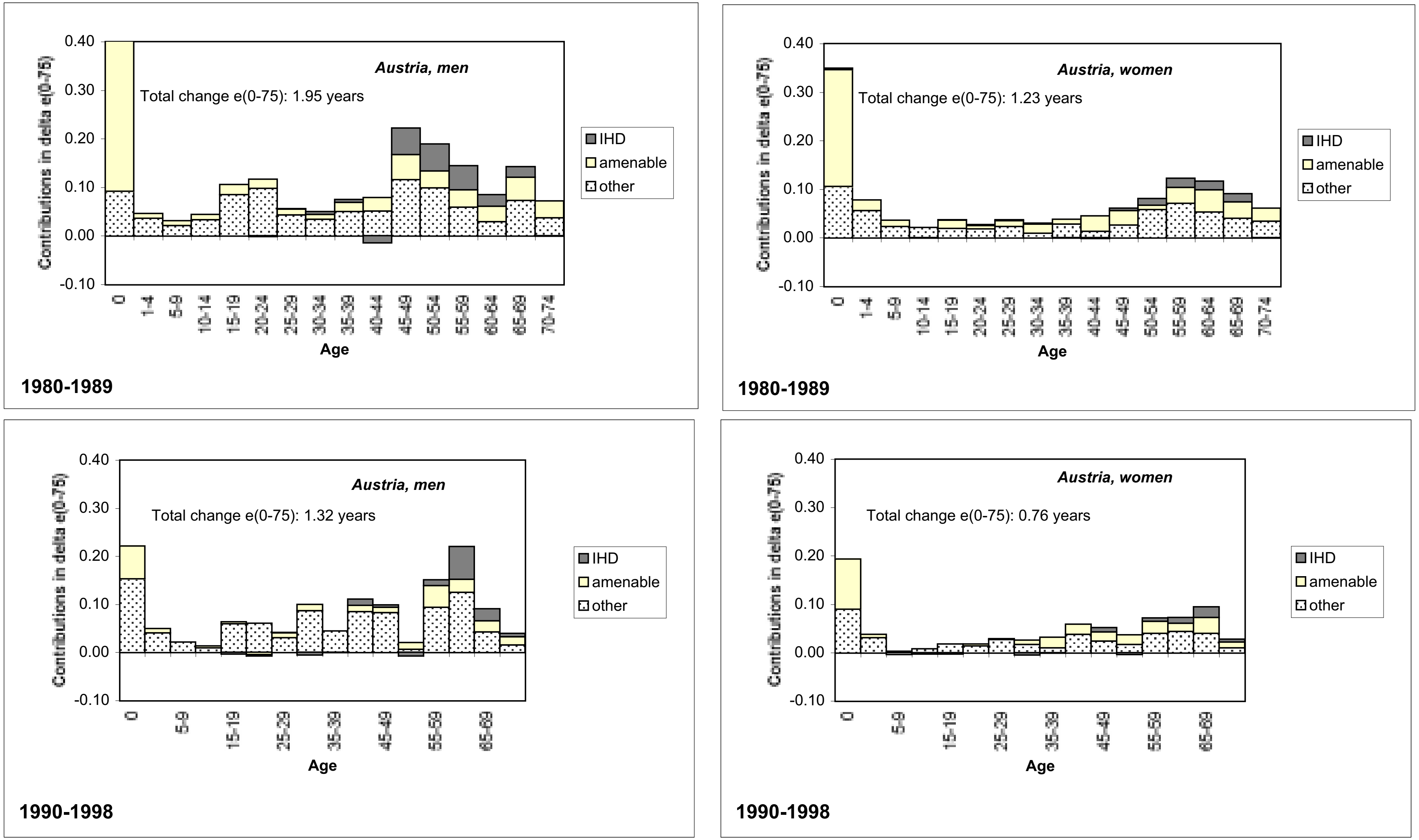
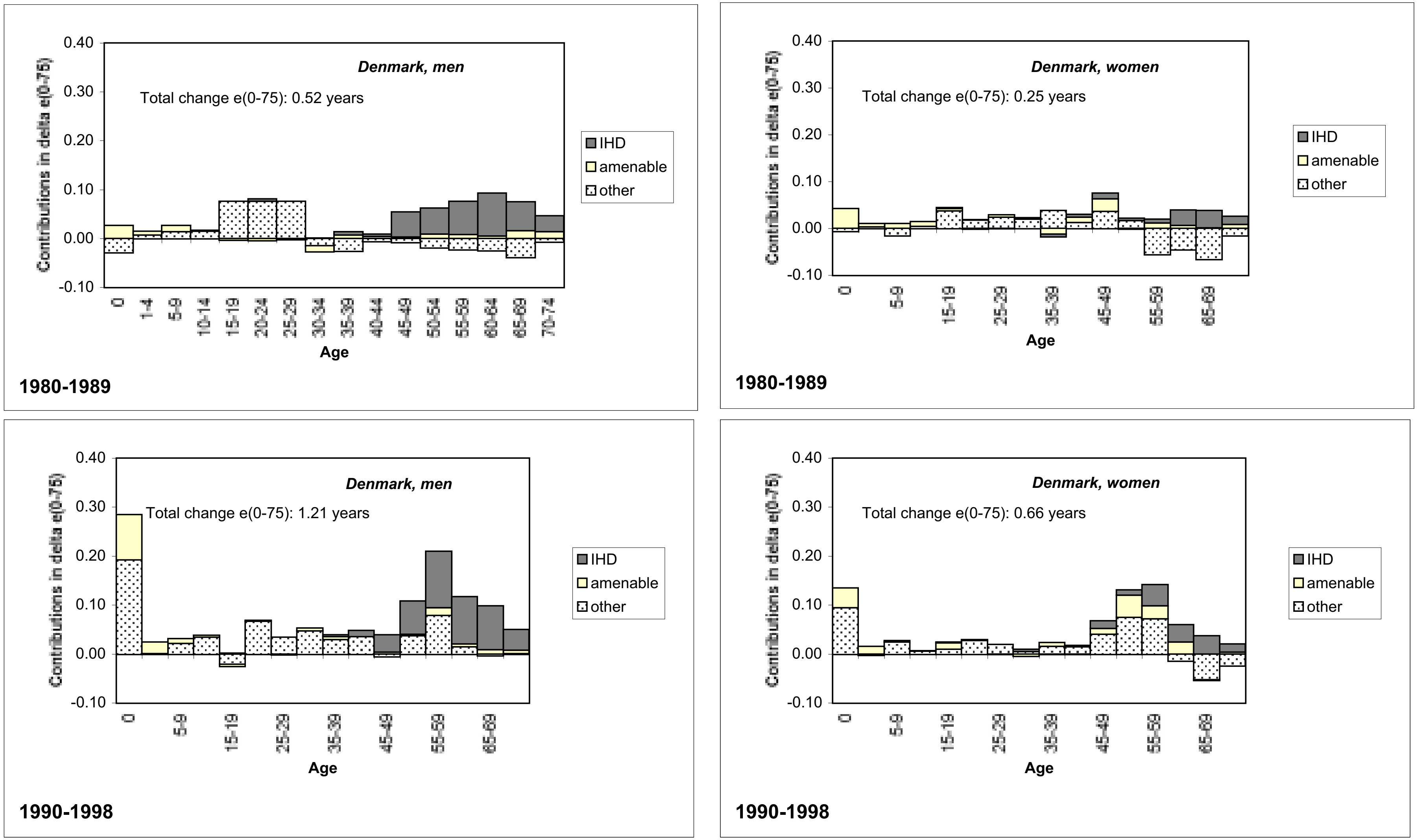


Figure 4 Age- and cause specific contributions to changes in temporary life expectancy in Denmark: 1980-1989 and 1990-1998



This last observation was even more pronounced among women, thus concealing improvements seen at younger ages that were due, in part, to declining mortality from amenable conditions (Figure 4). Falling infant mortality was an important contributor to the favourable changes in amenable morality as were fewer amenable deaths among women aged 40-49.

Again unlike Austria, changes in temporary life expectancy in Denmark in the 1990s were substantially higher than they were in the 1980s, at 1.2 years in men and 0.66 of a year in women. These changes were due to improvements in mortality at all ages with the exception of 15-19 year old men and women over 65, but especially among infants and the middle-aged. As with Austria, the impact of falling mortality from amenable conditions was less than in the 1980s, at 15% in men and 30% in women. However, much of the improvement in amenable mortality seen among women occurred among the middle-aged, who accounted for 0.1 of a year or 17% of the overall change in temporary life expectancy in the 1990s. Adding declining mortality from IHD increases the relative impact of amenable mortality to about 55% of the overall change in both sexes.

Finland

The mortality pattern underlying changing temporary life expectancy in Finland appears somewhat similar to that seen in Denmark, with smaller changes in the 1980s, especially among women, and substantial improvements among men in the 1990s (Figure 5). Also, the improvements in life expectancy in the 1980s were driven largely by declining amenable mortality and mortality from ischaemic heart disease. Compared with Denmark, the decline in amenable mortality had a larger impact in Finland, accounting for 30% of the overall increase in life expectancy among men and for over 60% among women. Adding falling IHD mortality, its contribution increases to almost 100% of the change in both men and women. Unlike in Denmark there were little improvements in death rates from ‘other causes’. In fact, both men and women recorded a net increase in mortality at ages 15-39 that was largely due to deaths in this category.

By the 1990s this last pattern had, however, changed with particularly young men now showing substantial improvements in mortality, mainly from ‘other causes’. As with Austria and Denmark, falling mortality from amenable causes now made a smaller contribution to the overall change in temporary life expectancy, accounting for 18% in men and 28% in women. In both men and women, much of this improvement was due to fewer amenable deaths among those over 40 years of age, contributing 10% and 15% of the total change, respectively. Again, as with Denmark, adding the decline in mortality from IHD causes the the relative impact of amenable mortality to increase even further, contributing about half of the total change in life expectancy in the 1990s.

France

An again different mortality pattern was observed in France, which, as in Austria, saw considerable improvements in temporary life expectancy for men in both periods although there were only small changes among women in the 1990s (Figure 6). As with the other

Figure 5 Age- and cause specific contributions to changes in temporary life expectancy in Finland: 1980-1989 and 1990-1998

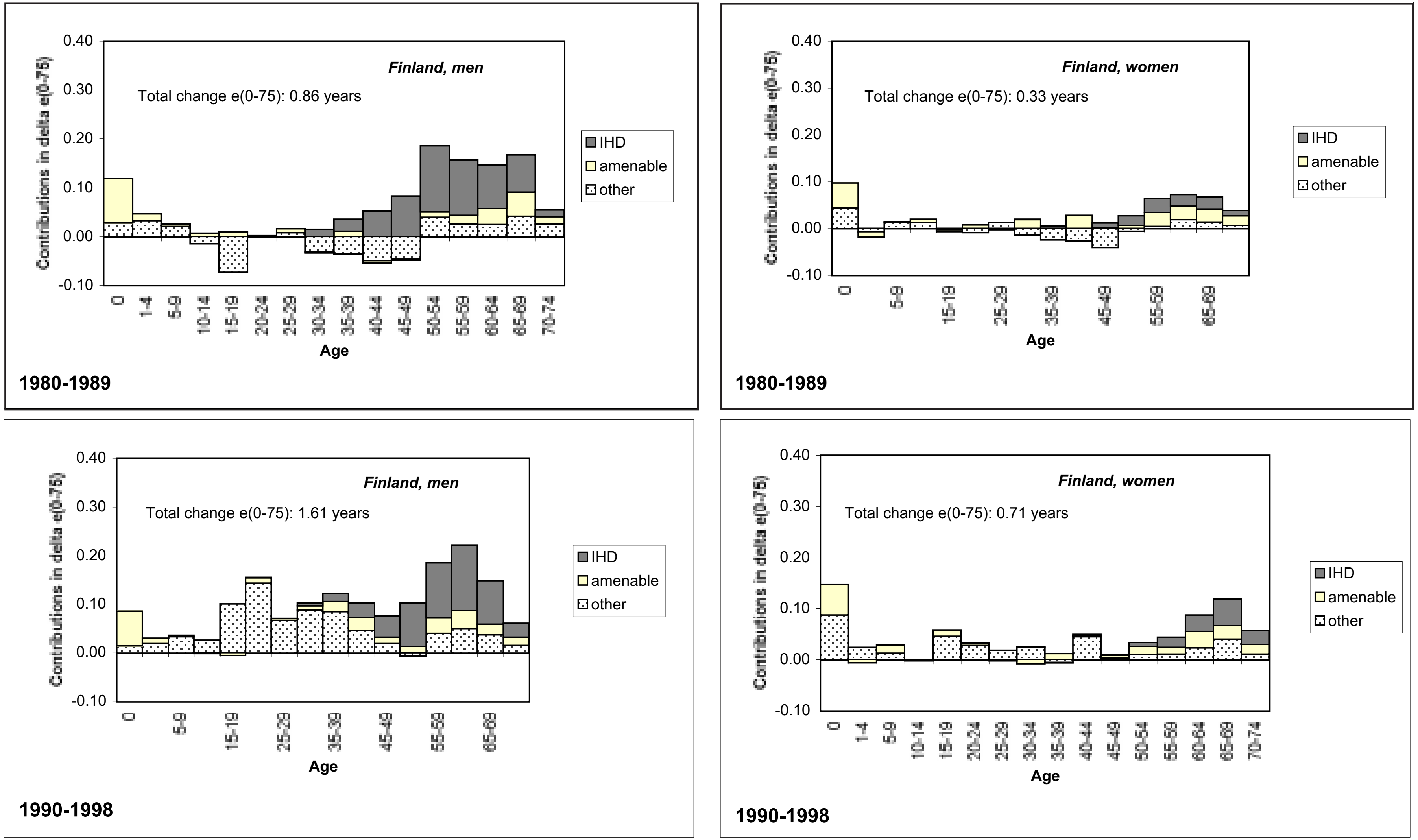
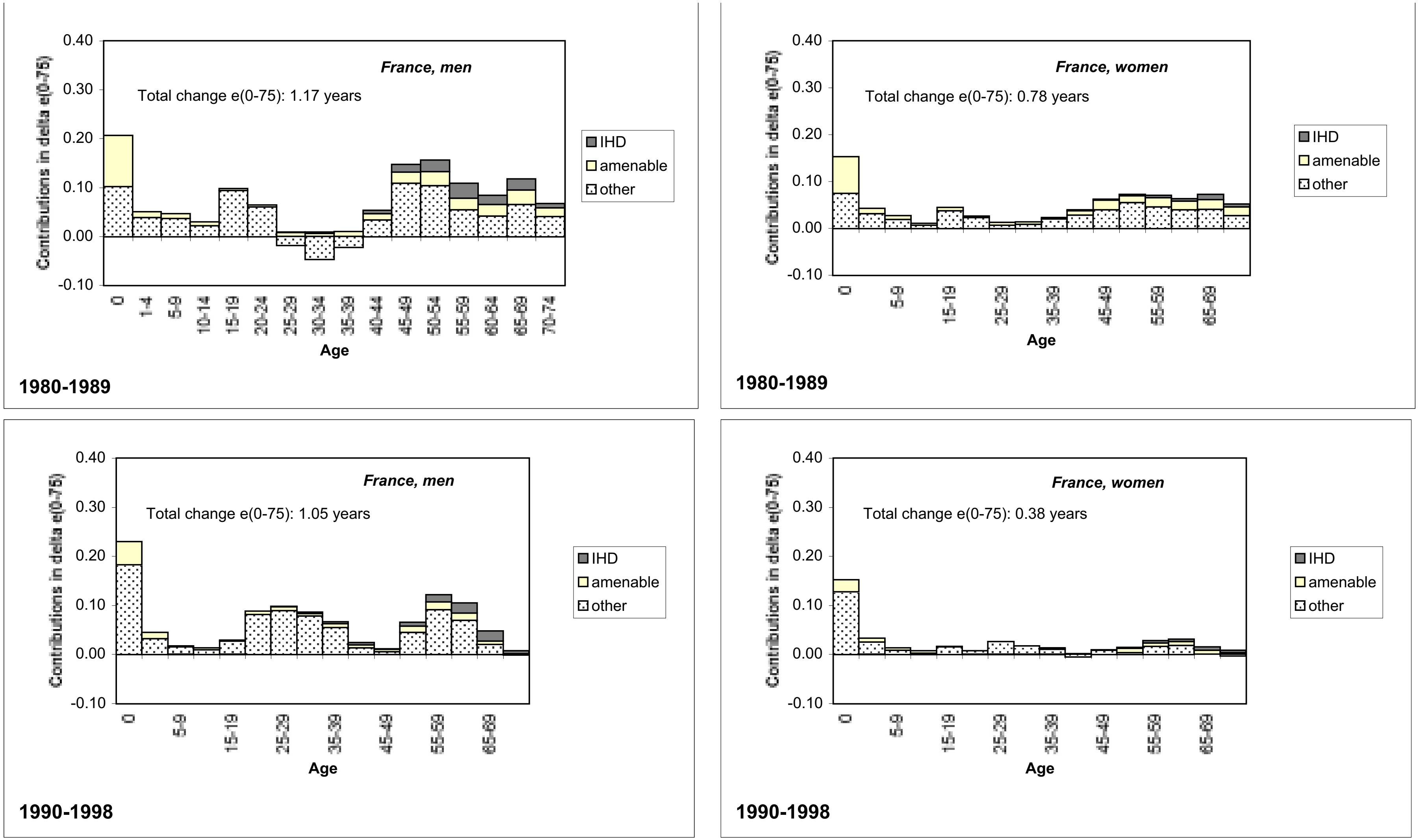


Figure 6 Age- and cause specific contributions to changes in temporary life expectancy in France: 1980-1989 and 1990-1998



countries described thus far, declining mortality from amenable causes made considerable positive contributions to the overall change in life expectancy in the 1980s, accounting for about one third of the observed improvements in both sexes. As can be inferred from Figure 6, falling death rates among infants and the middle-aged contributed equally to these gains, at about 10% each. As in Austria, declining mortality from IHD contributed only little to the total change in life expectancy, at 11% in men and 5% in women, thus increasing the potential impact of amenable mortality to 35-40%.

However, declining mortality from ‘other causes’ was the most important contributor to changing life expectancy in France, accounting for about two thirds of the total change. This contribution was not entirely beneficial, though, as men aged 25-39 years experienced an actual net increase in mortality from ‘other causes’.

In contrast, in the 1990s, all age groups contributed positively to the changes in temporary life expectancy, at 1.1 years in men and 0.38 of a year in women. As with what has been described earlier, amenable conditions now had a smaller impact on these changes, accounting for 15% in men and 21% in women. For women, this was the smallest contribution by amenable conditions observed thus far. However, as in the 1980s, the changes were equally due to declining mortality among infants and among the middle-aged, together accounting for 10-12% of the total improvement in temporary life expectancy in the 1990s.

Again, as in the 1980s, declining IHD mortality had only little impact on the overall changes in life expectancy whereas falling mortality from ‘other causes’ had become more important in the 1990s, now accounting for about 75% of the total change in temporary life expectancy in both sexes.

Germany, west

Turning to west Germany, the picture is very similar to that seen in Austria, particularly in the 1980s (Figure 7). Thus, between 1980 and 1989 improvements in amenable mortality made substantial positive contributions to the overall increase in temporary life expectancy, accounting for 0.58 of a year or 34% in men and 0.49 of a year or 45% in women. About one fifth of the total improvement was due to a decline in infant mortality, with another 12-14% attributable to declining mortality among those aged 40+. However, among men, declining IHD mortality had a higher impact on life expectancy than among Austrian men, at 19% compared with 11%. Among women, the impact of IHD was similar, at about 6% in both countries.

As in Austria, mortality from ‘other causes’ declined at all ages, especially among young men, and made the largest contribution to the total change in life expectancy, at almost 50% in both sexes.

In the 1990s, changes in amenable causes again made a smaller contribution to the changes in life expectancy than they had in the 1980s, especially among men, where falling amenable mortality accounted for 14% of the overall increase of 0.89 of a year (Figure 7). However, as with Danish men, declining infant mortality remained the most important contributor for increasing male life expectancy. Among women, in contrast, falling amenable

Figure 7 Age- and cause specific contributions to changes in temporary life expectancy in west Germany: 1980-1989 and 1990-1998

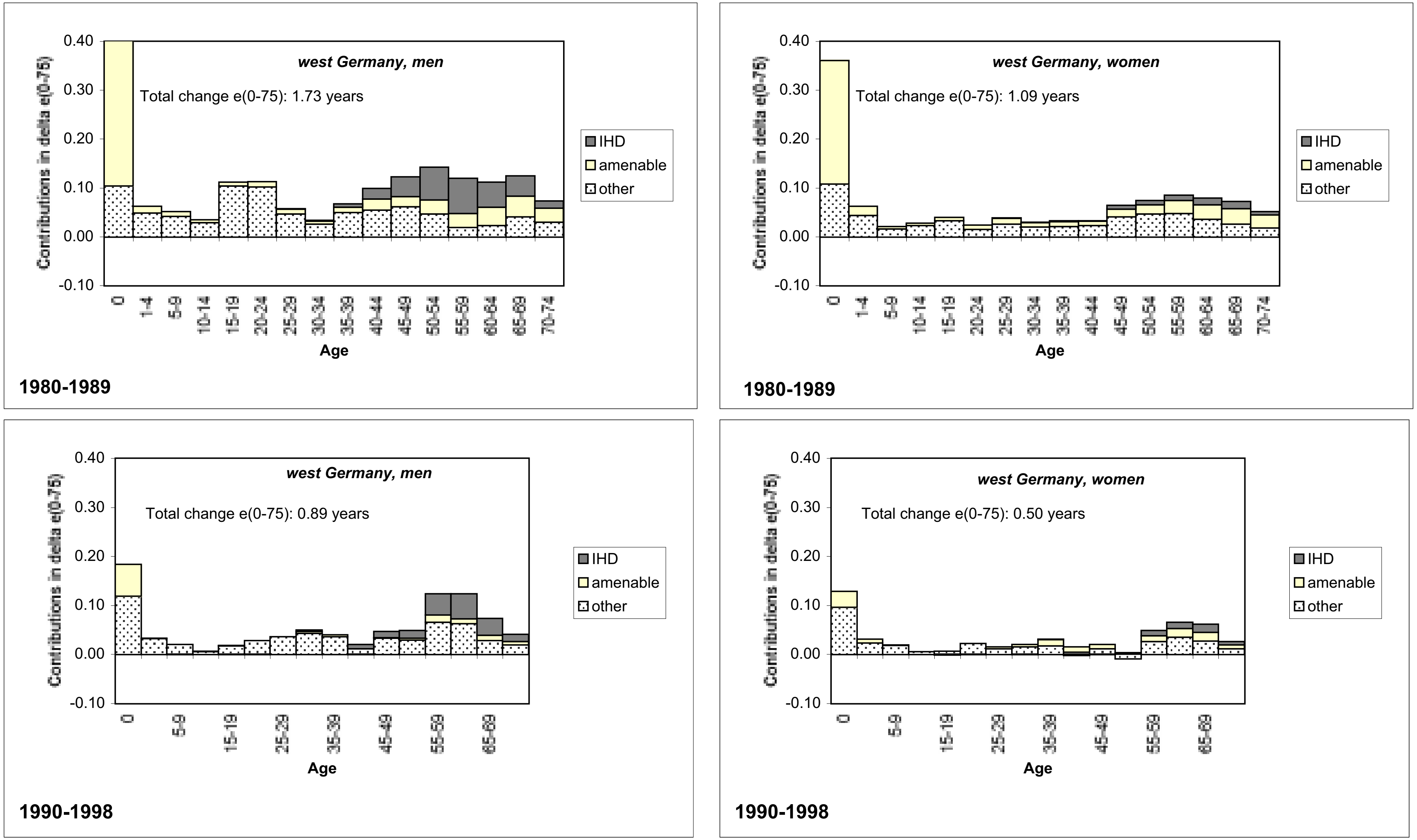
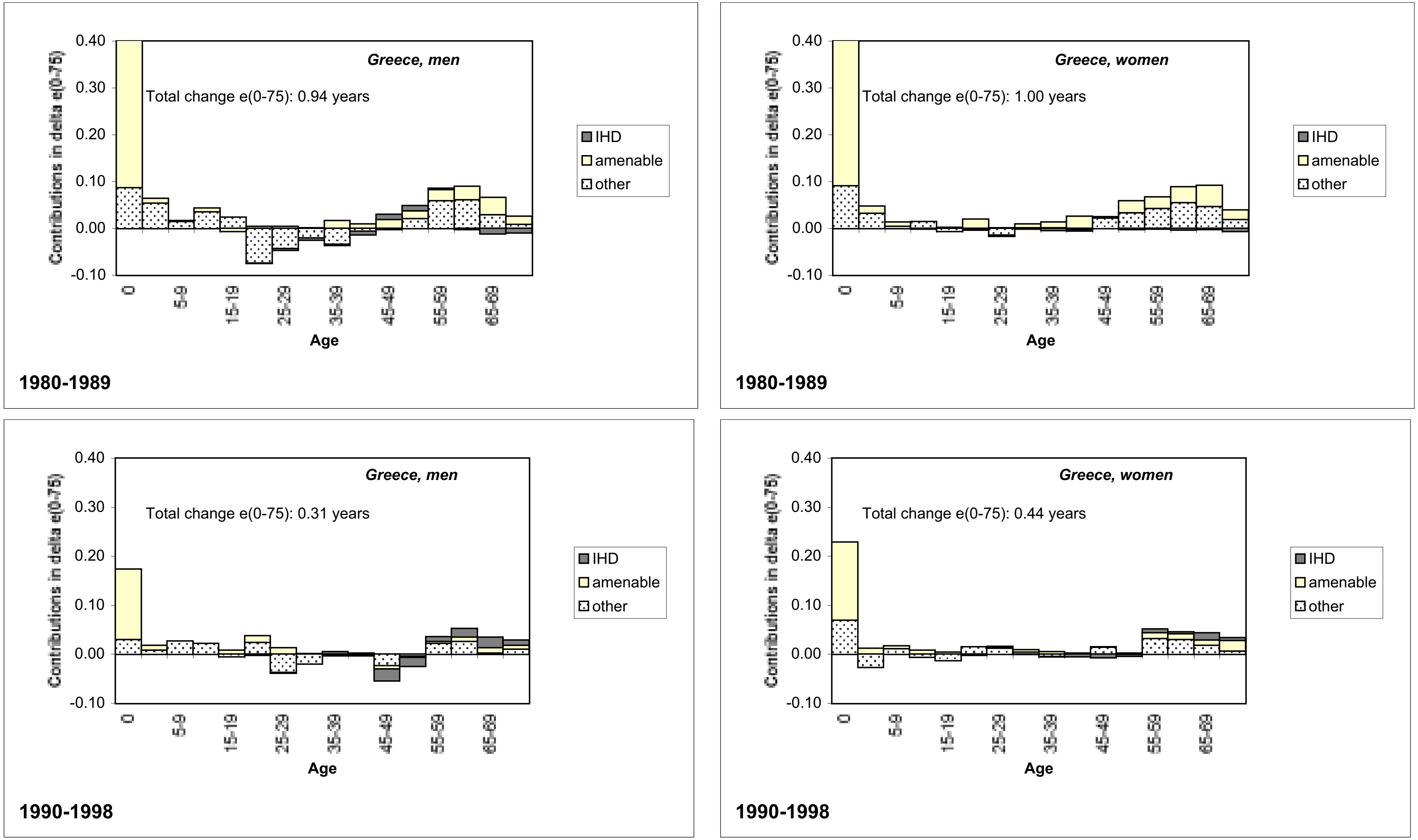


Figure 8 Age- and cause specific contributions to changes in temporary life expectancy in Greece: 1980-1989 and 1990-1998



mortality among the over 40s became more important in the 1990s, now accounting for 15% of the total change in life expectancy although falling infant mortality remained an important contributor, at 6%.

The impact of declining IHD mortality increased slightly in both sexes, now accounting for 20% of the increase in life expectancy in men and 9% in women. Combined with amenable mortality, the potential impact of health care would thus amount to 35% of the total change in temporary life expectancy in west Germany in the 1990s.

Greece

Compared with the countries analysed thus far, Greece displayed a very different mortality pattern. Firstly, increases in temporary life expectancy were higher in women than in men in both the 1980s and 1990s (Table 12). Secondly, in the 1980s, at least 70% of the total improvements in life expectancy were due to falling amenable mortality in both sexes, with about half of this improvement due to declining infant mortality (Figure 8). In contrast, mortality from ischaemic heart disease increased slightly in both sexes, thus diminishing the impact of health care to changing life expectancy in Greece in the 1980s to some extent. At the same time, men aged 20-39 years recorded a net increase in mortality, largely from ‘other causes’, thus counterbalancing the overall mortality improvements seen in men. Net increases in mortality among young men were also observed in Finland and France, as described above.

Turning to the 1990s, there were only small further improvements in temporary life expectancy in both men and women, at 0.31 and 0.44 of a year, respectively. As with the other countries, amenable mortality made a somewhat smaller contribution than it had in the 1980s, although its impact was still substantial, accounting for a about two thirds of the total increase in life expectancy in both sexes. Again, much of this change was driven by falling death rates in infancy, accounting for 36% in women to 47% in men of the observed improvements.

In contrast with all other countries analysed so far, there remained an increase in IHD mortality among the middle-aged, especially men. This was, however, counterbalanced by a simultaneous improvement in IHD death rates among the over 55s. As a result of these diverging trends, there was a net decline in IHD mortality that accounted for 4-6% of the total increase in temporary life expectancy in Greece in the 1990s.

Compared with the 1980s, falling mortality from ‘other causes’ also became an increasingly important contributor to changing life expectancy. However its impact remained less than that of amenable mortality, accounting for 28% of the total change in temporary life expectancy in men and 38% in women. Interestingly and contrary to what has been observed for the other countries analysed so far, changing amenable mortality had a somewhat higher impact among men than among women in both time periods.

Italy

Italy, on the other hand, seemed to have some similarities to the mortality patterns seen in Austria and west Germany, at least among women. It recorded comparatively large increases in temporary life expectancy in the 1980s, at 1.6 years in men and 1.1 years in women, and somewhat lower improvements in the 1990s, at 1.2 and 0.51 of a year, respectively (Table 12). However, in the 1980s, changing mortality from amenable conditions exerted only little impact on the overall improvements in life expectancy, at least in men (Figure 9). In fact, there was an actual increase in male infant mortality attributable to amenable conditions that was, however, more than compensated for by falling mortality from 'other causes'. As a consequence, there was a net decline in infant mortality that accounted for 0.45 of a year or 28% of the total increase in male life expectancy in the 1980s. Falling mortality at other ages was also mainly due to 'other causes', with declining IHD mortality only having a relatively small impact.

In contrast, the mortality pattern among women was very similar to that seen in Austria and west Germany, with 0.50 of a year or 45% of the total change in female temporary life expectancy due to falling amenable mortality, largely infant mortality at about 20%, and another 7% attributable to declining IHD mortality.

In the 1990s, while the overall changes in temporary life expectancy were less, unlike in the other countries analysed so far, the impact of amenable mortality actually increased in both men and women. This was especially apparent in men where falling amenable mortality now accounted for 28% (0.32 of a year) of the total increase in life expectancy, 17% of which was due to declining infant mortality. Among women, its impact was considerably higher, at 50%, with falling amenable mortality among infants and the over 40s being equally important, at about 20% each.

In addition, the impact of declining IHD mortality increased slightly in both sexes, now accounting for 13% of the increase in life expectancy in men and 9% in women. Combined with amenable mortality, the potential impact of health care would thus amount to 41% of the total change in temporary life expectancy among men and almost 60% among women in Italy in the 1990s.

Netherlands

In The Netherlands the mortality pattern underlying changing temporary life expectancy appears to have more in common with those seen in Denmark and Finland, at least in the 1980s. Temporary life expectancy improved in both periods, with very similar changes in both the 1980s and the 1990s, at 0.8-0.9 of a year in men and 0.3 of a year in women (Table 12). Among men, falling mortality from amenable conditions accounted for about 20% of the overall life expectancy increase in the 1980s, largely due to both declining infant mortality and fewer deaths among those aged 40-64 (Figure 10). Adding declining mortality from ischaemic heart disease, the impact of amenable mortality rises to over 60%. This was less than in Danish and Finnish men, largely because, in the 1980s, Dutch men did not experience net increases in mortality from 'other causes' as did their Danish and Finnish counterparts.

Turning to women, the picture is again very similar to that seen in Denmark and Finland, with much of the improvement in temporary life expectancy in the 1980s driven by falling amenable mortality, accounting for almost 70% of the total increase. One quarter of this

Figure 9 Age- and cause specific contributions to changes in temporary life expectancy in Italy: 1980-1989 and 1990-1998

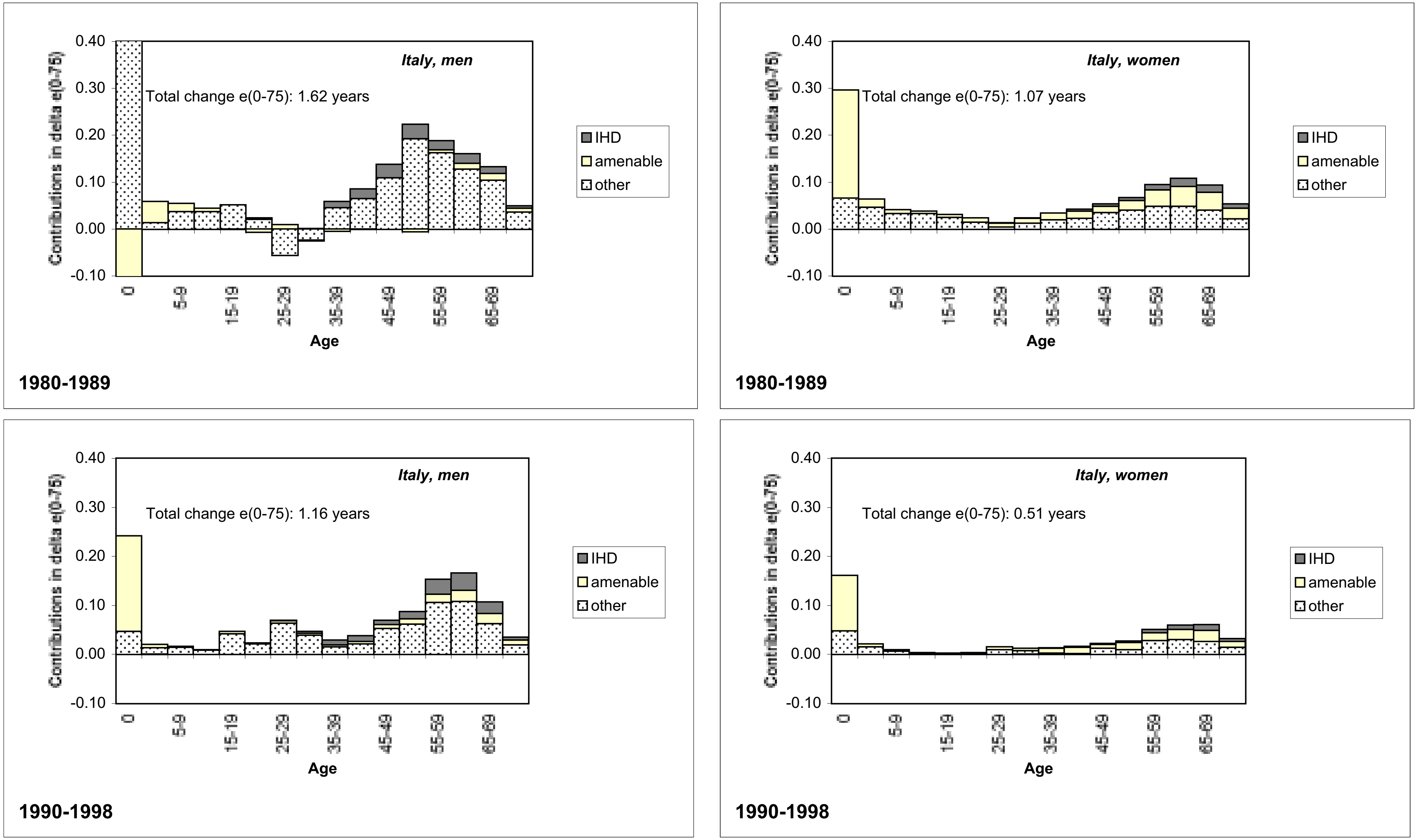
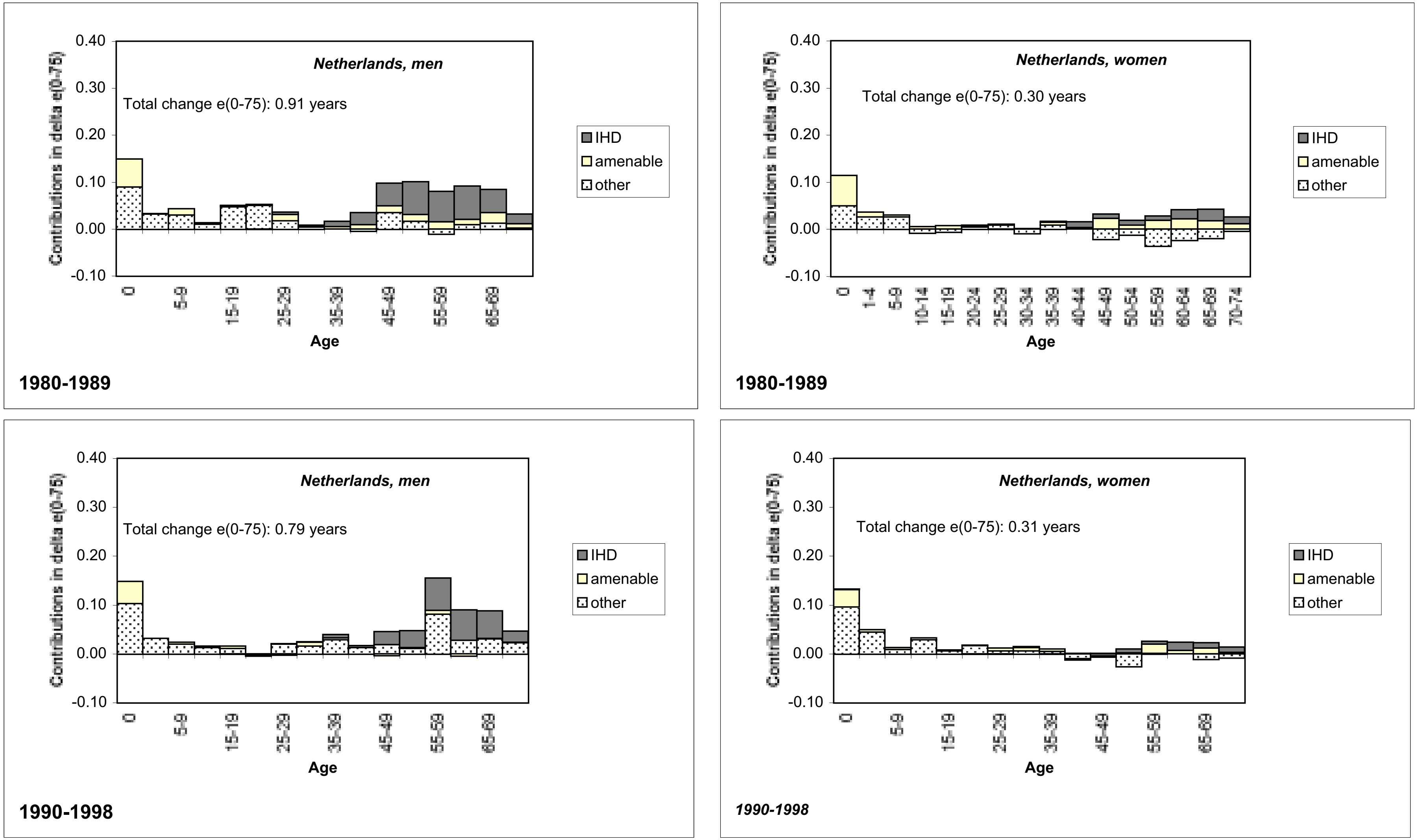


Figure 10 Age- and cause specific contributions to changes in temporary life expectancy in The Netherlands: 1980-1989 and 1990-1998



improvement was due to falling amenable mortality among middle-aged women with another 20% attributable to declining infant mortality. Combined with declining IHD mortality, amenable mortality contributes almost 100% of the total change in temporary life expectancy. As in Finland, there were only small improvements in death rates from 'other causes'. In fact, women over 40 experienced a net increase in deaths in this category.

By the 1990s, this pattern had changed markedly, especially among men. Falling amenable mortality now accounted for less than 10% of the total increase in male temporary life expectancy between 1990 and 1998. Instead, the overall improvement was mainly driven by declining mortality from 'other causes', although falling IHD mortality remained an important contributor, accounting for 36% of the total improvement. For women, although a somewhat less important contributor in the 1990s, falling amenable mortality still accounted for 35% of the total change in temporary life expectancy in the 1990s. As can be inferred from Figure 10 this was mainly because of declining infant mortality although the smaller rate of amenable deaths among women aged over 40 remained important (13%). However, as with Denmark and Finland, adding falling mortality from IHD increases the relative impact of amenable mortality even further, contributing about half of the total change in female temporary life expectancy in the 1990s.

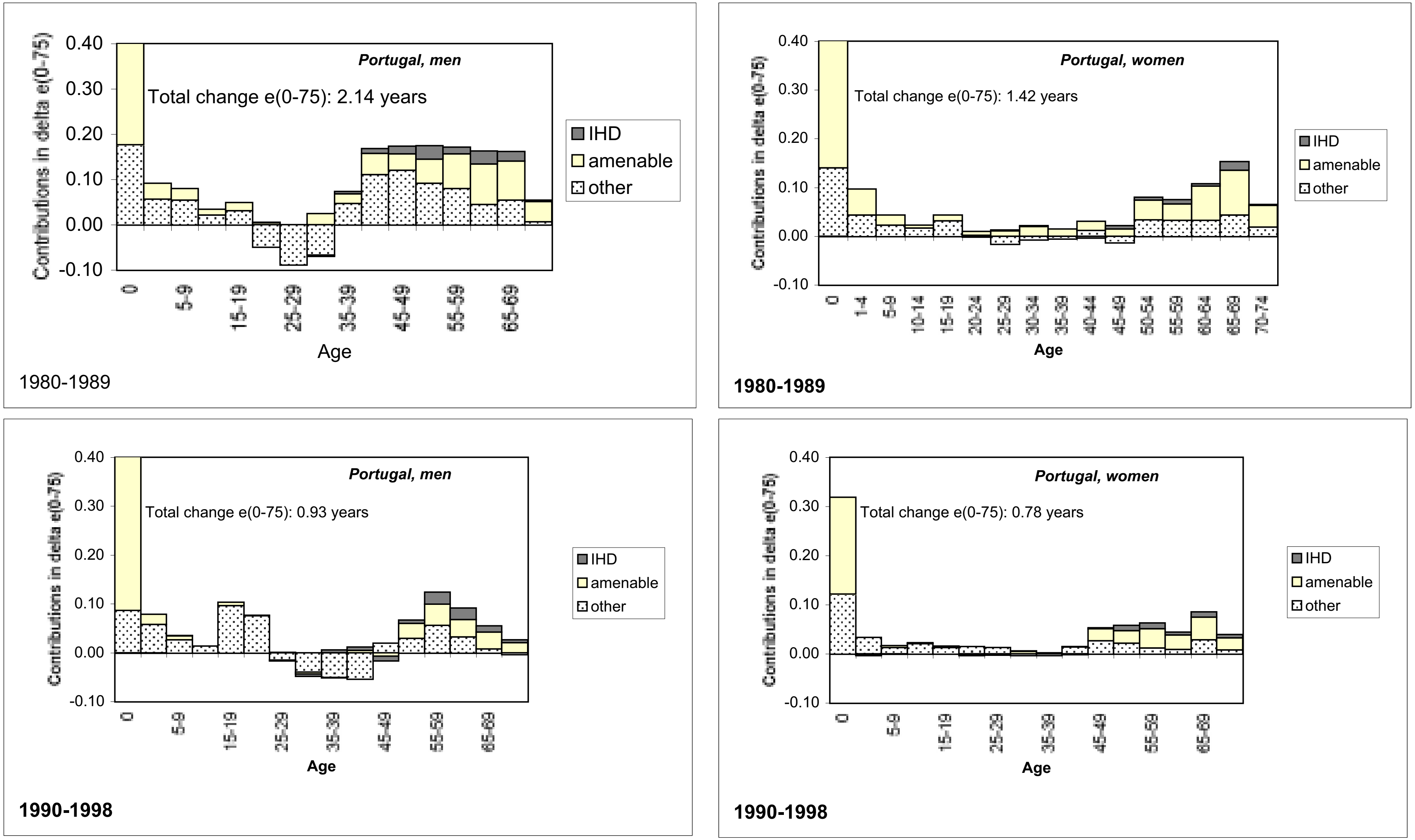
Portugal

Portugal displayed a mortality pattern that was similar to that seen in Greece although on a very different scale (Figure 11). Thus, Portugal recorded the largest improvements in temporary life expectancy in the 1980s, at 2.1 years in men and 1.4 years in women. As with Greece, these improvements were mainly due to changing amenable mortality, largely falling infant mortality, which accounted for 35% of the total increase in life expectancy in both sexes (or 0.75 of a year in men and 0.53 of a year in women). Another 20% was attributable to falling amenable mortality among men and women aged 40 and more. Unlike in Greece there was no increase in mortality from ischaemic heart disease although there was not much improvement either, thus exerting a small impact only, at 6% in men and 3% in women.

On the other hand, young Portuguese men experienced a net increase in mortality, as did Greek men at that age, mostly from 'other causes' thus counterbalancing improvements in mortality from these conditions seen at other ages.

By the 1990s, while still improving, the pace of the increase in male temporary life expectancy had substantially slowed down, falling to less than one year. Portuguese women, however, still showed the largest increase in life expectancy, at 0.78 of a year between 1990 and 1998. As with all other countries analysed so far, the impact of amenable mortality on changing life expectancy was now somewhat less than it had been in the 1980s. However, as with Greece, falling amenable mortality remained the largest contributor to increasing life expectancy, accounting for over 50% of the total change in both sexes. Again, this was mainly driven by falling infant mortality although for women, declining deaths among those aged 40-64 years became increasingly important. This last group accounted for 15% of the total change in temporary life expectancy among women in Portugal in the 1990s.

Figure 11 Age- and cause specific contributions to changes in temporary life expectancy in Portugal: 1980-1989 and 1990-1998



As with Greece, the net mortality increase among men aged 20-24 seen in the 1980s had reversed by the 1990s (Figure 11). Instead, the unfavourable mortality pattern had moved towards somewhat higher ages, now affecting men aged 30-40, thus offsetting the overall improvement in temporary life expectancy among Portuguese men in the 1990s.

Spain

In Spain somewhat similar issues to those in Portugal arise although there were also important differences. In the 1980s, Spanish men experienced the lowest increase in temporary life expectancy among the EU member states under study, at 0.37 of a year (Table 12). This was mainly because of a net increase in mortality among men aged 15-39 that offset much of the improvements seen at other ages (Figure 12).

Otherwise the mortality pattern among Spanish men looks very similar to that seen among men in Greece (Figure 8), with a substantial impact of declining amenable mortality on the total increase in life expectancy, largely due to falling infant mortality but also fewer deaths among the over 40s. Falling IHD mortality was also of some importance for changing life expectancy, although its impact was generally small.

The mortality pattern among women also showed some striking similarities to that seen in Greece. The only exceptions were declining infant mortality that had a somewhat smaller impact on the total increase in life expectancy among Spanish women in the 1980s, at 23% (compared with 45% in Greece) and, importantly, a net increase in mortality among young women aged 15-29 years.

By the 1990s, the unfavourable mortality trend among young Spanish men had resolved, thus adding 0.4 years to an overall increase in temporary life expectancy of 1.1 years between 1990 and 1998, which was almost three times that in the 1980s. About one third of this change was due to falling amenable mortality, with declining infant mortality accounting for 0.14 or a year or 12% of the total increase in temporary life expectancy as did declining mortality amongst men aged 15-64. For women, declining amenable mortality, while somewhat less important compared with the 1980s also continued to exert a substantial impact, accounting for 40% of the total change in temporary life expectancy in the 1990s. A sustained decline was also seen in mortality from ischaemic heart disease in both men and women, however its impact on changes in life expectancy remained relatively small.

As a consequence, and in contrast to Greece and Portugal, falling mortality from ‘other causes’ became the most important contributor to changing life expectancy in Spain in the 1990s, accounting for 56% in women to 68% in men.

Sweden

Not unexpectedly, the mortality pattern underlying changing temporary life expectancy in Sweden was very different from that seen in southern Europe. It had rather more in common with The Netherlands, except that it did not experience the rise in female mortality. Thus, temporary life expectancy improved consistently in both sexes and in both

Figure 12 Age- and cause specific contributions to changes in temporary life expectancy in Spain: 1980-1989 and 1990-1998

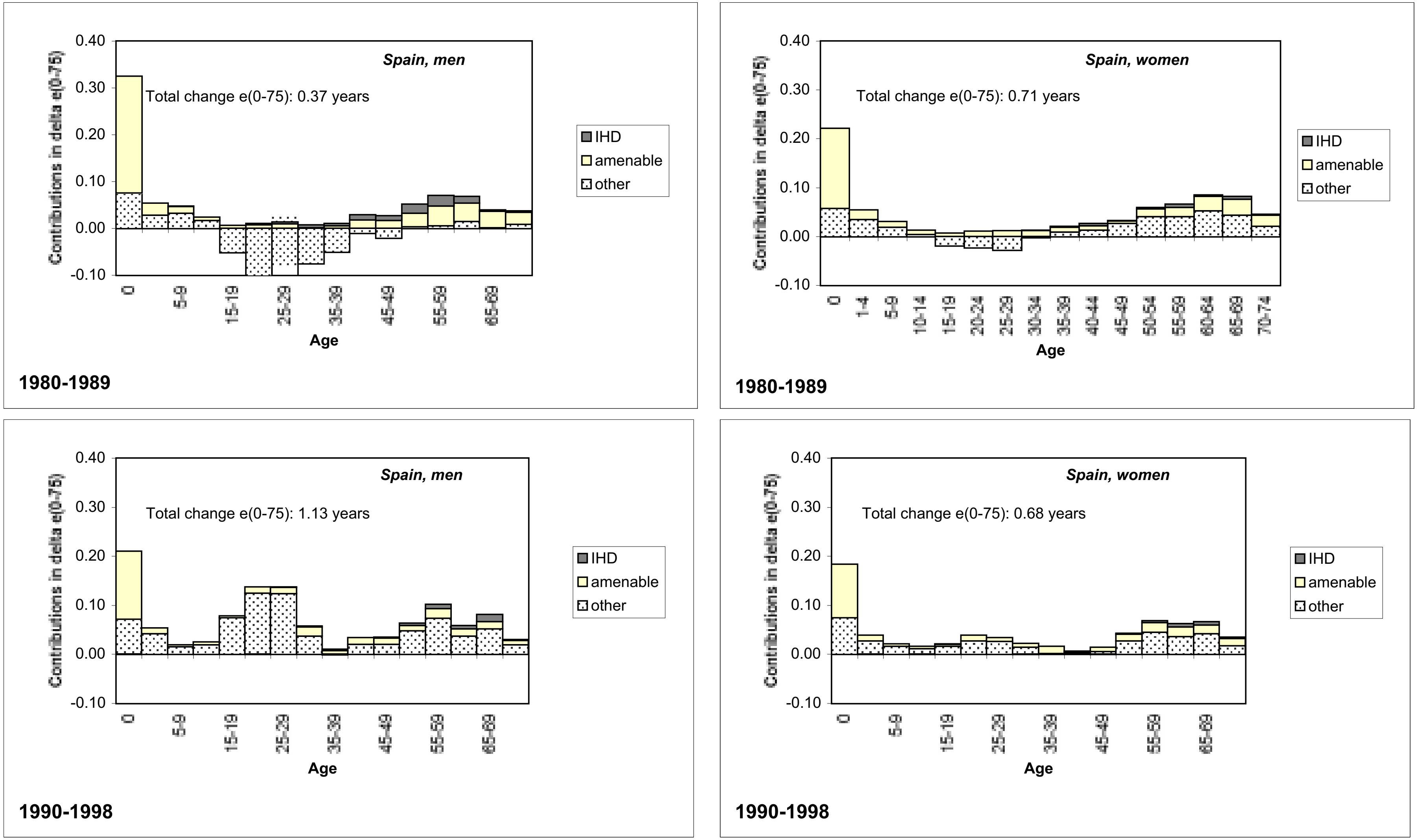
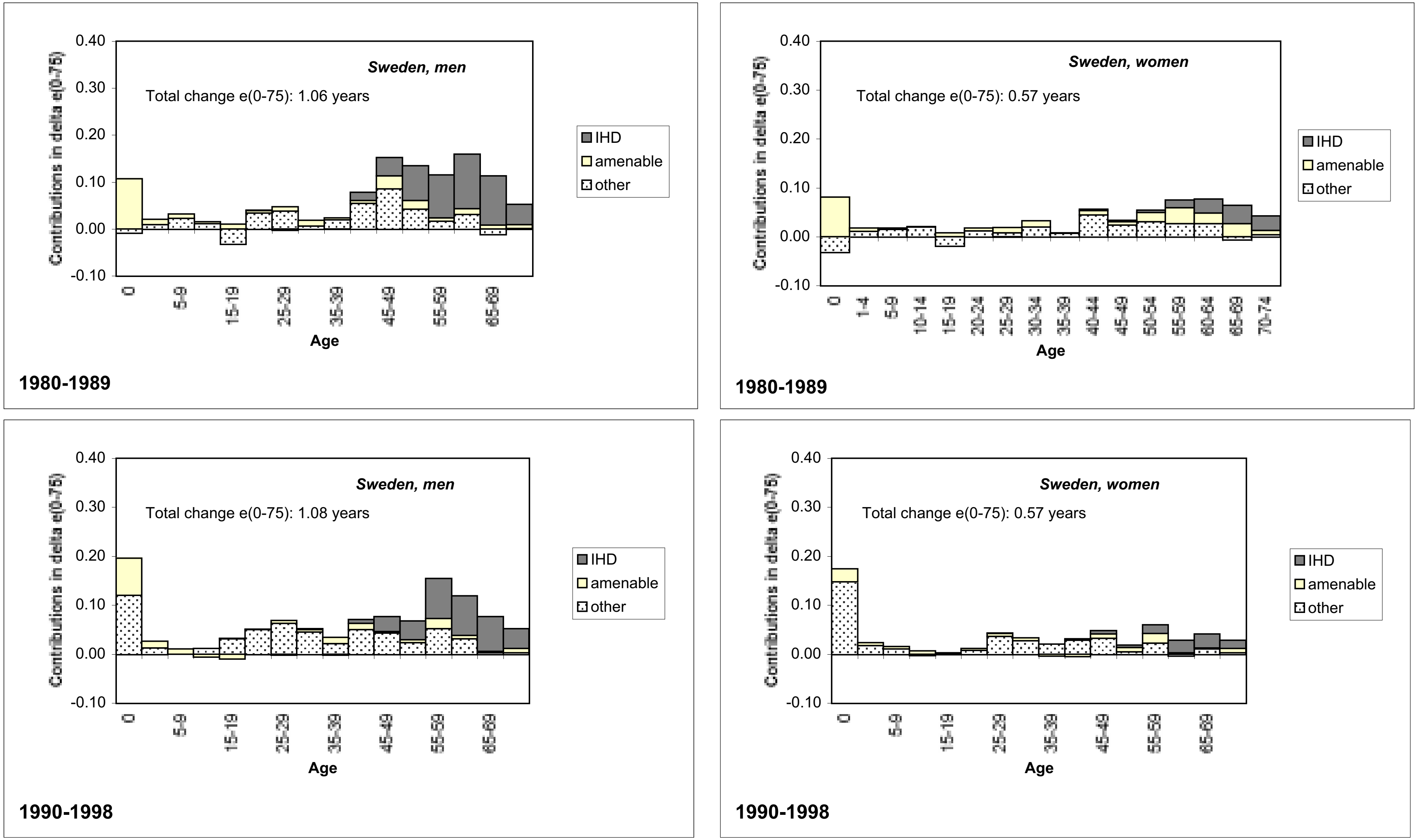


Figure 13 Age- and cause specific contributions to changes in temporary life expectancy in Sweden: 1980-1989 and 1990-1998



the 1980s and the 1990s, at 1.1 years in men and 0.57 years in women (Figure 13). As in The Netherlands, in the 1980s, falling amenable mortality did have a noticeable impact on changing temporary life expectancy, accounting for 0.26 of a year or 25% of the total increase in men and 45% (0.25 of a year) in women. While infant mortality was an important contributor to these changes, falling amenable mortality among women aged over 40 years had a somewhat greater impact, accounting for just over 22% of the overall increase in life expectancy.

Again as in The Netherlands, adding declining mortality from ischaemic heart disease makes the impact of amenable mortality rise further, quite substantially so for men, to about 70% in both sexes. For women, this increase was less than that seen for Dutch women, mainly because Swedish women did not record a net increase in mortality from ‘other causes’ as did Dutch women over 40 years of age.

By the 1990s this pattern had changed. As seen elsewhere, falling amenable mortality now contributed less to the overall change in temporary life expectancy than it had in the 1980s, especially among women where its impact had fallen to less than 20%, similar to that seen in men but even lower than in French women. Instead the overall improvement was now mainly driven by ‘other causes’ although falling IHD mortality remained an important contributor, accounting for 0.10 of a year or 18% of the total change in temporary life expectancy in women and 32% (0.35 or a year) in men.

Thus, if ischaemic heart disease was to be included with amenable conditions, their impact on life expectancy would be considerably higher, accounting for about 40% of the overall improvement in women and 50% in men.

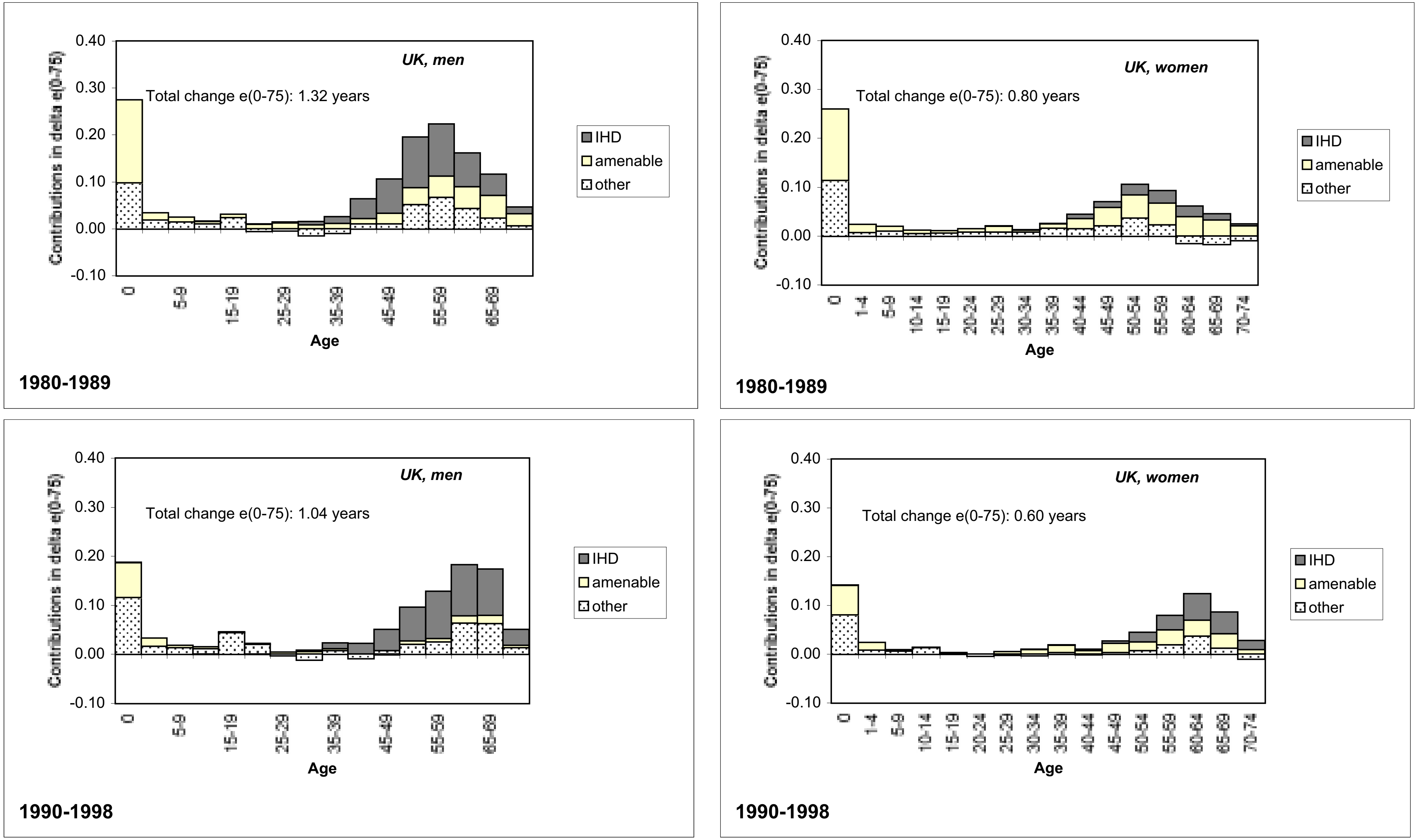
United Kingdom

Turning finally to the United Kingdom, we find a pattern that looks somewhat similar to that seen in Austria and west Germany, at least in the 1980s (Figure 14). Thus, declining amenable mortality made substantial contributions to the overall change in temporary life expectancy, at 37% of the total increase of 1.32 years in men and 58% of 0.8 years in women. However, unlike in Austria and Germany, this was mainly due to falling mortality among adults aged over 40, accounting for 0.24 of a year or 18% in men and, again, 0.24 of a year or 30% in women. Only Finnish women experienced a higher impact of falling amenable mortality among adults in the 1980s.

However, among men, declining IHD mortality was as important a contributor, accounting for another 37% of the total change in temporary life expectancy. Thus, if IHD was to be combined with amenable mortality it would increase the potential impact of health care to 75%. This proportion was somewhat less in women, at 70%.

As with many other countries analysed thus far, this pattern had changed by the 1990s, with, among men, amenable mortality now accounting for much less than it had in the 1980s, at only 16% of the improvement in temporary life expectancy. This figure was very similar to that seen in France, Finland, west Germany and Sweden. Whilst also declining in women, amenable mortality remained an important contributor to changing life expectancy in the 1990s, accounting for 0.26 of a year or 43% of the total change, still mainly women over 40, contributing 24%.

Figure 14 Age- and cause specific contributions to changes in temporary life expectancy in the United Kingdom: 1980-1989 and 1990-1998



Importantly, both men and women recorded a sustained decline in mortality from ischaemic heart disease. In men, falling IHD mortality became the most important contributor to changing temporary life expectancy in the 1990s, accounting for almost half of the total change of 1.04 years between 1990 and 1998. Among women, falling IHD mortality contributed about one third to the total change. Thus, if IHD mortality was to be combined with amenable mortality its impact remains very high in the UK in the 1990s, at about 60% in men and 70% in women.

Discussion

This analysis of the contribution of amenable mortality to changing life expectancy in countries of the European Union in the 1980s and 1990s demonstrated that, while men and women in all countries experienced increases in life expectancy between birth and age 75, the pace of these changes differed between the two time periods and between countries. It is not possible, within the scope of this report, to comment in detail on the changes in particular causes of death observed in each country so the following sections will concentrate on some major issues, highlighting findings common to a number of countries and, specifically, focusing on the role of amenable mortality.

Trends in temporary life expectancy

The improvements in temporary life expectancy were generally due to declining mortality at all ages. However, there were some important exceptions. In the 1980s, the southern European countries as well as France and Finland recorded a net increase in mortality among young men aged 15-39, offsetting some of the improvements seen at other ages. This was most notable in Spain, where the loss in temporary life expectancy due to increasing mortality among young men was as large as the overall increase in life expectancy in that country between 1980 and 1989. Spain was also among the two countries that, along with Finland, also recorded a net increase in mortality among young women. Elsewhere it was shown that the worsening in young adult mortality in Spain in the 1980s was largely attributable to rising mortality from traffic related injuries, and, among men, possibly AIDS.[209] AIDS was also put forward as the main explanation for unfavourable mortality pattern among young men in Italy in the 1980s, with traffic related injuries coming a close second.[210] Somewhat less is known about the causes of the mortality increases in Greece and Portugal but rising mortality from external causes, especially traffic related injuries among young men has been observed in both countries, with only little recent improvement in Greece.[211] However, in all countries except Greece and Portugal the deterioration in mortality among young men had resolved in the 1990s.

The other exception was a net increase in mortality among women aged over 55 in Denmark in the 1980s, and, to a smaller extent, in the 1990s, mainly reflecting rising death rates from smoking related diseases.[212] Smoking-related deaths also account for much of the increase in mortality among Dutch women in that age group.[213]

The contribution of amenable mortality to changing life expectancy

In the 1980s in all countries improvements in mortality from amenable conditions made substantial positive contributions to the overall change in temporary life expectancy. In most cases this was driven by falling infant mortality. The only exceptions were Denmark, The Netherlands, the United Kingdom, France (men) and Sweden (women) where falling amenable mortality among the middle-aged was equally or even more important.

In contrast, in the 1990s, changes in amenable mortality made a somewhat smaller contribution to improvements in temporary life expectancy than they had in the 1980s. Among men, falling amenable mortality now accounted for only 8% in the Netherlands and around 15% in west Germany, France, Sweden and the UK. However it remained an important contributor in southern Europe, especially in Portugal and Greece. Among women, the impact of amenable mortality on changing temporary life expectancy had also declined somewhat in the 1990s but still accounted for at least 20% of the total improvement. As in the 1980s, the impact of amenable mortality among men was largely attributable to a continuous decline in infant mortality in most countries. However, among women, declining amenable mortality among the middle-aged was more important in all countries except the southern European ones.

Next steps

What do these findings say about the use of the concept of "avoidable mortality" in Europe in the 21st century? There is clear evidence that improvements in access to effective health care have had a measureable impact in many countries during the 1980s and 1990s, in particular through reductions in infant mortality and in deaths among the middle aged and elderly, especially women. However the scale of impact has, to a considerable extent, reflected the starting point. Thus, those countries where infant mortality was relatively high at the beginning of the 1980s, and which had the greatest scope for improvement, such as Greece and Portugal, unsurprisingly saw the greatest reductions in amenable mortality in infancy. In contrast, in countries with infant mortality rates that had already reached very low rates by the beginning of the 1990s, such as Sweden, the scope for further improvement was small.

Similarly, the scope for improvement in amenable deaths in adulthood was greatest in those countries where initial rates were highest. The corollary of this is that as rates fall in all countries, the extent of variation decreases. As a consequence, it seems likely that, in the 21st century, the ability to compare health system performance at this aggregate level is likely to be very limited, simply because the differences will be relatively small. This clearly has implications for the attempts being made by the WHO to develop rankings of health systems based on health attainment, at least when applied to countries in western Europe.

This approach has, at its heart, an important contradiction, which relates to the definition of the boundaries of the health care system. For two of the three dimensions being assessed, responsiveness and fairness of financing, the health care system consists, implicitly, of personal health services. It is the interaction with these services that is being assessed when judging responsiveness; similarly it is the cost of these services that is being assessed when

Table 13 Selected measures of population health outcome

Country	Life expectancy	Disability-adjusted life expectancy	Age standardised death rates from amenable causes
Austria	78.1	71.6	72.90
Denmark	76.7	69.4	68.37 x
Finland	77.5	70.5	64.73 x
France	78.9	73.1	62.75
Germany	77.8	70.4	75.38 ‡
Greece	78.3	72.5	72.35
Italy	79.1	72.7	68.95
Netherlands	78.2	72.0	71.15
Portugal	75.4	69.3	113.64
Spain	78.7	72.8	66.24
Sweden	79.6	73.0	49.55 x
United Kingdom	77.5	71.7	87.43

x Selected amenable conditions excluded (see text)
‡ West Germany only (1997)
Source: WHO HFA database; WHR 2000; author's calculations

judging fairness of financing. In contrast, when assessing health attainment, using disability-adjusted life expectancy, it is by implication the entire range of policies that impact on health, whether they are in the housing, transport, economic development or other sectors (arguably education is taken into account in the process of stochastic frontier analysis used to assess what level is theoretically attainable).

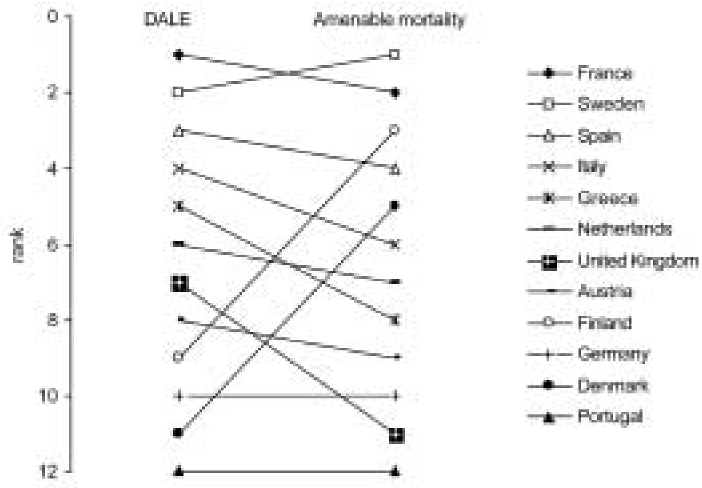
Elsewhere we have argued that a preferable approach to assessing health attainment attributable to health systems would be to compare outcomes from only those causes where there is demonstrable evidence that health care will have an impact.[214]

The results of such an exercise are shown in Table 13, which shows, for the countries included in this study, three measure, life expectancy at birth (1998), disability adjusted life expectancy (1999; as used in the 2000 World Health Report), and the age standardised death rate from amenable causes between birth and age 75 in 1998.

As in the World Health Report, these figures can be used to generate rankings of performance. The consequences of using avoidable mortality, rather than disability adjusted life expectancy, is shown in Figure 15. Although, for some countries, the ranking changes little, for some it differs considerably. Finland improves from ninth to third place and Denmark improves from eleventh to fifth place, although it has to be noted that certain conditions were excluded (see table 13). Greece falls from fifth to eighth place and the United Kingdom from seventh to eleventh place.

To some extent this is a reflection of the greater weight given to cardiovascular disease (and by extension the risk factors that cause it, which have their roots in broader health policies) in estimation of disability-adjusted life expectancy, which tends to disadvantage some northern European countries. However there are clearly other factors involved. In particular

Figure 15 Comparison of rankings based on DALE and amenable mortality rates



the change in ranking of the United Kingdom raises some important questions about timely access to health care, which have already been echoed in the national debate about thefuture of health care in the United Kingdom in the light of other evidence of relative under-achievement in relation to other European countries.

Returning to the question asked at the beginning of this section, what does this mean for current efforts to revise the methodology used in the World Health Organisation's rankings? Clearly a more detailed study of causes of death where the link to health system performance is stronger than it is with overall mortality and disability will generate different rankings. Of course, this can only be done for those countries where appropriate data are available and it is noteworthy that, even in the European Union, a country such as Belgium is unable to produce timely mortality data. This approach will not be possible for the 130+ countries that at present fail to collect adequate mortality data. This argument does, of course, also apply to the existing approach, which gets around this problem by estimating mortality.

It can, of course, be argued that 'avoidable' mortality does not take into account disability, and so will underestimate the burden of disease attributable to mental health. However, at present most data on disability are extrapolated from observations in a relatively small number of countries and other work that we have undertaken (paper submitted) shows that these estimates can be very different from what is found when specific studies are undertaken. In addition, measures of disability, especially in relation to mental health, are very susceptible to cultural differences.

One striking finding has been the substantial decline in deaths from ischaemic heart disease in the northern European countries. The reasons for this decline are complex and seem to include both changes in lifestyle, in particular improved diet and reduced smoking, as well as greater access to effective treatment. Disentangling these contributions is beyond the scope of this report and anyway is likely to be extremely difficult.

What are the next steps? When the concept of "avoidable mortality" was first developed it was seen as a way of identifying topics for further study, rather than being an end in itself.

This is even more true now that it was then. While the results presented here provide much new information on what has happened in the 1990s in each country, they can also be used to identify areas for further exploration. For example, although there have been large improvements among British women in the 1990s, their death rates remain higher than in otherwise comparable countries, possibly suggesting relative under-treatment. Similarly, there is scope for a better understanding of the continuing relatively high infant mortality in southern Europe.

This study has been undertaken at the level of entire countries. As the earlier review noted, where it has been looked for, deaths from amenable mortality have been higher among the poor. There is scope for further analysis within countries, both by socio-economic group and, especially in the larger countries, by region. Thus, overall death rates vary considerably between the constituent parts of the United Kingdom or among the German Länder, with death rates in Scotland or in Mecklenburg-Vorpommern especially high. Similarly, there is substantial diversity within both Italy and France.

What is now needed is more detailed examination of specific causes of death, recognising that, especially where numbers are small, variations may be due to chance but they may also indicate areas of concern that might otherwise be overlooked. Once identified, it will then be possible to examine such tracer conditions to identify differences in processes and outcomes of care.

Table 14 Age-standardised death rates (per 100 000) for selected causes and cause groups in EU countries in 1980, 1990 and 1998: age 0-74

	Austria			*Denmark**			*Finland**			*France*			*Germany west*			*Greece*		
	1980	***1990***	***1998***	***1980***	***1990***	***1998***	***1980***	***1990***	***1998***	***1980***	***1990***	***1998***	***1980***	***1990***	***1997***	***1980***	***1990***	***1998***
men																		
amenable causes	164.05	100.94	76.39	82.81	71.18	60.54	118.77	98.53	71.32	107.10	74.52	64.87	135.01	86.62	76.37	127.90	83.34	73.39
IHD	150.12	122.67	105.70	209.31	150.60	82.77	297.31	209.17	137.54	71.62	51.52	40.70	164.53	119.47	94.00	87.30	90.11	82.14
other causes	475.68	387.95	323.26	406.00	419.90	393.93	424.39	398.05	350.90	520.45	440.84	397.98	449.72	391.34	348.98	336.06	310.97	302.26
all causes	789.85	611.55	505.34	698.12	641.67	537.25	826.43	705.76	559.77	699.17	566.89	503.55	749.26	597.43	519.35	551.26	484.43	457.79
women																		
amenable causes	128.54	89.30	69.41	97.15	88.05	76.19	94.01	76.09	58.14	86.31	65.92	60.62	118.44	85.38	74.39	127.08	86.81	71.32
IHD	47.37	39.11	32.65	66.75	50.74	29.30	76.02	59.38	37.67	19.32	13.12	9.65	46.90	36.89	30.30	24.90	27.50	23.46
other causes	215.07	165.35	138.74	226.02	243.29	241.09	165.22	164.46	143.26	197.31	154.41	145.06	208.93	174.36	155.15	176.60	145.08	132.39
all causes	390.98	293.76	240.81	389.92	382.09	346.59	335.26	299.93	239.08	302.94	233.46	215.33	374.27	296.63	259.84	328.58	259.39	227.16

	Italy			*Netherlands*			*Portugal*			*Spain*			*Sweden**			*United Kingdom*		
	1980	***1990***	***1998***	***1980***	***1990***	***1998***	***1980***	***1990***	***1998***	***1980***	***1990***	***1998***	***1980***	***1990***	***1998***	***1980***	***1990***	***1998***
men																		
amenable causes	143.10	89.12	70.00	87.92	69.34	67.31	251.39	160.74	130.42	128.79	88.94	70.54	75.40	57.97	47.23	146.16	95.36	85.58
IHD	107.60	77.35	61.02	167.09	115.97	78.33	83.86	69.66	58.69	73.80	63.69	57.99	209.39	138.68	89.83	250.72	188.72	126.20
other causes	437.41	376.81	318.76	372.13	356.74	321.78	488.93	444.30	422.52	389.40	396.54	347.18	305.26	283.64	256.15	347.01	315.14	280.51
all causes	688.12	543.27	449.78	627.13	542.05	467.41	824.18	674.70	611.63	591.98	549.16	475.71	590.06	480.30	393.21	743.89	599.23	492.28
women																		
amenable causes	119.68	84.08	67.91	96.31	81.59	75.00	181.39	123.28	96.86	105.75	78.71	61.93	75.41	59.08	51.86	146.90	107.19	89.28
IHD	32.84	22.68	17.10	48.22	34.08	26.52	29.96	25.21	18.98	20.95	17.81	14.81	60.22	41.00	27.09	82.37	68.57	45.23
other causes	185.79	149.19	132.33	154.42	156.64	158.11	203.95	181.58	160.56	174.54	145.89	120.06	169.60	159.61	144.83	179.66	172.15	164.40
all causes	338.31	255.95	217.33	298.95	272.30	259.62	415.30	330.07	276.40	301.24	242.41	196.80	305.23	259.68	223.78	408.92	347.91	298.90

* selected amenable causes excluded (see text)

Table 15 Life expectancy at birth in selected European countries in 1980, 1989, 1990 and 1998 (in years)

	men 1980-1989				women 1980-1989			
	amenable	*IHD*	*other*	*all*	*amenable*	*IHD*	*other*	*all*
Austria								
0	0.4121	0.0000	0.0918	*0.5040*	0.2405	0.0032	0.1056	*0.3493*
1-14	0.0302	0.0000	0.0906	*0.1208*	0.0348	0.0000	0.0999	*0.1347*
15-39	0.0805	0.0121	0.3100	*0.4026*	0.0653	0.0060	0.0989	*0.1703*
40-64	0.1811	0.1710	0.3537	*0.7059*	0.1494	0.0538	0.2215	*0.4246*
65-74	0.0811	0.0222	0.1108	*0.2141*	0.0606	0.0164	0.0745	*0.1516*
all	*0.7851*	*0.2053*	*0.9569*	1.9473	*0.5506*	*0.0795*	*0.6004*	1.2305
Denmark								
0	0.0268	0.0000	-0.0285	*-0.0017*	0.0420	0.0000	-0.0064	*0.0356*
1-14	0.0230	0.0000	0.0349	*0.0579*	0.0268	0.0000	-0.0074	*0.0194*
15-39	-0.0179	0.0110	0.1865	*0.1796*	-0.0017	-0.0049	0.1373	*0.1306*
40-64	0.0278	0.2664	-0.0817	*0.2124*	0.0530	0.0644	-0.0348	*0.0826*
65-74	0.0300	0.0913	-0.0451	*0.0762*	0.0094	0.0542	-0.0814	*-0.0178*
all	0.0897	0.3686	0.0660	*0.5243*	0.1294	0.1137	0.0073	*0.2504*
Finland								
0	0.0912	0.0000	0.0273	*0.1185*	0.0528	0.0000	0.0437	*0.0965*
1-14	0.0251	0.0000	0.0388	*0.0638*	-0.0034	0.0000	0.0183	*0.0149*
15-39	0.0249	0.0388	-0.1292	*-0.0656*	0.0181	0.0057	-0.0361	*-0.0122*
40-64	0.0528	0.4729	-0.0065	*0.5192*	0.0935	0.0846	-0.0481	*0.1300*
65-74	0.0644	0.0896	0.0665	*0.2206*	0.0488	0.0373	0.0194	*0.1055*
all	*0.2584*	*0.6013*	*-0.0030*	0.8566	*0.2098*	*0.1276*	*-0.0028*	0.3346
France								
0	0.1047	0.0000	0.1015	*0.2062*	0.0790	0.0000	0.0738	*0.1528*
1-14	0.0295	-0.0003	0.0972	*0.1264*	0.0225	0.0001	0.0569	*0.0796*
15-39	0.0307	0.0046	0.0671	*0.1025*	0.0264	0.0006	0.0926	*0.1196*
40-64	0.1113	0.0965	0.3410	*0.5488*	0.0828	0.0172	0.2057	*0.3057*
65-74	0.0480	0.0306	0.1055	*0.1842*	0.0384	0.0181	0.0672	*0.1237*
all	*0.3243*	*0.1315*	*0.7123*	1.1681	*0.2491*	*0.0361*	*0.4962*	0.7813
Germany, west								
0	0.3019	0.0000	0.1039	*0.4058*	0.2530	0.0000	0.1078	*0.3608*
1-14	0.0288	0.0000	0.1185	*0.1473*	0.0289	0.0000	0.0814	*0.1103*
15-39	0.0446	0.0116	0.3256	*0.3818*	0.0475	0.0029	0.1120	*0.1624*
40-64	0.1381	0.2537	0.2027	*0.5944*	0.0987	0.0435	0.1923	*0.3345*
65-74	0.0711	0.0563	0.0699	*0.1974*	0.0579	0.0217	0.0434	*0.1230*
all	*0.5846*	*0.3215*	*0.8207*	1.7268	*0.4861*	*0.0680*	*0.5369*	1.0910
Greece								
0	0.5621	0.0000	0.0869	*0.6490*	0.4521	0.0000	0.0912	*0.5433*
1-14	0.0211	0.0000	0.1032	*0.1243*	0.0225	0.0000	0.0506	*0.0731*
15-39	0.0194	-0.0140	-0.1484	*-0.1431*	0.0435	-0.0101	-0.0214	*0.0120*
40-64	0.0969	0.0160	0.1320	*0.2449*	0.1139	-0.0109	0.1478	*0.2508*
65-74	0.0558	-0.0225	0.0363	*0.0696*	0.0647	-0.0109	0.0656	*0.1195*
all	*0.7553*	*-0.0206*	*0.2099*	*0.9446*	*0.6968*	*-0.0319*	*0.3338*	*0.9987*
Italy								
0	-1.5624	0.5635	1.4452	0.4464	0.2300	0.0000	0.0661	*0.2961*
1-14	0.0698	-0.0001	0.0865	0.1562	0.0300	0.0001	0.1125	*0.1426*
15-39	-0.0039	0.0129	0.0377	0.0467	0.0484	0.0028	0.0739	*0.1251*
40-64	0.0117	0.1198	0.6550	0.7865	0.1269	0.0439	0.1933	*0.3641*
65-74	*0.0225*	*0.0196*	*0.1389*	*0.1810*	*0.0614*	*0.0243*	*0.0606*	*0.1463*
all	*0.1966*	*0.3700*	*0.3390*	*0.9056*	*0.2065*	*0.1017*	*-0.0108*	*0.2974*

Table 15 Life expectancy at birth in selected European countries in 1980, 1989, 1990 and 1998 (in years) (*continued*)

	men 1980-1989				women 1980-1989			
	amenable	*IHD*	*other*	*all*	*amenable*	*IHD*	*other*	*all*
Netherlands								
0	0.0607	0.0000	0.0888	*0.1495*	0.0646	0.0000	0.0491	*0.1136*
1-14	0.0178	0.0000	0.0715	*0.0893*	0.0187	0.0000	0.0451	*0.0638*
15-39	0.0207	0.0217	0.1187	*0.1612*	0.0172	0.0042	0.0077	*0.0291*
40-64	0.0653	0.2782	0.0459	*0.3894*	0.0765	0.0588	-0.0899	*0.0455*
65-74	0.0321	0.0700	0.0142	*0.1163*	0.0295	0.0387	-0.0228	*0.0454*
all	*0.1966*	*0.3700*	*0.3390*	*0.9056*	*0.2065*	*0.1017*	*-0.0108*	*0.2974*
Portugal								
0	0.7534	0.0000	0.1764	*0.9298*	0.5287	-0.0012	0.1397	*0.6672*
1-14	0.0730	0.0000	0.1328	*0.2058*	0.0796	0.0000	0.0831	*0.1627*
15-39	0.0674	0.0041	-0.1264	*-0.0549*	0.0645	0.0028	0.0058	*0.0731*
40-64	0.3045	0.0986	0.4457	*0.8489*	0.1768	0.0234	0.0967	*0.2969*
65-74	0.1306	0.0241	0.0603	*0.2151*	0.1362	0.0198	0.0626	*0.2186*
all	*1.3289*	*0.1268*	*0.6889*	*2.1446*	*0.9858*	*0.0448*	*0.3879*	*1.4184*
Spain								
0	0.2495	-0.0002	0.0754	*0.3247*	0.1640	0.0005	0.0569	*0.2214*
1-14	0.0474	0.0008	0.0767	*0.1250*	0.0409	0.0006	0.0568	*0.0983*
15-39	0.0299	0.0178	-0.4217	*-0.3739*	0.0502	0.0033	-0.0629	*-0.0094*
40-64	0.1443	0.0776	-0.0080	*0.2138*	0.0784	0.0183	0.1717	*0.2684*
65-74	0.0601	0.0067	0.0099	*0.0767*	0.0554	0.0087	0.0632	*0.1273*
all	*0.5313*	*0.1027*	*-0.2677*	*0.3664*	*0.3889*	*0.0314*	*0.2857*	*0.7059*
Sweden								
0	0.1073	0.0000	-0.0086	*0.0987*	0.0811	0.0000	-0.0317	*0.0495*
1-14	0.0249	0.0000	0.0424	*0.0673*	0.0117	0.0000	0.0445	*0.0562*
15-39	0.0415	-0.0032	0.0648	*0.1030*	0.0359	0.0006	0.0273	*0.0638*
40-64	0.0716	0.3373	0.2297	*0.6385*	0.0882	0.0562	0.1511	*0.2955*
65-74	0.0155	0.1491	-0.0106	*0.1541*	0.0351	0.0673	-0.0020	*0.1004*
all	*0.2607*	*0.4831*	*0.3178*	*1.0616*	*0.2521*	*0.1240*	*0.1893*	*0.5654*
United Kingdom								
0	0.1772	-0.0005	0.0976	*0.2743*	0.1466	-0.0006	0.1131	*0.2591*
1-14	0.0305	-0.0004	0.0428	*0.0730*	0.0329	-0.0004	0.0214	*0.0539*
15-39	0.0478	0.0242	-0.0107	*0.0614*	0.0363	0.0037	0.0444	*0.0844*
40-64	0.1665	0.4059	0.1768	*0.7492*	0.1910	0.0898	0.0774	*0.3582*
65-74	0.0761	0.0603	0.0261	*0.1625*	0.0551	0.0163	-0.0278	*0.0437*
all	*0.4921*	*0.4895*	*0.3388*	*1.3204*	*0.4593*	*0.1088*	*0.2312*	*0.7993*

Table 16 Age- and cause specific contributions (in years) to changes in temporary life expectancy in selected countries of the European Union between 1990 and 1998

	men 1990-1998				**women 1990-1998**			
	amenable	*IHD*	*other*	*all*	*amenable*	*IHD*	*other*	*all*
Austria								
0	0.0674	0.0000	0.1534	*0.2208*	0.1044	0.0000	0.0893	*0.1937*
1-14	0.0132	0.0000	0.0714	*0.0846*	0.0059	0.0000	0.0348	*0.0408*
15-39	0.0222	-0.0103	0.2824	*0.2943*	0.0344	-0.0076	0.0850	*0.1117*
40-64	0.1104	0.0917	0.3928	*0.5949*	0.1024	0.0243	0.1611	*0.2878*
65-74	0.0403	0.0320	0.0579	*0.1301*	0.0453	0.0268	0.0498	*0.1219*
all	*0.2534*	*0.1134*	*0.9580*	1.3248	*0.2924*	*0.0434*	*0.4201*	0.7559
Denmark								
0	0.0926	0.0000	0.1923	*0.2849*	0.0405	0.0000	0.0942	*0.1347*
1-14	0.0376	0.0000	0.0565	*0.0941*	0.0201	0.0000	0.0270	*0.0472*
15-39	0.0060	0.0053	0.1552	*0.1665*	0.0155	0.0043	0.0773	*0.0971*
40-64	0.0266	0.3305	0.1603	*0.5174*	0.1115	0.1099	0.1801	*0.4014*
65-74	0.0151	0.1321	-0.0028	*0.1445*	0.0074	0.0542	-0.0830	*-0.0214*
all	*0.1780*	*0.4679*	*0.5616*	1.2075	*0.1950*	*0.1684*	*0.2956*	0.6590
Finland								
0	0.0707	0.0000	0.0145	*0.0852*	0.0602	0.0000	0.0870	*0.1471*
1-14	0.0124	0.0000	0.0778	*0.0902*	0.0075	0.0000	0.0352	*0.0427*
15-39	0.0390	0.0232	0.4809	*0.5431*	0.0194	-0.0024	0.1091	*0.1262*
40-64	0.1218	0.4100	0.1486	*0.6804*	0.0678	0.0636	0.0916	*0.2231*
65-74	0.0388	0.1178	0.0516	*0.2082*	0.0459	0.0789	0.0496	*0.1744*
all	*0.2826*	*0.5510*	*0.7734*	1.6071	*0.2007*	*0.1402*	*0.3725*	0.7134
France								
0	0.0481	0.0000	0.1820	*0.2301*	0.0241	0.0000	0.1277	*0.1518*
1-14	0.0187	0.0003	0.0552	*0.0742*	0.0169	-0.0004	0.0359	*0.0524*
15-39	0.0297	0.0082	0.3295	*0.3674*	0.0023	-0.0011	0.0767	*0.0779*
40-64	0.0538	0.0486	0.2236	*0.3259*	0.0254	0.0126	0.0416	*0.0796*
65-74	0.0087	0.0254	0.0193	*0.0534*	0.0115	0.0116	-0.0017	*0.0214*
all	*0.1591*	*0.0825*	*0.8094*	1.0510	*0.0803*	*0.0227*	*0.2802*	0.3831
Germany, west								
0	0.0652	0.0000	0.1183	*0.1835*	0.0325	0.0000	0.0958	*0.1283*
1-14	0.0021	0.0000	0.0572	*0.0592*	0.0099	0.0000	0.0455	*0.0555*
15-39	0.0096	0.0017	0.1587	*0.1700*	0.0214	-0.0012	0.0712	*0.0913*
40-64	0.0295	0.1311	0.2003	*0.3609*	0.0507	0.0222	0.0692	*0.1421*
65-74	0.0186	0.0488	0.0464	*0.1138*	0.0261	0.0229	0.0381	*0.0871*
all	*0.1249*	*0.1816*	*0.5809*	0.8875	*0.1406*	*0.0438*	*0.3198*	0.5042
Greece								
0	0.1434	0.0000	0.0302	*0.1736*	0.1592	0.0000	0.0696	*0.2289*
1-14	0.0102	0.0000	0.0568	*0.0669*	0.0262	0.0000	-0.0198	*0.0063*
15-39	0.0336	0.0020	-0.0386	*-0.0030*	0.0140	-0.0005	0.0142	*0.0277*
40-64	0.0010	-0.0174	0.0233	*0.0069*	0.0272	-0.0052	0.0784	*0.1003*
65-74	0.0174	0.0332	0.0134	*0.0640*	0.0324	0.0211	0.0248	*0.0783*
all	*0.2055*	*0.0178*	*0.0851*	0.3084	*0.2589*	*0.0154*	*0.1672*	0.4415
Italy								
0	0.1951	0.0000	0.0463	*0.2414*	0.1125	0.0000	0.0479	*0.1604*
1-14	0.0095	0.0000	0.0356	*0.0450*	0.0111	0.0003	0.0229	*0.0343*
15-39	0.0197	0.0160	0.1795	*0.2152*	0.0245	0.0014	0.0206	*0.0466*
40-64	0.0638	0.1004	0.3481	*0.5124*	0.0715	0.0238	0.0803	*0.1756*
65-74	0.0309	0.0295	0.0811	*0.1415*	0.0351	0.0180	0.0398	*0.0929*
all	*0.3189*	*0.1459*	*0.6907*	1.1554	*0.2546*	*0.0436*	*0.2116*	0.5098

Table 16 Age- and cause specific contributions (in years) to changes in temporary life expectancy in selected countries of the European Union between 1990 and 1998 ***(continued)***

	men 1990-1998				women 1990-1998			
	amenable	*IHD*	*other*	*all*	*amenable*	*IHD*	*other*	*all*
Netherlands								
0	0.0455	0.0000	0.1023	*0.1478*	0.0355	0.0008	0.0959	*0.1321*
1-14	0.0066	0.0000	0.0636	*0.0702*	0.0135	-0.0013	0.0807	*0.0929*
15-39	0.0111	0.0060	0.0732	*0.0902*	0.0202	-0.0027	0.0385	*0.0560*
40-64	0.0005	0.1932	0.1502	*0.3440*	0.0249	0.0292	-0.0396	*0.0146*
65-74	0.0009	0.0800	0.0532	*0.1340*	0.0144	0.0213	-0.0193	*0.0164*
all	*0.0646*	*0.2792*	*0.4424*	*0.7861*	*0.1085*	*0.0473*	*0.1562*	*0.3120*
Portugal								
0	0.3328	-0.0011	0.0866	*0.4183*	0.1969	0.0000	0.1214	*0.3183*
1-14	0.0298	-0.0008	0.0970	*0.1260*	0.0025	-0.0018	0.0669	*0.0677*
15-39	0.0019	0.0022	0.0646	*0.0686*	0.0033	0.0011	0.0340	*0.0384*
40-64	0.1072	0.0536	0.0823	*0.2431*	0.1199	0.0286	0.0817	*0.2302*
65-74	0.0550	0.0182	0.0041	*0.0773*	0.0715	0.0176	0.0356	*0.1247*
all	*0.5266*	*0.0722*	*0.3345*	*0.9333*	*0.3940*	*0.0455*	*0.3397*	*0.7792*
Spain								
0	0.1392	-0.0003	0.0711	*0.2099*	0.1094	0.0003	0.0739	*0.1836*
1-14	0.0218	-0.0001	0.0758	*0.0974*	0.0217	-0.0009	0.0539	*0.0747*
15-39	0.0568	0.0054	0.3581	*0.4203*	0.0451	0.0014	0.0851	*0.1317*
40-64	0.0724	0.0230	0.1973	*0.2927*	0.0655	0.0135	0.1147	*0.1936*
65-74	0.0240	0.0163	0.0702	*0.1106*	0.0329	0.0096	0.0584	*0.1009*
all	*0.3142*	*0.0442*	*0.7726*	*1.1310*	*0.2746*	*0.0239*	*0.3860*	*0.6845*
Sweden								
0	0.0761	0.0000	0.1201	*0.1962*	0.0266	0.0000	0.1477	*0.1744*
1-14	0.0192	0.0000	0.0229	*0.0421*	0.0172	0.0000	0.0262	*0.0434*
15-39	0.0147	-0.0013	0.2103	*0.2236*	0.0106	0.0009	0.0937	*0.1052*
40-64	0.0493	0.2388	0.1995	*0.4877*	0.0359	0.0578	0.0832	*0.1770*
65-74	0.0113	0.1118	0.0057	*0.1289*	0.0102	0.0447	0.0137	0.0686
all	*0.1705*	*0.3494*	*0.5586*	*1.0785*	*0.1005*	*0.1035*	*0.3646*	*0.5685*
United Kingdom								
0	0.0711	0.0012	0.1155	*0.1877*	0.0609	0.0005	0.0799	*0.1414*
1-14	0.0253	0.0005	0.0410	*0.0669*	0.0207	0.0000	0.0260	*0.0467*
15-39	0.0177	0.0142	0.0566	*0.0885*	0.0304	0.0013	-0.0059	*0.0258*
40-64	0.0200	0.3350	0.1130	*0.4679*	0.1014	0.1116	0.0693	*0.2823*
65-74	0.0201	0.1268	0.0773	*0.2241*	0.0350	0.0641	0.0052	*0.1042*
all	*0.1611*	*0.4777*	*0.3964*	*1.0352*	*0.2570*	*0.1775*	*0.1660*	*0.6005*

PART III: EMPIRICAL STUDIES OF 'AVOIDABLE' MORTALITY
ANNOTATED REVIEW

Introduction

This part gives an overview of 70 studies that have empirically applied the concept of avoidable mortality. Studies were analysed using a structured protocol, extracting information on (1) study region, (2) time period under investigation, (3) aim of study and definition of 'avoidable mortality', (4) causes of death and age group(s) under study, (5) analytical design and (6) main results. This information was drawn together in the form of an annotated bibliography. Studies are ordered according to the main objective of their analysis, thus distinguishing four broad groups: (1) geographical variation of 'avoidable' mortality, (2) assessment of regional/national level of 'avoidable' mortality, (3) variation by socio-economic and/or socio-demographic factors and (4) variation over time. Within each cluster, studies are further organised according to the study region to enable an overview of countries or regions within countries that have so far been subject to studies of 'avoidable' mortality.

Empirical studies of 'avoidable' mortality: Analyses of geographical variation ('cross-sectional')

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Charlton et al. 1983[20]	England & Wales by 98 Area Health Authorities (AHA)	1974-78	Small area variation in mortality considered 'avoidable' with "appropriate medical intervention" excl. conditions amenable to primary prevention (e.g. lung cancer); 'non-preventable causes': little effect of medical intervention on likelihood of fatal outcome	basis: Rutstein et al. • 14 conditions/groups of conditions plus perinatal deaths • ages 5-64; respiratory causes: 5-49, maternal causes: 10-44, Hodgkin's disease: 5-34	Cross-sectional SMR by AHA, adjusted for socio-economic factors (%unskilled employed; % home renting; % car ownership)	Considerable variation between 98 AHAs in mortality from most of the diseases considered 'avoidable' with medical care even after adjustment for socio-economic factors; social indicators explain 8% (maternal deaths) to 64% (TB) of variance of 'avoidable' deaths and about 40% of all-cause and 'non-preventable' mortality
Carr-Hill et al. 1987[64]	E&W by 15 Regional Health Authorities (RHA)	1976-83	Small area variation in 'avoidable' mortality in relation to socioeconomic factors and health care resources; 'avoidable' mortality: mortality "apparently avoidable given appropriate medical intervention"	• 4 major causes of avoidable death (hypertensive disease, cancer of cervix/uterus, selected respiratory diseases, perinatal mortality) • no age given	Cross-sectional Correlation of mortality rates and socioeconomic factors / health care expenditure [capital/ recurrent]; hospital services for diagnosis & treatment; family practitioner services; # nurses & midwifes/patient	Social factors unemployment, average domestic rateable value & no. cars/person explain 40-91% of variance of 3 indicators (perinatal, respiratory, cancer) of avoidable mortality and 28-40% of variance in total mortality; correlation between avoidable deaths & health care resources positive for most variables except cervical ca, pneumonia & perinatal mortality with capital & practitioner services
Bauer & Charlton 1986[65]	E&W by 98 Area Health Authorities (AHAs)	1974-78	Evaluation of contribution of varying morbidity to area variation in mortality from diseases amenable to medical intervention	basis: Charlton et al. (1983) • 13 conditions/groups of conditions excl. maternal and perinatal mortality • no age given	Cross-sectional Multiple regression of SMR, morbidity indicators (registration ratios, hospital discharge rates) and socioeconomic factors (see Chalton et al. 1983) by AHA	Social factors explained up to 42.9% (cervical ca) of area variation in SMRs, morbidity up to 37.4% (chron rheum heart disease); significant improvement in variation explained after adjusting for social factors and morbidity combined with significant heterogeneity persisting
Poikolainen & Eskola 1988[26]	25 developed countries	1975-1978	Association of health service resources with mortality amenable to interventions by health services	basis: Rutstein et al. • 4 categories: amenable (74 conditions); non-amenable (31), partly amenable (20); violent causes (13) • ages <65; diabetes, respiratory: 0-49	Cross-sectional Linear regression of SDR, GDP (indicator socioeconomic development), health services resources [US$/capita; # medical doctors, # nurses, # hospital beds], other [alcohol & tobacco consumption, military expenditure]	Mortality from amenable causes significantly negatively associated with GDP but not with no. doctors/nurses, hospital beds, alcohol consumption (neg. association with non-amenable in men) [even after excluding socialist countries]

Empirical studies of 'avoidable' mortality: Analyses of geographical variation ('cross-sectional') – *continued*

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Buck & Bull 1986[61]	A. 17 developed countries; B. England & Wales	A. 1971-1974 B. 1974/5-1977/8	A. Cross-country analysis of association between preventable deaths & health services input (expenditure) B. 'Micro-analysis' of association between preventable deaths & training of GPs in E&W by local authority 'preventable' deaths: conditions that are amenable to treatment	basis: Rutstein et al. • 27 conditions/groups of conditions plus infant mortality as separate category; similar to Charlton's list excl. hypertensive disease & Hodgkin's disease, incl. skin cancer, benign neoplasm, venous thrombosis & some infectious diseases • ages 0-64	Cross-sectional A. Age-sex adjusted DR; correlation with 5 indicators for health services input (public investment in health facilities, total health expend, public health expend. [all: %GDP], % medical graduates passing exam, income/capita) B. death rates & IMR adjusted for socioeconomic factors; correlation with 13 indicators of GP training; regression (GLS)	A. significant (negative) correlation between preventable deaths & public investment in health facilities [-0.49] (correlation higher for IMR: -0.74); & with per capita income [-0.56] (IMR: -0.39) B. significant correlation between preventable deaths & 1 indicator of GP training (IMR: sign. correlation with 5 indicators); in GLS multiple regression analysis 8 indicators in total explained 22% of variation in IMR and 10% of preventable mortality
Holland 1988[28]	10 EC member states (with UK separated into England & Wales, N. Ireland and Scotland) by administrative area (total: 360)	1974-1978	Examination of selected 'unnecessary untimely deaths' with causes distinguished into those "for which it is reasonably certain that effective treatment or secondary prevention are available" and those mainly amenable to primary preventive intervention "usually outside the control of health services", by region; comparison between and within countries; relation between variation in avoidable deaths and levels of health services inputs	basis: Charlton et al. (1983) • 17 conditions/groups of conditions (primary prevention: 3 causes) • ages 5-64; cervical ca: 15-64; chron. rheum. heart dis: 5-44; respiratory: 1-14; asthma: 5-44; hypertensive & cerebrovascular: 35-64; whooping cough: 0-14; tetanus: 0-64; measles: 1-14; osteomyelitis: 1-64; liver cirrhosis: 15-74; maternal mortality & motor vehicle accidents: all ages	Cross-sectional SMR for each country (within-country variation) and EC in total (between-country variation); heterogeneity between areas; summary scores by administrative area (excess of 'avoidable' mortality using (1) own country's or (2) EC standard); indicators of health services input (# GPs/100k, # acute hospital beds/100k, # consultants/100k) & socio-economic indicators (% households with fixed bath/shower, average # persons/room, # cars/100 inhabitants) by region	Substantial within- and between-country-variation for most avoidable conditions, esp. tuberculosis, cervical cancer, hypertensive & cerebrovascular disease, perinatal deaths and all-cause mortality (ages 5-64 and all ages) [for details see country-specific studies below]
Holland 1993[29]	12 EC member states (with UK separated into England & Wales, N. Ireland and Scotland) by administrative area (total: 554)	1980-1984	Expanding the work of Holland 1988 & 1991 by analysing mortality from conditions that "reflect extensions of the abilities of health services and their technical and administrative infrastructures", specifically conditions for which it is "reasonably certain that effective treatment or primary or secondary prevention could be provided by health care services"	• 8 conditions/groups of conditions • ages 0-64; intestinal infect: 0-14; breast ca: 25-64; skin ca: 35-64; testis ca: 0-64; leukaemia: 0-44; IHD: 35-64; peptic ulcer: 25-64; congenital heart disease:1-14	Cross-sectional SMR for each country (within-country variation) and EC in total (between-country variation); degree of heterogeneity between areas	Substantial between-country variation for all avoidable conditions, esp. IHD with national SMRs lowest in France (51), Spain (60), Portugal (62) & highest in Scotland (255) & N. Ireland (258); also: breast cancer lowest in Mediterranean countries (73-81) & highest in UK (134-137); very high SMR in intestinal infections in Portugal (1094) but well below 100 in all other EC countries; sign. within-country variation esp. for IHD (all regions), peptic ulcer & breast cancer (most regions)

Empirical studies of 'avoidable' mortality: Analyses of geographical variation ('cross-sectional') – *continued*

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Jougla et al. 1987[33]	France by 95 departments	1973-1977	Analysis of regional variation in 'avoidable' mortality and its association with indicators of health services (input), divided into causes 'avoidable' by 'curative' measures or by 'primary prevention' (3 causes)	basis: EC (1988) list • 21 conditions/groups of conditions incl. cancer of oral cavity, infectious dis, nephritis & other dis of kidney, other accidents (primary prevention: 4 causes) • ages 5-64; appendicitis/ hernia/cholelithiasis: 20-64; nephritis: 30-49; maternal mortality: 10-44; cirrhosis & motor vehicle accidents: 15-64; other accidents: 1-14	Cross-sectional Regional SMR; score 'avoidable' mortality; factor analysis of explanatory variables: 6 health services supply indicators (physician & bed density, % specialists & private beds, hospital admissions, presence of regional hospital) & 12 socio-economic indicators; multiple regression	Associations between 'avoidable' mortality and generally stronger with socio-economic variables than indicators of health services supply; substantial geographical variation with mortality from causes amenable to curative measures concentrated in the North-East (esp. among females)
Kunst et al. 1988[34]	10 EC member states (with UK separated into England & Wales, N. Ireland and Scotland) by administrative area (total: 360)	1974-78	Analysis of within and between-country differences in mortality from avoidable conditions in EC with 'avoidable' referring to conditions amenable to medical intervention; main questions: (1) common pattern of regional variation in avoidable causes within EC countries? (2) regional differences in cause-specific mortality explainable by differences in medical care supply?	basis: EC (1988) list • 12 conditions/groups of conditions excl. infectious diseases • ages: see Holland 1988	Cross-sectional SMRs by administrative area; heterogeneity within countries; principal component analysis of avoidable causes; rank-correlation for selected causes; multiple regression of SMR, independent variables: medical care supply (# GPs/1000, # hospital beds/1000, # consultants/ 1000); socio-economic: % households with fixed shower/bath, average # persons/room, # private cars/100	(1) sign. within-country heterogeneity for TB, cervical cancer, rheumatic heart dis, hypertensive & cerebrovascular dis, perinatal mortality; common pattern of regional mortality for selected conditions largely resembling pattern of regional variation in all-cause mortality; no specific intercorrelations between causes of death that refer to same type of medical care (2) association between avoidable causes & medical care supply not consistent and rarely significant; no important differences to all-cause mortality
Mackenbach et al. 1988a[66]	The Netherlands by 28 regions	1950-1984	Geographical variation in mortality from conditions amenable to medical intervention in relation to medical care supply in 4 time periods (1950-54, 1960-64, 1970-74, 1980-84)	basis: Rutstein et al. • 13 conditions/groups of conditions [ordered accord. to time of introduction of medical care intervention]; • age limit 0-74 (cancer at young ages: 0-34)	Cross-sectional Regional SMRs, regression analysis of logarithm of SMR, independent variables: medical supply characteristics (4, e.g. # GPs/hospital beds), socio-demographic factors (average income, net immigration, urbanisation), fertility rate	Sign. regional variation for all conditions except cancer in children in all 4 periods with indication of increasing homogeneity of mortality from some causes; few sign. associations between mortality & medical supply (1980/84), e.g. TB & hospital bed density [positive], CVA & % bed in university hospital [negative]; associations time dependent, e.g. largest association between TB & medical care in 1980/84; overall association between amenable mortality & medical care supply weak and inconsistent

Empirical studies of 'avoidable' mortality: Analyses of geographical variation ('cross-sectional') – *continued*

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Mackenbach 1991[67]	11 EC countries: Belgium, Denmark, France, Germany (west), Greece, Italy, Ireland, Netherlands, Portugal, Spain, UK	1980-84 (Greece: 1980-82; Italy: 1979-83; Spain: 1979-83)	Association of level of national health care expenditure and mortality from conditions considered to be "sensitive to variations in effectiveness of health services"; includes both preventable (e.g. TB, cervical ca) and curable conditions (e.g. appendicitis)	basis: EC (1988) • 12 conditions/groups of conditions excl. infectious diseases • see Holland	Cross-sectional SMR for each condition; average SMR for 2 subgroups: (1) related to GDP (TB, chron rheum heart dis, resp dis, hypertensive/ cerebrovasc, perinatal deaths); (2) not related to GDP; GDP-adjusted 'observed' & 'expected' [least square regression] SMR (1st grp); weighted overall average SMR by country; correlation with health expenditure (US$/capita)	GDP-adjusted amenable mortality was lowest in Greece, NL and DK and highest in Portugal, Italy & Germany (indicative of cost-effectiveness); mortality from conditions in 1st subgroup generally lower in countries with higher level of health care expenditure; no association between per capita health care expenditure and GPD-adjusted average SMR from amenable conditions
Westerling 1993[50]	Sweden by 26 health administrative areas	1974-1979, 1980-1985	Analysis of variation in death rates for selected indicators of avoidable mortality among health administrative areas, divided into 'medical care indicators' and 'health policy indictors'	basis: Rutstein et al. • 13 conditions/groups of conditions (medical care: 10, health policy: 3) • ages 0-64	Cross-sectional regional SMR; analysis of levels of systematic (nonrandom) variance between regions	Systematic variance accounted for at least 85% of observed variance for health policy indicators (& total mortality) and up to 80% for medical care indicators with remainder due to random variation (most medical care indicators); sign. differences between regional SMR and national standard for all health policy indicators and selected medical care ind. (bronchitis, pneumonia, colon ca, cervix ca, CVA, ulcer, perinatal mortality, asthma)
Westerling 1996[153]	Sweden by 26 health administrative areas	1987-1990	Analysis of whether proportion of deaths outside hospital from selected 'avoidable' causes can explain regional variations in mortality from these causes; 'avoidable' causes: conditions for which acute medical management may be important to the outcome	• 5 causes of 'avoidable' death: diabetes, ischaemic heart disease, cerebrovascular disease, asthma, ulcer of duodenum • ages 0-69	Cross-sectional (age-sex-standardised) mean annual death rate for deaths in and outside hospital, unknown place, total; analysis of variation between regions; correlation between proportion deaths outside hospital with all deaths for each cause and by region	58% of deaths from asthma & 54% from IHD occurred outside hospital (ulcer: 44%, diabetes: 31%, CVA: 16%); sign. correlation between in-hospital & outside hospital deaths (CVA, IHD, diabetes: 0.5); sign. [but moderate] correlation between outside hospital deaths and all deaths for ulcer & diabetes only (coeff: 0.4)
Suarez-Varela et al. 1996[215]	Valencia, Spain	1982-1990	Analysis of regional variations in avoidable mortality by level of urbanisation and health care resources; 'avoidable' mortality: causes of death "amenable to intervention by health services"	basis: Rutstein et al. • 14 conditions/groups of conditions (see Holland 1988 excl. causes amenable to primary prevention) • no age given	Cross-sectional Age-standardised death rates by level of urbanisation (= proxy for health care resources, such as number of hospitals)	Among men levels of pneumonia tuberculosis, rheumatic heart disease, bacterial disease, Hodgkin's disease sign. higher in urban areas (women: cervical cancer, pneumonia, abdominal hernia, cholecystitis); CVA sign. higher in rural areas (both sexes)

Empirical studies of 'avoidable' mortality: Analyses of geographical variation ('cross-sectional') – *continued*

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Humblet et al. 1987[32,60]	Belgium by 43 districts	1974-78	Analysis of geographical variations of 'avoidable' mortality as defined by Holland (1988)	basis: EC (1988) • 12 conditions/groups of conditions excl. maternal & perinatal mortality, infectious diseases, motor vehicle accidents • ages 5-64; hypertensive & cerebrovascular disease: 35-64; respiratory: 1-14; asthma: 5-49; liver cirrhosis: 15-64	Cross-sectional Regional SMR; multiple correspondence analysis of avoidable causes; multiple regression analysis of thus identified 'types of mortality' against socio-economic indicators (index of social well-being; index of industrial growth 1961-1970; mean income level) & indicators of health services (age-morbidity-standardised rate of GP consultations, specialist consultations; 'technical coeff')	Two types of mortality: (1) loading highest on mortality from tuberculosis, liver cirrhosis, hypertension, (2) lung cancer, cervical cancer, hypertension; both showing specific regional pattern (north-south or east-west gradient); sig. & strong neg. association of factor 1 mortality with industrial growth and (pos.) 'technical coefficient', also specialist consultations; factor 2 with mean income (neg.) and specialist consultations (neg.)
Lorant 2000[216]	Belgium by 557 communities	1985-1993	Analysis of the association between socio-economic deprivation and mortality from all causes and from causes avoidable by primary and secondary prevention	basis: Simonato et al. (1998) • 11 conditions/groups of conditions • ages < 65	Cross-sectional SMR by community; SES: Townsend & Carstairs index, factor analysis of 11 socio-economic indicators; regression analysis & 'concentration illness index' and P90/P10 ratio	Strong positive association between deprivation & all-cause mortality <65 (B=0.71), mortality from liver cirrhosis (0.57), lung cancer (0.49), suicide (0.35), falls (9.34); concentration of mortality (sign. unequal distribution): liver cirrhosis (14%), falls (7%), suicide (4%), lung cancer (6%)
Marshall & Keating 1989[46]	Auckland, New Zealand	1977-1985	Geographical variation in mortality burden that is 'avoidable' by appropriate medical intervention and treatment	basis: Rutstein et al/ • 16 conditions/groups of conditions • ages 0-64; asthma, cervical ca, respiratory dis, diabetes, bronchitis/ emphysema, peptic ulcer, meningitis, viral hepatitis, pregnancy complications: 0-49	Cross-sectional SMRs by census unit	Avoidable deaths accounted for 2.4% of all deaths & 8% of all deaths <65; substantial regional variation in amenable mortality with indication of rates being highest in deprived areas (correlation avoidable mortality rates & % Maori population: 0.53, with % Pacific Islanders: 0.65; with % unemployed: 0.57; with % blue collar worker: 0.45; with % car owner: -0.60, with average income: -0.54
Velkova et al. 1997[82]	12 Countries of central and eastern Europe (CCEE), 16 countries of western Europe (CWE)	1985-1991	Contribution of differences in mortality from conditions amenable to medical intervention to difference in life expectancy between CCEE and CWE in comparison with contribution of differences in mortality from 4 major cause of death groups (cancer, CVD, respiratory diseases, external causes)	basis: Rutstein et al. • 9 conditions/groups of conditions, perinatal mortality replaced by early neonatal mortality • ages 0-75	Cross-sectional Age-adjusted death rates; decomposition of life expectancy between birth & age 75 by cause of death between each CCEE and average of CWE	Amenable causes accounted for 11-50% of the difference in temporary LE between CCEE & CWE in men and 24-59% in women (excluding early neonatal deaths); for all CCEE, amenable causes contributed 1.2 years of the overall gap of 4.8 years (24%) in men and 0.9 of 2.3 years in women (40%); contribution of amenable causes of similar magnitude as that of CVD (1.5 yrs in men, 1 yr in women) and much larger as that from neoplasms (0.5 & 0.2), respiratory diseases (0.7 & 0.4) or external causes in women (0.3)

Empirical studies of 'avoidable' mortality: Analyses of geographical variation ('cross-sectional') – *continued*

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Treurniet et al. 1999[62]	The Netherlands	1984-1994	Association between regional variations in 'avoidable' mortality and variations in disease incidence (as measured by hospital discharge data); 'avoidable' conditions: "(excess) occurrence of these outcomes points to potential problems in health care"	basis: Rutstein et al. • 12 conditions/groups of conditions plus 4 perinatal causes • ages 5-64; cervical ca: 15-64, cancer testis: 0-64, leukaemia: 0-44, rheumatic heart disease: 5-44, hypertensive/ cerebrovasc disease (CVA): 35-64, influenza/ pneumonia: 0-74, benign prostatic hyperplasia: 0-74, congenital cardiovasc anomalies: 1-14	Cross-sectional Log-linear regression to estimate RR for mortality, incidence, incidence-adjusted mortality and in-hospital mortality; linear regression examining the association between mortality & incidence, and incidence-adjusted mortality & in-hospital mortality	Significant regional mortality variations for 7 out of 16 conditions, e.g. cervical cancer, cancer of testis, CVA, influenza/pneumonia, perinatal causes; with exception of cervical cancer regional differences only partly accounted for by variation in incidence; also regional variation in in-hospital mortality that explained 60% of mortality variation in CVA, 29% in appendicitis, i.e. high death rate is associated with high risk of dying in hospital

Empirical studies of ‘avoidable’ mortality: Analyses of geographical variation (‘cross-sectional’ and time trend)

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Holland 1991[29]	12 EC member states by administrative area (total: 451)	1980-1984 (1974-78)	See Holland 1988 plus analysis of changes in ‘avoidable’ mortality between 1974/78 & 1980/84 (except for Portugal & Spain who became EC member states in 1986)	see Holland 1988	Cross-sectional & time trend SMR for each country (within-country variation) and EC in total (between-country variation); degree of heterogeneity between areas; ranks of SMRs in 2 periods (relative change) by cause & region, age-standardised death rates by cause & region; excess mortality relative to EC rates by region	Between 1974/78 & 1980/84 standardised death rates from all causes (ages 5-64) fell in all EC countries, by 3.5% in Greece to 10% in France (EC: -7.8%) except DK (+4.4%); deaths from avoidable causes (EC) fell more steeply, by at least 20% (hypertensive/ cerebrovascular disease) to 67% (chron. rheum. Heart disease) except asthma (+24%), rates were however small (e.g. asthma: 0.62/100k); as in 1974/78 there was considerable between- and within country variation regarding avoidable causes of death
Holland 1997[31]	12 EC member states by administrative area (total: 554)	1985-1989 (1980-84)	Expanding the work of Holland 1988, 1991 & 1993 plus analysis of trends in avoidable deaths between 1980/84 & 1985/89	basis: EC (1988, 1993) • 16 conditions/groups of conditions • ages: see Holland 1988 & 1993	Cross-sectional & time trend SMR for each country (within-country variation) and EC in total (between-country variation); degree of heterogeneity between areas; annual % change in avoidable mortality (SDR) by cause & area/country	Between 1980/84 & 1985/89 SDR from all causes (ages 5-64) fell in all EC countries, by 0.4%/year in DK to 3.2/year in Lux (EC: -1.7%/year); deaths from avoidable causes fell more rapidly than for all causes, from at least 10%/yr for TB , appendicitis, cholelithiasis % chronic rheum heart disease to about 3%/yr for IHD & cervical ca; increase in asthma (+1.6%/yr) & breast cancer (+0.4%/yr); small increases in SDR from IHD in Greece (+2.2%/yr), cervical ca in E&W (+0.3%/yr), cholelithiasis in DK (+4.1%/yr); as in 1974/78 & 1980/84 there was considerable between- and within country variation regarding avoidable causes of death
Carstairs 1989[36]	10 EC member states, focus: Scotland	1974-78 (1979-84)	Based on EC Atlas Vol. 1 (see Holland 1988)	see Holland 1988	Cross-sectional & time trend see Holland 1988 + comparison with age-standardised death rates 1979-84; %-change between 1974-78 & 1979-84	In 1974/78 Scotland had highest death rates from asthma and CVA [exceeding EC average by 81% and 51%], within-Scotland variation esp. high for tuberculosis (highest in Greater Glasgow); between 1974/78 and 1979/84 decline in no. of deaths from all avoidable causes, by 8%, but increase in deaths from all causes (ages 5-64), by 10%
Barry 1992[35]	12 EC member states, focus: Ireland	1980-1984 (1974-78)	Based on EC Atlas Vol. 2 (see Holland 1991)	see Holland 1991	Cross-sectional & time trend see Holland 1991	Between 1974/78 &1980/84 crude DR for avoidable conditions fell by 20% for cervical ca to 60% for appendicitis; asthma mortality increased by 30%; In 1974/78 death rates from tuberculosis highest in Ireland & rel. high for asthma, considerable within-country variation for both; despite 42% decline in TB mortality between 1974/78 & 1980/84 death rates remained highest in Ireland

Empirical studies of 'avoidable' mortality: Analyses of geographical variation ('cross-sectional' and time trend) – *continued*

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Pampalon 1993[43]	Québec, Canada, by 15 (+2) health regions	1969-73 & 1982-90	Temporal and geographical (international, regional) differences in 'avoidable' mortality, defined as being "reasonably certain that effective treatment or secondary prevention are available for these […] diseases [apart from tuberculosis, which is, however, amenable to primary prevention)"	basis: EC (1988) • 13 conditions/groups of conditions excl. infectious diseases & conditions amenable to primary prevention • ages: see Holland 1998	Cross-sectional & time trend Regional SMR [standard: 1982/90 mortality]; factor analysis of explanatory variables: 10 health services indicators (GP, specialist & hospital bed density, use & supply of ambulatory services, hospital use) & 10 SES indicators; plus incidence of prematurity, prevalence of hypertensive & cerebrovascular disease (ages 35-64); multiple regression	Between 1969/73 & 1982/90 avoidable mortality [except asthma] fell on average by 300% compared with 28% decline in mortality from all other causes [both sexes]; avoidable death rates in Quebec as low as in Sweden & Japan in 1984/1988; within Quebec, sign. regional variation for tuberculosis, hypertensive disease & perinatal mortality only; regional variation in these avoidable causes largely explained by socio-economic factors (TB: 26%, hypertension/ CVA: 42%, periantal mortality: 83%), only perinatal mortality also related to services provided by GPs (variation explained: 5%)

Empirical studies of 'avoidable' mortality: Analyses of 'avoidable' mortality at regional/national level

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Westerling 1992a[14]	Sweden	1974-1985	Proportion of mortality in Sweden covered by Rutstein's original list of avoidable causes; identification of most common potentially avoidable causes of death, divided into 'preventable' and 'treatable' causes of death as defined by Rutstein	basis: Rutstein et al. • 68 causes of death in men, 66 causes of death in women • ages 0-64	Cross-sectional Crude and age-standardised death rates	18% of deaths in men classified as 'avoidable' (women: 22%) with neoplasms & respiratory diseases being the most common [avoidable] causes (at 50% and 15-17%); large number of 'avoidable' causes relatively rare (men: 63%, women: 82%), 14 'avoidable' causes accounted for 16% of total mortality in men aged 0-64 (women: 12 causes)
Benavides et al. 1992[52]	Valencia, Spain	1988	Estimation of years of life expectancy to be gained by preventing 'avoidable' deaths by dividing deaths into those 'avoidable' by primary or by secondary prevention as defined by Holland (1988)	basis: EC (1988) • 16 conditions/groups of conditions (perinatal mortality excluded) (primary prevention: 3 conditions) • no age restriction (life expectancy at birth)	Cross-sectional Life expectancy at birth (LE) for (1) all causes, (2) excl. all avoidable causes, (3) excl. causes avoidable by primary prevention; (4) excl. causes avoidable by secondary prevention	LE at birth: 72.5 in men & 79.7 in women (1988); removing all avoidable deaths would increase LE by 2.01 (men) & 0.8 (women); of these, 1.59 yrs [78%] (men) attributable to primary prevention (women: 0.46 yrs [58%]); total gain (both sexes): 1.47 (1.09 primary prevention [74%]; 0.37 secondary prevention)
Sanchez et al. 1993[38]	Spain	1983-1986	Analysis of 'avoidable' mortality using measure of life expectancy LEFAM ("Life Expectancy Free of Avoidable Mortality"), defined as mean years one can be expected to live if health system were as efficient as it ought to be; 'avoidable' causes: causes "directly due to the health system"	basis: EC (1988) • 14 conditions/groups of conditions (perinatal mortality excluded) plus anaemia • age restriction as in Holland 1988 (anaemia: age 0-64)	Cross-sectional Life expectancy at ages 0, 1, 5, 14, 35, 44, 64, with & without avoidable deaths; correlation of LE & LEFAM with annual changes in GDP, IMR, mortality rate, hospital beds, health personnel, ambulatory contacts (1975-1986)	LEFAM was about 1.1-1.2 years (men: 1.5-1.8; women: 0.6) higher than LE at birth with difference declining with increasing age; (sign.) correlation between LEFAM & GDP (R=0.98), IMR (-0.98), health human resources (0.96), hospital beds (-0.86) stronger than between LE & these measures; no sign. correlation with ambulatory contacts for both
Adler 1978[19]	USA	1968-71	Evaluation of preventable mortality in the USA; 'preventable' mortality: includes preventable and treatable conditions as defined by Rutstein	basis: Rutstein et al. • all conditions/groups of conditions as in Rutstein's list A • no age restriction	Cross-sectional Total deaths, proportion of deaths	Conditions classified as 'sentinel health events' ["only if the occurrence of a single case…would justify…an immediate inquiry into the question, 'Why did it happen?'"] accounted for 14% of all deaths in US

Empirical studies of 'avoidable' mortality: Analyses of variation by socio-demographic factors

Author	*country / region*	*time period*	*Topic/aim of study*	*Number of causes*	*Design/method*	*Results*
Westerling et al. 1996[51]	Sweden	1986-1990	Analysis of socio-economic differences in 'avoidable' mortality in Sweden, divided into 'medical care indicators' and 'health policy indictors' plus 'others' including causes for which health services intervention programs had been recommended (suicide, breast cancer)	basis: Rutstein et al. • 18 conditions/groups of conditions (medical care: 12; health policy: 4; other: 2) • ages 21-64	Cross-sectional Linked mortality-census data; SMR for selected causes/cause groups by SES (=occupied vs. non-occupied; blue- vs. white collar; level of training [unskilled-skilled blue collar; low-medium-high white collar])	SMRs for non-occupied were higher for all causes studied, medical care SMR: 212, health policy: 186, all: 210; (occupied: 73, 80, 75); esp. high rates for bronchitis (346), diabetes (335), meningitis (361), liver cirrhosis (333) [healthy worker effect?]; smaller differences between blue & white collar workers (medical care- blue: 107, white: 95; health policy – blue: 116, white: 85; other-blue: 114, white: 88); only exception ulcer death rates with blue collars almost 3 times those of white collars
Westerling & Rosen 2002[217]	Sweden	1986-1990	Analysis of differences in 'avoidable' mortality among immigrants in Sweden; 'avoidable' conditions divided into 'medical care indicators' (MCI) and 'health policy indictors' (HPI) plus 'others' including causes for which health services intervention programs had been recommended (suicide, breast cancer)	basis: Rutstein, EC (1988) • 18 conditions/groups of conditions (medical care: 12; health policy: 4; other: 2) • ages 21-69	Cross-sectional Linked mortality-census data; SMR for selected causes/cause groups by country of birth	SMRs for avoidable/all causes highest in population born in Nordic countries other than Sweden, SMR MCI: 119, HPI: 163, all: 133 (Sweden: 100, 95, 98; countries other than Nordic/Sweden: 83, 117, 91); SMR variation for MCI smaller than HPI; high rates among Nordic immigrants for, e.g. CVA (Finland: 143), chronic bronchitis (DK & Iceland: 252), rectal CA (DK & Iceland: 311); for other countries of birth also chronic rheumatic heart disease (SMR 345); immigrants from Finland had highest SMR for all causes (by 41) and for MCI (21%); HPI highest for immigrants from DK/Iceland (106%)
Woolhandler et al. 1985[68]	Alameda County, CA, USA	1978	Racial differences in mortality from preventable and manageable causes compared with 'non-preventable' causes; definition of death as 'preventable' or 'manageable' if resulted from a condition as listed by Rutstein's list A or B	basis: Rutstein et al. • all conditions/groups of conditions as in Rutstein's lists A & B excl. those where preventable/manageable proportion <50%, plus all diagnoses primarily associated with drug & alcohol abuse, mental disorders, accidents, suicides, homicides, other external causes • all ages; acute resp infect: <45; hernia: <65; Hodgkin's dis: <25; neuroblastoma, nutritional marasmus, congenital anom of heart: <1	Cross-sectional Age-adjusted death rates for all ages and <65; death rate ratios; potential years of life lost before age 65 (PYLL)	Total death rates under 65 among blacks exceeded those of whites by 58% (m: 65%, f: 48%); mortality from preventable/ manageable conditions [list A+B] under 65 was 77% higher in blacks (m: 85%, f: 64%); 33% of excess mortality (<65) in black men attributable to potentially preventable conditions (f: 37%); 44% of PYLL in blacks attributable to potentially preventable deaths (whites: 32%); sig. excess black rates for IMR, cancer of thoracic organs, hypertension, acute pulmonary infection; elevated: cervical ca, diabetes, peptic ulcer amongst others

Empirical studies of 'avoidable' mortality: Analyses of variation by socio-demographic factors – *continued*

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Carr et al. 1989[63]	New York State, USA	1983	Occurrence of 'sentinel health events' among hospitalised residents and differences among population subgroups': "negative health states – diseases, disabilities, and deaths – that are deemed to be avoidable given current medical and public health knowledge and technology"	basis: Rutstein et al. • no age limits	Cross-sectional Age-adjusted disease and death rates based on hospital discharge data by population subgroup (racial/ethnic), social class (proxy: Medicaid, Blue Cross), hospital type (municipal, voluntary); case-fatality ratio	Approx. 10% of all hospital deaths were potentially avoidable, 1/3 of which occurring under age 65; 50-80% of these deaths possibly avoidable through primary prevention; case-fatality higher among blacks, Medicaid enrolees & NY municipal hospitals
René et al. 1995[69]	Texas, USA	1980-1989	Ethnic differences in "sentinel causes of mortality" as a measure of access and availability of health-care delivery services	basis: Schwartz et al. (1990) • 12 conditions/groups of conditions excl. bacterial infections, anaemia, perinatal & maternal mortality but incl. influenza • ages 15-64	Cross-sectional Age-standardised death rates; SMRs (comparing with white population) and by region	Amenable mortality among Texas African Americans was >3 times that of white Americans [SMR: 3.4], especially hypertension but also tuberculosis, asthma, appendicitis & cervical cancer; for Spanish-speaking Americans rates only slightly higher [SMR: 1.1] (mainly TB & cervical cancer)
Wood et al. 1999[73]	British Columbia, Canada	1981-1991	Socio-economic differences in male mortality from causes of death amenable to medical care	basis: Charlton et a. (1983) • 12 conditions/groups of conditions excl. cervical cancer & perinatal mortality • ages 15-64	Cross-sectional Age-standardised death rates; classification into social levels by occupation (adapted from UK system), education, median income, combined index; rate ratios between lowest and highest social level; weighted regression to assess strength of social class gradient	Mortality from amenable causes highest in lowest occupational class [ratio: 1.9; sign.]; similar associations for education, income and education & income combined with sign. gradients for hypertensive disease (2.9), tuberculosis (2.7), asthma (2.2), pneumonia (2.3) and all amenable causes (2.1)
Malcolm 1994[42]	New Zealand	1985-1987	Avoidable mortality among Maori and non-Maori New Zealanders with deaths divided into causes avoidable by primary or secondary prevention	See Holland (1988)	Cross-sectional Potential gains in life expectancy (YLG)	Excluding all preventable deaths, YLG in Maori men was 2.6 years compared with 2.3 in non-Maori men (women: 2.7 & 1.7); excl. deaths avoidable by secondary prevention only, potential gain would be 1.15 yrs in Maori and 1.0 in non-Maori men (44% of total gain in both) (women: 1.74 & 1.04 yrs [62-65% of total gain])

Empirical studies of 'avoidable' mortality: Analyses of variation by socio-demographic factors – *continued*

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Schwartz et al. 1990[70]	USA and District of Columbia	1980-1986	Race-specific analysis of conditions for which mortality is largely avoidable given timely and appropriate medical care; 'avoidable' mortality as indicator of access or quality of health care ("causes preventable by medical intervention")	basis: Charlton et al. (1983) • 12 conditions/groups of conditions excl. bacterial infections, anaemia, perinatal & maternal mortality but incl. influenza • ages 15-64	Cross-sectional & time trend Age-adjusted cause and race specific death rates; YPLL < age 65; excess number of preventable deaths by indirect standardisation (standard: death rates of US White population)	Non-significant decline in mortality from all avoidable causes by 8.7% between 1980& 1986 (US); SDR from avoidable causes 4.5 times sign. higher in Blacks than Whites, esp. TB (ratio:8.9), hypertension (6.5), asthma (4.4); of all avoidable deaths among Blacks 78% in excess of Whites, mostly hypertension, pneumonia, cervical ca, tuberculosis; DC rates higher for Blacks & Whites compared with US, B/W ratio within DC 3.6 for all avoidable causes
Tobias & Jackson 2001[59]	New Zealand	1981-1997	Trends in avoidable mortality in New Zealand: 'primary avoidable mortality' (preventable at individual/population level intervention, condition prevented before it develops); 'secondary avoidable mortality' (preventable through early detection/intervention); 'tertiary avoidable mortality' (case fatality can be significantly reduced by existing medical or surgical treatment); update of Charlton's (1983) list, each weighted for 'preventability' by level of prevention; variation by ethnicity and deprivation	basis: Charlton et al. (1983) • 56 conditions/groups of conditions with 24 considered mainly amenable to primary prevention, 16 mainly secondary prevention and 16 mainly tertiary prevention • ages 0-75 (upper age limit to reflect improvements in life expectancy)	Cross-sectional & time trend Age-standardised death rates; 'avoidable' conditions partitioned among three categories of prevention by authors and external reviewers; 'level of deprivation' assessed by factor analysis of 9 socio-economic variables (1996/97)	Total avoidable mortality fell by 38% compared with 9% drop in non-avoidable mortality (all-causes: -31%); 'excess' reduction of 29% in avoidable mortality (or 1.5%/year) estimated 'added value' of health system [health promotion, disease prevention, treatment]; declines greatest for PAM & SAM among <14, declines equally steep for all 3 measures for those aged 45-74 (where about 80% of all avoidable causes occur); ethnic and socio-economic gradient for avoidable causes greatest for PAM & SAM, with rates more than twice as high among Maori vs. non-Maori and the most deprived vs. the least deprived

Empirical studies of 'avoidable' mortality: Analyses of variation by socio-demographic factors – *continued*

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Poikolainen & Eskola 1995[72]	City of Helsinki, Finland	1980-1986	Analysis of regional and social class differences in RR of death from amenable causes (Rutstein's list adapted to state of medical knowledge & preventability of death at beginning of study period)	basis: Rutstein et al. • 23 conditions/groups of conditions • ages 0-64; Hodgkin's disease: 5-64, diabetes: 5-39	Case-control study 1 case:4 controls, data by age, marital status, area of residence & social class/status (occupation); multiple logistic regression to estimate adjusted OR's	Regional differences in amenable mortality very small after adjustment; significant differences by social class with OR in lowest being 8.5-fold that in highest; sign. elevated risks for those with no address (OR 5.6), mainly amenable heart disease & respiratory disease
Song & Byeon 2000[56]	Korea	1992-1996	Socioeconomic mortality differentials in Korean male civil servants, with causes of death divided into 'avoidable', 'partly avoidable' and 'external' conditions; 'avoidable' conditions: preventable and treatable conditions as defined by Rutstein (Table A)	basis: Rutstein et al. • all conditions/groups of conditions as in Rutstein's list A ('clear-cut, immediate use of Quality-of-Care indexes' – 'avoidable deaths') & B ('limited use of Quality-of-Care indexes' – 'partly avoidable deaths') plus external causes as separate category • ages 30-64	Prospective observational study RR (Cox proportional hazard regression) by SES (grade of monthly salary), adjusted for age, smoking status, drinking habit, BMI, cholesterol level, systolic blood pressure, area of residence, type of occupation	Mortality from external & avoidable causes accounted for 21 & 13% of overall mortality in lowest SES compared with 14 & 12% in high SES; fully adjusted RR for all cause mortality: 1.59 (lowest vs. highest SES), avoidable mortality: 1.65, external causes: 2.26, partly avoidable: 1.22, non-avoidable: 1.54; no SES differences in mortality from IHD but cerebrovascular disease (1.67)

Empirical studies of 'avoidable' mortality: Analyses of changes over time

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Lakhani et al. 1986[22]	England & Wales	1974/78-1979/83	Changes in mortality amenable to health services; update of Charlton et al. 1983	basis: Charlton et al. (1983) • 12 conditions/groups of conditions incl. perinatal & maternal deaths, stroke; excl. pneumonia & bronchitis, bact infect, anaemia; acute resp dis replaced by all resp but limited to age 1-14 • ages 5-64; hypertension & stroke: 35-64, CA cervix uteri: 15-64; asthma: 5-44; maternal deaths: 5-44	Time trend Comparison of deaths and crude death rates between 1974/78 & 1979/83 and expected changes due to changes in ICD	Mortality from causes amenable to health services fell by 23%, non-amenable by 6% and all-cause mortality by 9% between 1974/78 and 1979/83
Charlton et al. 1986[23]	England & Wales by 98 Area Health Authorities (AHAs)	1974/78-1979/83	Changes in mortality amenable to health services at national and local level	basis: Charlton et al. (1983) • 8 conditions/groups of conditions incl. perinatal & maternal deaths, stroke; excl. pneumonia & bronchitis, acute resp dis, bact infect, anaemia, abdominal hernia, cholecystitis • ages 5-64; hyperten. & stroke: 35-64, cervix ca: 15-64; asthma: 5-44; maternal deaths: 5-44	Time trend Comparison of SMR by AHA (& District Health Authority) for 1974/79 & 1979/83; comparison of geographical distribution of each indicator in 2 time periods; regional variation tested for heterogeneity; summary score based on standard deviation from national death rate	Except for asthma (national) death rates of conditions amenable to medical treatment fell by 10% (cervical cancer) to 63% (chronic rheumatic heart disease); observed increase in asthma deaths (27%) higher, by 18%, than expected from change in ICD in 1979; half of decline in mortality from chronic rheumatic heart disease explained by change in ICD; degree of heterogeneity between AHAs over time remained high although most AHAs improved over time
Poikolainen & Eskola 1986[25]	Finland	1969-81	Impact of health services on mortality from natural causes amenable to medical intervention excl. conditions amenable to primary prevention; 'partly amenable causes': causes changed from non-amenable to amenable or partly amenable through innovations in medical care over time	basis: Rutstein et al. • 21 conditions/groups of conditions (5 perinatal causes) + 7 partly amenable condistions (incl. IHD, larynx cancer) • ages 0-64; diabetes: 0-49, respiratory causes: 0-49	Time trend Linear regression of logarithm of mortality rates (unadjusted as similar to age-adjusted); estimating 'impact of medical care'	Between 1969&1981mortality amenable to medical intervention declined by 63% in men & 68% in women (non-amenable causes: 24 & 29%; all causes: 24% & 34%); approximately 50% of decline in amenable causes attributable to health services (4.2% p.a.)
McKee & Rajaratnam 1987[91]	England & Wales	1969-1978	Trends in mortality from conditions amenable to medical intervention	basis: Rutstein et al. • 17 conditions/groups of conditions as analysed by Poikolainen & Eskola 1986	Time trend Comparison of deaths between 1969 and 1978	Between 1969 & 1978 deaths from amenable causes fell by 44% in men and 34% in women, non-amenable causes fell by 15% in both sexes
Charlton & Velez 1986[24]	E&W, USA, France, Japan, Italy, Sweden	1950-80 (1956-78)	International comparison of mortality amenable to medical care ('avoidable' with "appropriate and timely health care")	basis: Charlton et al. (1983) • 9 conditions/groups of conditions + stroke, excl. pneumonia & acute resp dis; perinatal deaths replaced by infant deaths • ages 5-64	Time trend Trends in age-standardised mortality rates	Between 1956 and 1978 mortality [both sexes] from amenable causes (all other causes; total) fell: E&W: 51% (4; 12); USA: 55% (9; 18) [67% recalculated]; France: 64% (19; 26); Japan: 72% (43; 53); Italy: 57% (17; 25); Sweden: 61% (3; 12);

Empirical studies of 'avoidable' mortality: Analyses of changes over time – *continued*

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
McKee & Bewley 1987[96]	Northern Ireland	1969-1978	Trends in mortality from conditions amenable to medical intervention	basis: Rutstein et al. • 18 conditions/groups of conditions as analysed by Poikolainen & Eskola 1986 • ages 0-64; diabetes & respiratory diseases: 0-49	Time trend Linear regression of number of deaths against time (1969=1); estimating 'impact of medical care'	Deaths from amenable conditions declined by 58% in men & 44% in women, non-amenable mortality remained stable in men & fell by 6% in women; 58% of decline in amenable mortality in men attributable to health services compared with 35% in women; excl. perinatal mortality still shows sign. fall in amenable mortality; declines especially marked for TB, hypertension, infectious dis, & perinatal mortality
Wiesner & Zimmermann 1990[39,40]	Former GDR	1980-1987	Analysis of 'avoidable' mortality with respect to life expectancy; 'avoidable' causes defined according to Charlton et al. (1983)	Basis: Charlton et al. (1983) • 11 conditions/groups of conditions (excl. maternal & perinatal mortality)	Time trend Life expectancy at birth with and without 'avoidable' causes of death; 'avoidable' loss of life expectancy at birth	LE at birth excl. 'avoidable' causes improved at pace similar to LE at birth incl. these causes, by 0.7 yrs in men & 0.9 yrs in women; 'avoidable' loss of life expectancy at birth was 0.41 yrs in men and 0.45 yrs in women
Mackenbach et al. 1988b[76]	The Netherlands	1969-1984	Regional variation in mortality decline within The Netherlands from selected conditions including a selection of conditions considered 'amenable to medical intervention'	basis: Charlton et al. (1983, 87) • 13 conditions/groups of conditions; perinatal mortality as separate category • ages 0-75	Time trend Log-linear regression to estimate national & regional mortality levels & trends, controlled for size & age/sex composition of population; correlation of levels & trends with health care (# university hospitals, # beds, #GPs) & socioeconomic indicators (income/capita, % primary education, % unemployed)	Between 1969 & 1984 amenable mortality declined by 4.5% per year compared with all cause mortality at -1.6%/a; amenable (& perinatal) mortality declined faster in less urbanised, low income areas, decline not associated with presence of university hospital or changes in health care supply (# beds, GPs) but with socioeconomic indictors: declined faster in areas with higher increase in average income and/or educational level (as did perinatal and total mortality)
Mackenbach et al. 1988c[47]	The Netherlands	1950-1984 (1950-68, 1969-84)	Impact of medical care innovations on mortality amenable to medical care ["the application of biomedical knowledge through a personal service system"] excl. conditions amenable to primary care, with small numbers or high survival rates due to reasons other than increasing effectiveness of medical care (e.g. thyroid cancer)	basis: Rutstein et al. • 35 conditions/groups of conditions [ordered accord. to time of introduction of medical care intervention]; age limits for kidney cancer and leukaemia (<15) and diabetes (<25)	Time trend Loglinear regression analysis of observed no. of deaths in relation to person-years at risk, age and calendar year (slope of change)	Accelerated decline in mortality for many conditions in 1969-84 period, reflecting introduction of specific treatments; decline in mortality amenable to medical intervention added 2.96 years to male life expectancy between 1950/54 and 1980/84 [mainly infectious (+0.94) & perinatal (+0.72)] and 3.95 years to female life expectancy [mainly hypertension/ cerebrovasc. (+1.32) & acute respiratory (+1.13)]

Empirical studies of 'avoidable' mortality: Analyses of changes over time – *continued*

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Mackenbach et al. 1989[75]	England & Wales The Netherlands	E&W: 1931,61,81 NL: 1952, 62, 72, 82	Contribution of medical care to widening of mortality differences between socio-economic groups: analysis of differences in mortality from conditions which have become amenable to medical intervention	basis: Rutstein et al. • 25 conditions/groups of conditions grouped accord. to type of innovation in medical care & related to period of mortality effect of innovation [1930-60; 1960-80] • ages 15(16)-64 for E&W; 0-74 for NL	Time trend E&W: absolute & relative changes in cumulative mortality rates; SES by occupation NL: SMR (against national rate for 1950-84); regression against SES by geographic region, classified using index of 6 indicators (e.g. average income, average no. years education, % unemployed)	E&W: between 1931&1961 declines in amenable mortality were generally larger than declines in all-cause mortality with rates typically declining by about 80% compared with 6-40% in men (40-50% in women), declines were usually steeper in social classes I+II than in classes IV+V; pattern less consistent in 1961-1981 although proportional declines in amenable mortality were steeper than in total mortality NL: differential mortality decline for peptic ulcer only (1952-62) & 3 surgical conditions and hypertensive & cerebrovascular disease in 1962-82
Mackenbach 2000[49]	The Netherlands	1980/84-1991/95	Update of analysis of Mackenbach et al. 1988b	See Mackenbach et al. 1998b + 3 'new' conditions for which there have been important medical advances (IHD, rectal cancer, hip fracture)	Time trend See Mackenbach et al. 1998b	Decline in mortality from amenable conditions added an additional 0.23 years to male life expectancy at birth (females: +0.41 yrs); adding in IHD, rectal cancer & hip fracture results in overall addition of 1.07 yrs in men & 0.82 yrs in women
Westerling & Smedby 1992[37]	Sweden	1974-1985	Analysis of 'avoidable' mortality in Sweden using the EC Working Group avoidable death indicators with causes of death divided into indicators of 'medical care intervention' and of 'national health policies'	See Holland 1988	Time trend Linear (& log) regression analysis of yearly change in death rates, trends tested for significance; SMR using EC death rates as standard for 1974/78 & 1980/84	Health policy indicators constituted higher proportion of total mortality (10-18%) than medical care indicators at all ages except <0 (medical care: 40-43%) and women age 45-64 (11% vs. 7%); in 1980/84 10 out of 14 medical care indicators occurred in less than 50 cases (both sexes); significant decline in most avoidable deaths from 1974-1985, largest for CVA by 1.54%/a in men & 1.3%/a in women; in women sign. increase in lung cancer; levels of avoidable mortality in Sweden sign. lower than in EC except asthma (SMR: around 150 both periods)
Westerling 1992b[218]	Sweden	1974-1985	Trend analysis of potential avoidable mortality in Sweden, divided into 'preventable' and 'treatable' causes of death	basis: Rutstein et al. • 63 causes of death (women: 65) • ages 0-64	Time trend Linear (& log) regression analysis of yearly change in the proportion of deaths, trends tested for significance	Among men deaths from treatable causes declined more than total mortality; the proportion of treatable causes fell by 0.10% units/a [proportion of all avoidable causes fell by 0.11%/a]; excl. lung cancer preventable mortality also declined more than total mortality (at 0.11%/a in men and 0.16/a in women); sign. increase in treatable mortality in boys aged 1-14 by 0.48%/a, mainly asthma, bronchitis & leukaemia

Empirical studies of 'avoidable' mortality: Analyses of changes over time – *continued*

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Bjerregaard & Juel 1990[41]	Greenland	1968-1985	Analysis of 'avoidable' deaths among native Greenlanders, with causes divided into those amenable to treatment or primary prevention or both; list mainly based on Rutstein's (1976) list but taking account of mortality experience in Greenland	basis: Rutstein et al. • 15 conditions/groups of conditions; 5 treatable causes, 8 preventable causes, 2 causes amenable to both (meningitis, chronic bronchitis) • ages 0-64; TB, lung ca, cervix ca: 5-64; whooping cough, measles: 0-14; chronic rheumatic heart disease: 5-44; acute respiratory infections, chronic bronchitis: 5-49; maternal deaths: 15-49; suicide: 10+; alcohol related deaths: 15+; boat accidents: all	Time trend Poisson regression of mortality rates	(Sign) fall in deaths from selected 'treatable' conditions (respiratory dis, chronic rheumatic heart dis, chronic bronchitis) & measles, cervical ca ('preventable') & alcohol related accidents; increases in preventable conditions (lung ca, suicides, alcohol related deaths & boat accidents); regional differences for selected conditions attributed, in part, to differences in access to and quality of medical/health care (vaccine-preventable conditions, maternal deaths, appendicitis); SDR higher than in Denmark for all 'avoidable' causes, esp. TB (ratio: 41.5), whooping cough (43.9), measles (24.8); median ratio: 9.6
Bernat Gil & Rathwell 1989[78]	Spain	1960-1984	Trends in mortality amenable to medical care and non-amenable mortality in light of major reforms in Spanish health care system since 1982; 'amenable conditions': treatment available and sufficient evidence for mortality from being avoidable given appropriate standards of medical care	basis: Rutstein et al. • 13 conditions/groups of conditions (incl. infant mortality instead of perinatal mortality) • ages 5-64	Time trend Trends in age-standardised death rates (1960, 1970, 1976-1984); 'impact of health services': _ between average decrease of each amenable condition and average decrease of all non-avoidable conditions	Between 1960 and 1984 amenable mortality declined by 67% (all causes: 29%, non-amenable causes: 20%) [1976-1984: 36, 13, 10]; death rates declined for all amenable causes except cervical cancer, rates relatively low in international comparison (1982); 51% of decline in avoidable causes attributable to medical care (or 2.1%/a)
Albert et al. 1996[54]	Valencia, Spain	1975-1990	Analysis of the evolution of avoidable mortality between 1975-1990 comparing Holland's and Charlton's lists and by dividing causes into those amenable to secondary prevention or treatment ('medical care indicators'; MCI) & those avoidable through primary prevention ('national health policy indicators'; NHPI)	• EC (1988) list: 14 medical care indictors; 3 national health policy indicators • Charlton (1983) list • ages 5-64 for groups MCI, NHPI, Holland Class [all], Charlton Class [all]	Time trend Age-standardised death rates; linear & non-linear regression of trends; estimating 'impact of medical care'	Amenable mortality (MCI) declined by 63%, NHPI increased by 24%. Non-avoidable mortality fell by 17% (total mortality: -24%); NHPI rates increased by (ß=) 0.5 units/a, MCI fell by 1.6 units/a; 46% of decline in MCI (ages 5-64) estimated to be attributable to health services (or 2.9%/a)
Humblet et al. 2000[55]	Belgium (by 43 districts)	1974-78, 1980-84, 1985-89, 1990-94	Analysis of levels and trends in EC avoidable deaths indicators ('Holland's list') and assessment of impact of avoidable causes of death on premature mortality, divided into 'curative indicators' and 'preventive indicators'	basis: EC (1988) • 18 conditions/groups of conditions plus cancer of testis, peptic ulcer, skin cancer; excluding perinatal mortality (13 curative indicators, 5 preventive indicators) • ages 1-64	Time trend Age-adjusted Years of Potential Life Lost (YPLL), ratio of YPLL rates for changes between 1974/78 and 1990/94 in total and by district	Between 1974/78 and 1990/94 YPLL for curative indicators declined by 53% in men & 29.7% in women, YPLL for preventive indictors fell by 30.8 & 26.7%, all avoidable: -34.2 & 28.1%, all causes: -23.9 & 26.7%; proportion of all avoidable causes to overall YPLL in women around 40% & stable over time (no improvement in breast cancer & liver cirrhosis [as in men], increase in lung cancer), declining in men from 47% in 1974/78 to 40% in 1990/94

Empirical studies of 'avoidable' mortality: Analyses of changes over time – *continued*

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Schwartz 1987[219]	New Hampshire, USA	1970-1985	Distribution of deaths due to conditions amenable to medical intervention ("(t)hey generally do not lead to death if appropriate medical intervention is provided")	basis: Charlton et al. (1983) • 14 conditions/groups of conditions excl. anaemia but incl. influenza • ages 15-64; pneumonia, asthma, influenza & acute respiratory infections: 15-54; maternal deaths: 15-44; rheumatic heart disease: 15-44; Hodgkin's disease: 15-34	Time trend Age-standardised death rates; YPLL	Age-standardised death rates from 'avoidable' conditions declined by 51% between 1970 and 1987 (no information on changes in all-cause mortality); cervical cancer, hypertension & pneumonia accounted for 69% of 'avoidable' deaths over 16 year period & for 60% of YPLL
Hisnanick & Coddington 1995[81]	USA	1972-1987	Evaluation of the concept of "human betterment" using measurable health outcome 'avoidable mortality' among American Indians/Alaska Natives (AI/AN) [served by Indian Health Service, IHS]; hypothesis that "reforms leading to universal health care in US could result in better access to care and an increase in overall human betterment through a reduction in avoidable mortality"	basis: Rutstein et al. • 8 conditions/groups of conditions • ages 5-75	Time trend Mortality rates [crude death rates per 10000 population eligible for HIS]; Linear regression	Total mortality among AI/AN declined by 3.7%/year between 1972 & 1987, avoidable mortality fell by 7.5%/a (7% of all causes); for those eligible for IHS, avoidable mortality fell by 57% between 1972/79 and 1980/87 compared with decline of 28% in mortality from all other causes [declines similar in men & women]; reductions greatest at ages 45-74 (by 70-75%)
Manuel & Mao 2002[44]	USA, Canada	1980-1996	Comparison of avoidable mortality trends in the USA and Canada as a means to "encourage further evaluation and improvement of health care systems" if differences existed; 'avoidable' mortality classified according to 1997 EC Atlas of Avoidable Death (see Holland 1997)	basis: EC (1997) • 11 conditions/groups of conditions excl. chronic rheum heart dis. & respiratory dis; incl. IHD • ages 0/5-64; see Holland 1997	Time trend SMR standardised to European population of 1985-89	IHD accounted for _ of all deaths at ages 15-64 & for _ of all avoidable deaths in US & Can in 1985/89; higher SMR for 9 out of 11 causes in US, esp. cervical ca , TB, asthma, hypertension/CVA; avoidable mortality fell in both US & Can except asthma in US; rate of decline more rapid in Can than US esp. for cervical ca, TB, hypertension/CVA, asthma [changes not quantified]
Malcolm & Salmond 1993[71]	New Zealand	1968-1987	Time trends in amenable mortality among Maori and non-Maori in New Zealand; 'amenable mortality': mortality amenable to medical intervention	basis: Charlton et al. (1983) • 15 conditions/groups of conditions • ages 0-64	Time trend Age-standardised death rates; trends modelled by linear or quadratic regression; estimation of impact of medical care	Mortality from amenable conditions declined by 73% in Maori women & 54% in non-Maori women compared with fall in non-amenable mortality by 46 & 18% (men: 76 & 62%; 37 & 22%); about 37% of amenable mortality decline in Maori women (men: 51%) attributable to medical care compared with 66% in non-Maori (men: 64%); Maori to non-Maori ratio in amenable mortality declined from 2.3 to 2.0 in women (men: 2.5 & 2..0), ratio for non-amenable fell from 2.4 to 1.6 (men: 1.8 & 1.5)

Empirical studies of 'avoidable' mortality: Analyses of changes over time – *continued*

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Marshall et al. 1993[79]	New Zealand	1975-1977, 1985-1987	Time trends and social class patterns of mortality amenable to medical intervention in New Zealand males	basis: Charlton et al. (1983) • 12 conditions/groups of conditions excl. cervical cancer, pneumonia & bronchitis, perinatal mortality • ages 15-64	Time trend Age-standardised death rates; classification into socio-economic groups by index of median income & median education; rate ratios between each social level and pooled rates for all social levels; weighted regression to assess strength of social class gradient	Pooled death rate for amenable causes fell by 30% compared with 14% for non-amenable causes & 15% for all causes; strong social gradient in amenable mortality fell from 34% to 28% (all causes: 13% & 15%), gradient for TB (40->61%), appendicitis & hernia increased; amenable rate ratio for lowest social class declined from 2.68 to 1.72 (highest social class: 0.70->0.50) [amenable causes accounted for 5% of total mortality]
Niti & Ng 2001[45]	Singapore	1965-1994 (1989-1997)	Trends & ethnic differences in amenable mortality with mortality divided into 'treatable' (preventable by 'timely therapeutic care') & 'preventable' conditions (preventable by 'primary preventive policy measures')	basis: EC (1988, 1991, 1993) • 9 'treatable' conditions excl. perinatal & maternal mortality, plus diabetes, peptic ulcer; 6 'preventable' conditions incl. colon cancer, liver cancer, cervical cancer, cerebrovascular disease • ages 5-64	Time trend Age-standardised death rate, by 5 consecutive 5-year periods; SMRs (1990 baseline); linear regression for time trend; impact of health care as differential % decline in amenable mortality after subtracting % decline of non-amenable mortality	Total amenable mortality fell by 52% between 1965/69 & 1990/94 (both sexes) [annually: -1.77% men; -1.72% women]; non-amenable: –27% (men) & -35% (women) [annually: 0.91 & 1.17]; all causes:–40% & 43%; treatable causes fell by 78% [men] & 68% [women], preventable deaths by 29 & 34%; 51% of decline in avoidable mortality attributable to medical care in men [women: 33%] [attributable to health policy: 1 & -1%] amenable mortality almost twice as high in men than in women 1990/94 (mainly preventable causes); amenable mortality highest among Malay with rate ratio 1.3-2 compared with Chinese, mainly treatable mortality; increase in treatable mortality in Malay and Indian men between 1989/91 & 1995/7 (10 & 14%), decline in Indian women (-15%) and Chinese (-5 in men & -24 in women); preventable & all cause mortality: decline in all groups except Indian men
Gai_auskien_ & Gurevi_ius 1995[53]	Lithuania	1970-1990	Trends in 'avoidable' mortality with deaths divided into 'treatable' and 'preventable' causes according to Rutstein	basis: Rutstein et al. • 14 conditions/groups of conditions (similar to Charlton's list); 11 treatable causes, 3 preventable causes • ages 5-64; cervical cancer: 15-64; respiratory diseases: 1-14; asthma: 5-44; hypertens./ cerebrovascular disease: 35-64; liver cirrhosis: 15-64	Time trend Age-standardised death rates; linear regression analysis of trends (annual % change)	Treatable mortality fell sign. in both sexes, by 0.7%/a in men and 0.9/a in women (ages 0-64); preventable causes sign. increased, by 0.9 & 1.3/a; total avoidable mortality remained stable as did all-cause mortality in both sexes; total avoidable mortality accounted for 26-27% of total mortality (1970-90) with male death rates > twice as high as in women; main causes of avoidable mortality were motor vehicle accidents (men: 29%, women: 13%), hypertensive/ cerebrovasc. disease (18 & 30%), perinatal mortality (20%) and lung cancer (16%)

Empirical studies of 'avoidable' mortality: Analyses of changes over time – *continued*

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Gai_auskien_ & Westerling 1995[220]	Lithuania & Sweden	1971-1990	Trends in avoidable mortality in Lithuania and Sweden in 4 periods: 1971-75, 1976-80, 1981-85, 1986-90; 'avoidable' mortality as defined by Holland (1988)	basis: EC (1988) • 15 conditions/groups of conditions excl. Hodgkin's disease • ages: see Holland (1988)	Time trend Age-standardised death rates; (indirect) standardised death ratios (Swedish rates as standard)	Lithuania: Increase in all-cause mortality by 12% between 1971/75 & 1980/85 & subsequent fall; increase in mortality from hypertensive/cerebrovasc disease by 19% between 1971/75 & 1986/90; Sweden: all-cause mortality fell by 18%, mortality from hypert/cerebrovasc. fell by 44%; death rates higher in Lithuania than in Sweden for most avoidable causes (TB, rheumatic heart dis., appendicitis, respiratory diseases etc.) gap widening over time (e.g. TB ratio from 10.7 in 1971/75 to 36.2 in 1986/90, appendicitis: 3.4 and 5.6; all causes: 1.6 and 1.9)
Jozan &Forster 1999[74]	Budapest, Hungary	1980-83, 1990-93	Trends in 'amenable' and 'non-amenable' mortality in Budapest between 1980/3 and 1990/3 by 'social advantage'; amenable mortality defined as deaths "potentially preventable by direct, timely and appropriate medical care"	basis: EC (1988) • 12 conditions/groups of conditions excl. infectious diseases; perinatal mortality replaced by infant mortality • ages: 0-64; for specific causes see Holland (1988)	Time trend SMR standardised to 1980/3 rates comparing most to least disadvantaged district (composite indictor: % unskilled workers among economically active population; % resident population > 25 without completed college/ university degree; overcrowding)	Between 1980/3 & 1990/3 SMR amenable causes declined in 'most disadvantaged' districts (men: 109.2, 98.4; women: 105.2, 89.8) while SMR all causes & non-amenable causes increased in men (non-amenable:115.0 & 124.1) but not women (109.6, 105.7); general decline in 'least disadvantaged' districts for all categories (amenable: men:81.5, 74.8; women: 89.2, 74.4 / non-amenable: men: 81.3, 77.9; women: 89.2, 78.3); ratio most-to-least disadvantaged increased for all categories, from 1.3 to 1.7 for amenable and 1.3 to 1.5 for non-amenable
Boys et al. 1991[77]	Hungary, Czechoslovakia, Poland, GDR, FRG, England & Wales, USA, Canada	1955/1959, 1970/1974, 1985/1987	Trends in mortality from conditions amenable to timely, appropriate medical care and from non-amenable conditions between 1955/59 and 1970/74 and between 1974/79 and 1985/87	basis: Rutstein et al. • 22 conditions/groups of conditions plus IHD as separate category (from 1968) • ages 0-64; cervical cancer: 15-64; Hodgkin's disease: 0-34; diabetes, rheumatic fever/heart disease, pneumonia: 0-49, hypertens./ cerebrovascular disease: 35-64; peptic ulcer, cholelithiasis: 5-64; maternal mortality: all ages	Time trend Age-standardised death rates for ages 0-64 and 65+ (data Poland from 1959; DDR for 1973 & 1974 and 1985-1987 only)	Amenable mortality fell in all countries, by in 33.5% in Hungary, 28.3 in Czech, 42.2 in Poland compared with 42.5 in FRG, 40.4 in E&W, 50.7 in Canada, 46.4 in US between 1955/59 & 1970/74; between 1970/74 & 1985/87 decline less steep in eastern countries at 14.7% (Hun), 28.2 (Cz), 22.6 (Pol), 26.5 (DDR), 61.6 (FRG), 49.7 (E&W), 60.1 (Can), 51.2 (US); non-amenable mortality incl IHD fell slightly in 1st period and increased in 2nd period in east (Hun: 29%; Cz: 2.2; Pol: 16.5, DDR: 2.9), fell in west (FRG: 19%, E&W: 15.5, Can: 22.9, US: 21.7); all cause mortality fell in 1st period in all countries, by about 8-15% but increased in Hun & Pol in 2nd period [17 & 7%], declined otherwise, by 3.2 (Cz), 3.8 (DDR), 27.3 (FRG), 22 (E&W), 28.4 (Can), 26.2 (US)

Empirical studies of 'avoidable' mortality: Analyses of changes over time – *continued*

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Bojan et al. 1991[221]	Hungary, Czechoslovakia, England & Wales, France, Italy, Japan, Portugal, USA	1979-1988	Pattern of avoidable mortality in Hungary in international comparison; 'avoidable' mortality: "causes of death avoidable with medical treatment"	basis: Rutstein et al. • 13 conditions/groups of conditions • ages 5-64; cervical cancer: 15-64; Hodgkin's disease: 5-34; rheumatic heart disease: 0-44, acute respiratory disease, pneumonia: 5-49	Time trend Age-standardised mortality rates	Between 1981 & 1988 amenable mortality fell by 35% in Japan, 20 in Italy, 20-30 in E&W, 15-20 in France, 10 in US, 30 in Portugal compared with all other causes at about 5-10%; except Hungary & Czech where amenable mortality first increased (4-10 & 10%), declined from 1985 in Hun (15-20%) and from 1983 in Czech (15%), all-cause mortality increased similarly but rate of decline was less rapid (about 5%; ages 5-64) by 1988 amenable mortality was below 1981 level, non-amenable mortality remained elevated
Nolte et al. 2002[57]	East & west Germany, Poland	1980/83-1988, 1991/92-1996/97	Trends in avoidable mortality with causes of death divided into those responsive to medical care ('amenable') and those responsive to health policy ('preventable')	basis: Mackenbach et al. (1988) & EC (1988, 1993, 1997) • 32 conditions/groups of conditions; 28 'amenable', 3 'preventable' plus IHD as separate group • ages 0-74	Time trend Age-standardised death rates; decomposition of life expectancy [0-75] by age & cause of death	Between 1980/83 & 1988 improvements in amenable mortality contributed 34 & 44% in west German men and women to total increase in temp. LE (east Germany: 62-63%; Poland: decline in amenable mortality offset by increase in IHD; still small increase in temp. LE); in 1990s, amenable mortality accounted for 12-16% in German men (Poland: 21%), women: 26, 27 & 32%; contribution of IHD- men: 21, 17 & 24%; women: 7, 10 & 13%; preventable conditions in men: 16, 23 & 16%; women: 8, 9 & 3%; 16 (men) – 25% (women) of gap in LE between E+W Germany in 1997 attributable to amenable conditions; preventable conditions: 46-50%
Kjellstrand et al. 1998[80]	Australia, Canada, France, Germany, Italy, Japan, New Zealand, Sweden, UK, US	1980-1990	Trends in mortality from 'avoidable' ["amenable to treatment by modern medicine"] and 'unavoidable' diseases and in cost of health care; relation between life expectancy, avoidable/unavoidable, infant and maternal mortality, acceptance rates for dialysis and transplantation and health expenditure; efficiency of health care	basis: Rutstein et al. • 2 categories: 'avoidable' (6 causes of death); 'unavoidable' (remainder) (ages 5-64) • life expectancy, maternal & infant mortality, acceptance rates for dialysis and renal transplantation	Time trend Slope of mortality & acceptance rates; regression analysis of life expectancy, mortality, acceptance rates as dependent and per capita cost & %GDP spent on health as independent variable (best fit); Efficiency-index: (avoidable mortality rate x mean $ expenditure per capita)/(individual country avoidable death rate x expenditures for country)	Avoidable death rate declined by 34% & unavoidable by 9%; cost/capita increased by 107%, health expenditure as % GDP by 10%; correlation between health expenditure and avoidable mortality strongest with 10 yr delay (1970 exp & 1980 avoid. mortality: R^2=0.71; 1980 exp. & 1990 avoid. mort.: R^2=0.33); no correlation between expenditure & unavoidable mortality, infant & maternal mortality; limited correlation between expenditure & acceptance rates; Australia most and US least efficient

Empirical studies of 'avoidable' mortality: Analyses of changes over time – *continued*

Author	*country / region*	*time period*	*Topic/aim of study*	*number of causes*	*Design/method*	*Results*
Simonato et al. 1998[58]	21 countries in Europe, divided into Southern Europe, Central Europe, Northern Europe & Nordic countries	1955-1994 (varies by country)	Trends of avoidable mortality in Europe: causes amenable to primary prevention through reduction of exposures, secondary prevention through early detection and treatment, and tertiary prevention through improved treatment and medical care	basis: Rutstein et al. • (1) causes avoidable through primary prevention (7 causes of death); (2) causes avoidable through secondary prevention (4 (mainly female) conditions); (3) causes avoidable through improved treatment and medical care (12 conditions = Charlton's list) • ages 5-64	Time trend Age-standardised 5-year death rates (standardised to world population)	Between 1955/59 and 1990/94 mortality from all avoidable causes declined by 45.8% in women and 39.3% in men (all-cause mortality: 45.1 and 32.6%); reduction greatest in causes amenable to medical care (grp 3), by 76-78% in both sexes while preventable causes declined by 17% in men and 29% in women; among women also decline in group 2 causes, by 11%; for men, main causes of avoidable mortality related to preventable conditions (tobacco, diet, occupational exposures), for women main avoidable causes were cancers that are considered preventable by screening

GLOSSARY

AHA .... Area Health Authority

Anaemia .... Deficiency anaemia

Bact .... Bacterial

CA .... Cancer

CVA .... Cerebrovascular disease

dis .... Disease(s)

E&W .... England & Wales

EC .... European Community

EU .... European Union

GP .... General Practitioner

IHD .... Ischaemic heart disease

IMR .... Infant mortality rate

infect .... Infection(s)

LE .... Life expectancy

MCI .... Medical care indicator

(N)HPI .... (National) health policy indicator

resp .... respiratory

SES .... Socio-economic status

SMR .... Standardised Mortality Ratio

TB .... Tuberculosis

YPLL / PYLL .... Years of Potential Life Lost

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