

**UHCE OXFORD REPORT MR4
MORTALITY RATES: LITERATURE REVIEW**

**Alastair Mason, Edel Daly and Michael Goldacre
National Centre for Health Outcomes Development
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1. INTRODUCTION

Over the last ten years there has been increasing interest in using mortality rates as health outcome indicators to make comparisons over time and between health authorities. Death rates feature prominently in the national performance assessment framework and most of the condition specific reports published by NCHOD in 1999 included outcome indicators related to mortality.

This review is concerned with population-based mortality rates. Case fatality rates are the subject of a separate review (*NCHOD 2000*).

Unlike indicators based on re-admission or case fatality rates that are intended mainly as potential measures of in-patient quality of care, indicators based on mortality rates may have a range of potential uses in the monitoring of health care delivery. These include indicators of:

- inadequate service provision at the population level
- variation in access to health care
- populations with higher than average rates of mortality
- significant differences or anomalies between health authority populations that require further detailed investigation
- health outcome.

This review is concerned with the use of mortality rates as health outcome indicators and the circumstances in which this occurs relate, in particular, to the effectiveness of:

- health promotion and disease prevention strategies
- primary and community care
- secondary care.

Indicators based on mortality rates may be used to highlight differences:

- over time
- between health authority populations
- between different socio-demographic groups.

The main use of such indicators is to make broad comparisons to identify significant differences or anomalies that require further detailed examination. Small differences in routine indicators may be attributable to a wide range of factors, many of which will probably not reflect differences in health outcomes that can be attributed to the process of health care.

Key issues

The main issues relating to the *calculation* of mortality rates are:

- diagnostic specificity
- risk adjustment for factors such as age, sex or case-mix
- accuracy of death certification.
- whether rates are based on the underlying cause of death or cause mentioned anywhere on the death certificate

The *usefulness* of a health outcome indicator will depend on:

- attributability of the outcome measured to the quality of health care
- reliability of the indicator
- sensitivity of the indicator to changes or variation in the quality of health care.

Key issues relating to the *interpretation* of mortality rates are:

- statistical power, relating to the adequacy of the number of events and size of the population denominators to show significant variations
- extent to which expectations of performance can be quantified by defining benchmarks.

Literature search questions

In reviewing the literature, an attempt has been made to address the following questions:

- What are the general factors affecting mortality rates?
- What factors influence mortality rates when they are being used specifically as outcome indicators for certain medical conditions?
- How should mortality rates be calculated when used as health outcome indicators?

Search strategy

Various electronic searches were performed in Medline and EMBASE for the years 1995 to 2000 using various combinations of the following words and phrases: mortality rate; mortality ratio; death rate; avoidable death;

combined with at least one of the following:

quality indicator; outcome indicator; clinical indicator; performance indicator; quality of health care; quality of care; quality assessment; outcome assessment; quality comparisons; quality assurance; quality improvement; performance measurement; health services research; health policy; length of stay; statistics and numerical data.

In addition, the following strategies were employed to identify relevant publications:

- electronic searching for publications which cited key papers on this subject
- electronic or hand searching of recent issues of journals where relevant significant papers are most likely to appear (e.g. *Medical Care*).

2. MORTALITY RATES USED TO MONITOR NATIONAL POLICY

Mortality rates for certain conditions (and groups) are considered to be useful performance indicators in two areas (health improvement and health outcomes of NHS care) of the Performance Assessment Framework (*Department of Health 2000*). The specified rates are:

- deaths from all causes (ages 15-64) (health improvement)
- deaths from all causes (ages 65-74) (health improvement)
- deaths from all malignant cancers (health improvement)
- deaths from all circulatory diseases (health improvement)
- suicide rates (health improvement)
- deaths from accidents (health improvement)
- stillbirths and infant deaths (health outcomes of NHS care).

The five year relative survival rates for people diagnosed with breast cancer, cervical cancer, lung cancer, and colon cancer are also included as national performance indicators (*Department of Health 2000*). These survival rates will reflect the underlying effectiveness of treatment by the NHS in reducing premature deaths among people diagnosed with such cancers.

Deaths from all causes

The standardised mortality ratios (SMR) for all causes (ICD-9 001-999) for people aged 15-64 and for those aged 65-74 are included as outcome indicators in the performance assessment framework (*Department of Health 2000*). All cause mortality ratios can be used as broad guides to the relative health status of health authority populations in the context of wider influences on health.

Two age bands are being used to reflect the differences in the types of factors and conditions that may contribute to mortality in adults (15-64) and older people (65-74). These indicators are likely to show a strong relationship with socio-economic factors outside the influence of the NHS, and this will need to be borne in mind when making comparisons across health authorities on these indicators.

Deaths from cancer

The age-standardised mortality rate from malignant neoplasms (ICD 9 140-208) in people aged under 75 (classified by underlying cause of death) is included as an indicator of the wider health status of the population (*Department of Health 2000*).

The prevention and treatment of cancer is a national priority. Cancers are amongst the commonest causes of death in the UK, accounting for one out of every four deaths, almost 130,000 each year. In those aged under 65 years, cancer accounts for one in three deaths. The chance over a lifetime of being diagnosed as having cancer is almost 4 in 10 for men and only marginally less for women.

There is much that can be done to reduce the death rate from cancers. The directly age-standardised mortality rate from all cancers for persons aged under 75 is a

national indicator (*Department of Health 1999*) and the target is a 20% reduction by the year 2010 from the baseline rate in 1995-97.

Appropriate indicators to use for breast cancer were discussed in the NCHOD Working Group Report (*Hayward 1999*) and specific cancers are not addressed further in this document.

Deaths from circulatory disease

The age-standardised mortality rate from all circulatory diseases (ICD-9 390-459) in persons aged under 75 is included as an indicator of the wider health status of the population (*Department of Health 2000*).

The prevention and treatment of circulatory diseases is a national priority. They are a major cause of early death, accounting for 18,000 deaths (a third of all deaths) in men and 7,000 deaths (one fifth of all deaths) in women, aged under 65 years. Deaths from coronary heart disease alone account for more than a million years of life lost each year amongst those aged under 75 years.

Heart disease and stroke can often be prevented. The directly age-standardised mortality rate from all circulatory diseases for persons aged under 75 is a national indicator (*Department of Health 1999*) and the target is a 40% reduction by the year 2010 from the baseline rate in 1995-97.

Deaths from suicide

The age-standardised mortality rate from suicide and injury undetermined whether accidentally or purposely inflicted (E950-E959 & E980-E989 excluding E988.8) is included as an indicator of the wider health status of the population (*Department of Health 2000*).

Suicides are a significant cause of early death, and are responsible each year for nearly half a million years of life lost in those aged under 75 years. The directly age-standardised suicide rate for persons of all ages is a national indicator (*Department of Health 1999*) and the target is a 20% reduction by the year 2010 from the baseline rate in 1995-97.

Deaths from accidents

The age-standardised mortality rate for accidents (ICD-9 E800-E949) is included as an indicator of the wider health status of the population (*Department of Health 2000*).

The prevention of accidents is a national priority. More than one person every hour died of accidental causes in England during 1996. The 1996 Health Survey for England estimated that the annual accident rate was 21 for every 100 adult men and 15 for every 100 adult women. Accidents are the greatest single threat to life for children and young people. There were over 180,000 hospital admissions for serious accidental injury in 1995/96. Accidental injury puts more children in hospital than any other cause.

The directly age-standardised mortality rate from accidents for persons of all ages is a national indicator (*Department of Health 1999*) and the target is a 20% reduction by the year 2010 from the baseline rate in 1995-97.

Stillbirths and infant deaths

Stillbirth and infant mortality rates reflect some of the most serious adverse outcomes of childbirth. The number of stillbirths per 1,000 total births and number of deaths in infants aged under one year per 1,000 live births is included as an indicator of outcome of NHS care (*Department of Health 2000*) to reflect the success of the NHS in reducing premature deaths.

The appropriate indicators to use are discussed in the NCHOD report on health outcome indicators in normal pregnancy (*Troop 1999*) and are not addressed further in this study.

3. STUDIES REVIEWING GENERAL FACTORS INFLUENCING MORTALITY RATES

In this section non-disease specific studies have been reviewed and sorted into those addressing:

- socio-economic factors
- relationship with population-based interventions.

Socio-economic factors

A number of studies have been done to identify the effect on mortality risk of different demographic and socio-economic risk factors including:

- sex and age
- ethnicity
- education
- occupational and employment status
- marital status.

The studies examining socio-economic factors in relation to mortality that have been reviewed are:

- *Law (1998)* attempted to identify and quantify the factors responsible for the differences in mortality between affluent and deprived areas, the north and the south, and urban and rural areas, in an analysis of cause specific mortality in the 403 local authority districts in England and Wales.
- *Jessop (1996)* tested the hypothesis that the relationship between deprivation and mortality is weaker among residents of non-metropolitan areas of England and Wales than among residents of metropolitan areas.
- *Morris (1996)* investigated the relationships between education, social conditions, and mortality in a study of 107 local education authority areas in England in 1991.
- *Bentham (1995)* examined geographical variation in self-reported limiting long-term illness using data from the 1991 Census for 401 local authority districts.
- *Carstairs (1995)* reviews selected publications from the last decade that illustrate the diversity of use of deprivation indices in relation to health and mortality.
- *Sloggett (1998)* investigated the association between the level of social deprivation in electoral wards and a range of life events including mortality, self reported long term illness, and still-birth, in a prospective census follow up of a random sample of more than 300,000 people (aged 10 to 64 in 1981) in England and Wales enumerated at the 1981 UK census.
- *Marang van de Mheen (1998)* assessed the size of mortality differentials in men by social class in Scotland as compared with England and Wales, and analysed the time trends in these differentials.
- *Davey-Smith (1998)* demonstrated the profile of mortality differentials, and the factors underlying these differentials, which are associated with two socio-economic measures (occupational social class and education) in a prospective observational study of 5,749 men (aged 35-64) from 27 work places in the West of Scotland who completed questionnaires and were examined 1970-1973.
- *Dolk (1995)* assessed how effectively a routine adjustment can be made for socio-economic confounding in small area studies of environment and health in the UK.

- *Gognalons (1999)* analysed the relative risk of mortality related to social factors independent of health status and occupational category among a random sample of 820 Swiss men and women (aged 40-65) followed up prospectively between 1984 and 1996.
- *Hunt (1991)* examined the effects of socio-demographic and cause of death variables on changing patterns in the place of death of South Australians using data relating to 2,566 deaths between 1910 and 1987.
- *Huff (1999)* defined ward level spatial health variations in the Trent Region, investigated urban and rural inequalities, and examined the relationship with deprivation, to identify the extent of small area health inequalities and to establish whether a quantifiable difference exists between urban and rural health as affected by deprivation.
- *Johnson (2000)* examined the effect of marital status (married, widowed, divorced/separated, and never-married) on mortality in a cohort of 281,460 men and women (aged 45 years and older) of black and white races, who were part of the National Longitudinal Mortality Study (NLMS).
- *Kawachi (1996)* prospectively examined the relationships between social networks and total and cause specific mortality in a four year follow up cohort study of 32,624 US male health professionals (aged 42 to 77 years in 1988) who were free of CHD, stroke, and cancer at baseline. Information on social networks was collected at baseline.
- *Birch (1996)* compared the use of a non-mortality based proxy for relative healthcare needs among regional populations with a mortality based proxy and evaluated the additional value of a proxy based on a combination of non-mortality and mortality measures.
- *Song (2000)* evaluated the magnitude and contributory factors of socio-economic differentials in mortality in a prospective observational cohort study of 759,665 Korean male civil servants aged 30-64 at baseline examination in 1992 followed up for five years.
- *Mackenbach (1994)* investigated the association between living standards and mortality in the European Community (EC) using regional level data covering the 1980s from all EC member countries.
- *Morris (1994)* assessed the effect of unemployment and early retirement on mortality among 6,191 men aged 40-59 who had been continuously employed for at least five years before initial screening in 1978-80 as part of a prospective cohort study (British Regional Heart Study).
- *Reijneveld (1994)* analysed the influence of the age distribution on the ranking of small areas by socio-economic status indicators (educational level, income, and unemployment) and on the association between their socio-economic status and standardised mortality.
- *Charlton (1996)* analysed, for England and Wales, mortality data from 1981 to 1992 by cause, local authority, and ward, using the new OPCS area classifications, and the urban/rural categorisation of 1991 Census enumeration districts based on land use.
- *Drever (1995)* presented regional and local authority patterns of mortality in England and Wales for both males and females are presented for 1989-1993.

Law (1998) reported that:

- All cause mortality was 15% higher in the districts comprising the most compared with the least deprived tenth of the population, 23% higher in

the most northern (55 degrees latitude) than in the most southern (50 degrees latitude) districts, and 4% higher in metropolitan (within large cities) than rural districts.

- More than two thirds of the overall excess mortality with deprivation (classified using the Jarman Index), latitude, and urbanisation was from three diseases (ischaemic heart disease, lung cancer, and chronic bronchitis and emphysema).
- The excess mortality from these and other diseases closely matched that predicted from differences according to deprivation and latitude in smoking, heavy alcohol consumption, *Helicobacter pylori* infection, and temperature, and thus could be attributed to these causes.
- About 85% of the overall excess mortality with deprivation was attributable to heavier smoking and 6% to heavier alcohol consumption, but diet varied little.
- Deaths more directly related to deprivation accounted for an estimated 12% of the excess deaths, but variation in provision and uptake of healthcare services only 1%.
- The more direct material effects of deprivation contribute to the variation in mortality but is particularly important with respect to differences in morbidity.
- Of the difference in mortality with latitude, about 45% was attributable to differences in smoking, and 25% to climate (mainly the association of cardiovascular and respiratory disease with cold). The differences with urbanisation were mainly because of smoking.

Jessop (1996) computed SMRs for all causes of death, for bronchitis and asthma (ICD9 codes 490-493), and for accident, violence, and poisoning (ICD9 codes 800-999), for members of a longitudinal study representing a quasi-random 1% sample of the population of England and Wales. Deprivation was classified by an electoral ward deprivation score and by home and car ownership. It was found that:

- There was an association between deprivation and mortality that was clear for all cause mortality, more noticeable for respiratory disease, and less clear for deaths from accident, violence, and poison.
- In general, the results showed a remarkable similarity between metropolitan and non-metropolitan areas.
- This study does not support the hypothesis that the relationship between mortality and deprivation differs between residents of metropolitan and non-metropolitan areas of England and Wales.

Morris (1996) carried out an ecological study relating measures of mortality to local rates of educational attainment at age 15/16 years and scores on the Department of the Environment's index of local conditions. The main findings were:

- Educational attainment was closely associated with all cause, coronary, and infant mortality and strongly associated with the index of local conditions.
- This social index was also closely associated with all the measures of mortality.

- In multiple regression, the social index was the stronger correlate of all cause mortality but for coronary and infant mortality, educational attainment remained highly statistically significant.
- Area levels of both educational attainment and deprivation-affluence are strong correlates of local mortality rates in England.
- In these analyses educational attainment may be indexing the general cultural level of a community.

Bentham (1995) assessed the level of similarity between geographical variation in limiting long-term illness and the distribution of mortality rates and of deprivation. The main findings were:

- The geographical pattern of limiting long-term illness shows many similarities with that of mortality but there are also some differences.
- Both are positively associated with indicators of social deprivation, with limiting long-term illness tending to show stronger correlations, particularly in the elderly.
- Most of Wales and many industrial areas of northern England have higher rates of long term illness than would be expected from their mortality rates, while much of south eastern England has lower than expected rates.
- However, further assessment of the reliability of these data on self reported morbidity is required.

Carstairs (1995) reported that:

- The link between deprivation and health has been clearly demonstrated in a number of studies, with populations living in deprived areas exhibiting levels of mortality, particularly below the age of 65, which vastly exceed those in affluent areas.
- In the decade 1981-91, these differentials increased in Scotland and the Northern Health Region and inequalities in health widened.
- Analysis shows that particular causes of death and sites of cancer are more likely to reflect the influence of socio-economic factors.
- The work so far mostly shows the associations between these factors and health measures and more investigation is required into the determinants of health.
- The authors conclude that area measures of deprivation can prove valuable in examining differentials in health and death.

Sloggett (1998) reported that:

- Without adjusting for personal circumstances, the risk of premature death (before age 70) and the risk of long term limiting illness in 1991, but not risk of stillbirth, showed a clear, significant, and approximately linear association with social deprivation of ward of residence in 1981.
- When adjustment is made for personal disadvantage the associations with local area deprivation were all attenuated, especially for those living in the more deprived areas.
- Residence in more deprived areas was more strongly associated with long-term illness than with mortality.
- These associations seem to be largely because residence in more deprived areas is associated with personal disadvantage.

Marang van de Mheen (1998) calculated relative indices of inequality for disease specific and all cause mortality (a measure which is not dependent on the size of the social class groups, so it can be used to compare the magnitude of differentials over time periods during which the relative sizes of social class groups change). It was found that:

- While overall death rates were higher in Scotland than in England and Wales around the 1951, 1961, and 1971 Censuses the relative indices of inequality indicate smaller differences between social classes in Scotland.
- Inequality, as indexed by the relative index of inequality, increased over time in both Scotland and England and Wales, but to a greater degree in Scotland, resulting in greater social class mortality differentials for Scotland in 1981 (the relative index of inequality increased from 1.40 to 2.43 for England and Wales, and from 1.22 to 2.57 for Scotland between 1951 and 1981).
- This greater increase in the magnitude of inequalities in all cause mortality in Scotland seemed to result from increasing social class differentials in cardiovascular disease, accidents and external causes, and 'all other causes of death'.
- Examining the trends in overall death rates, it seems that the greater increase in social class differences in Scotland occurred because of the greater decrease in death rates among the privileged social groups, in combination with a smaller decrease (or a greater increase) in the death rates in the lower social class groups.
- This study shows that trends in mortality and in inequalities in mortality differ within Great Britain.

Davey-Smith (1998) reported that:

- Over 21 years of follow up, 1,639 of the men died.
- Mortality from all causes and from three broad cause of death groups (cardiovascular disease, malignant disease, and other causes) showed similar associations with social class and education.
- For all cause of death groups, men in manual social classes and men who terminated full time education at an early age had higher death rates.
- Cardiovascular disease was the cause of death group most strongly associated with education, while the non-cardiovascular non-cancer category was the cause of death group most strongly associated with adulthood social class.
- The graded association between social class and all cause mortality remains strong and significant within education strata, whereas within social class strata the relation between education and mortality is less clear.
- As a single indicator of socio-economic position occupational social class in adulthood is a better discriminator of socio-economic differentials in mortality than is education.
- This argues against interpretations that see cultural, rather than material, resources as being the key determinants of socio-economic differentials in health.

- The stronger association of education with death from cardiovascular causes than with other causes of death may reflect the function of education as an index of socio-economic circumstances in early life, which appear to have a particular influence on the risk of cardiovascular disease.

Dolk (1995) calculated standardised morbidity ratios for cancers in 1981 and standardised mortality ratios for all cause mortality between 1982 and 1985. A deprivation index was used to measure gradients of deprivation according to the distance from industrial sites. Findings include:

- Strong relationships were found between all cause mortality and deprivation quintile.
- The relationship between deprivation, urban/rural status, and mortality is complex and is confounded by region.
- Mortality tends to be higher in urban than in rural areas within quintiles of deprivation.
- The main problems in the interpretation of the deprivation index may be its limited correlation with the risk factors of interest and its concentration on present rather than past socio-economic status.
- There is potential for important socio-economic confounding in small area studies of environmental pollution and health where the health outcome under examination has a strong relationship to socio-economic status and where the putative excess risk due to pollution may be small.
- One method of controlling for confounding is to use an ecological measurement of deprivation in small areas, and to adjust for deprivation by indirect standardisation.
- However, residual socio-economic confounding can be expected, which may seriously complicate the interpretation of small area studies.

Gognalons (1999) reported that:

- There were several social prognostic factors of mortality independent of health and occupational status with relative risks greater than 3.0 including:
 - period of unemployment during life time
 - feeling of not demonstrating initiative in the occupational setting
 - non-participation in social activities.
- The results suggest that differential mortality determined by occupational status can be explained in part by factors that are characteristic of "life style", social dynamics, occupational context, and ruptures during the course of occupational life.

Findings from *Hunt (1991)* include:

- The proportion of deaths that occurred at home decreased from 55.6% in 1910 to 26.2% in 1970, and thereafter about a quarter of all deaths occurred at home.
- By 1970 over two-thirds of all deaths occurred in hospitals; after 1970 death has been transferred from hospitals to nursing homes and inpatient hospices.
- Mortality patterns are determined by
 - social and demographic characteristics

- availability of hospital and nursing home beds
- changes to health insurance schemes
- emergence of hospice care and related services.

Huff (1999) adopted a small area ecological study design and calculated ward level (n=591) standardised ratios (population aged <75) for specific causes of death and limiting long-term illness. Deprivation was measured using the Townsend Index. It was found that:

- Wide variations in mortality and illness were evident at ward level, being widest for accident mortality (standardized mortality range 0-508).
- Stroke mortality accounted for the largest proportion of wards with standardised mortality ratios over 125 (36.2%).
- Relative deprivation correlated strongly with limiting long-term illness (r=0.82) and all cause mortality (r=0.68) across Trent, and in both urban and rural environments.
- Wide health inequalities were evident in Trent and the association between deprivation and health was of a similar magnitude in urban and rural wards.
- This small area approach allows health authorities access to ward level information in order to inform key debate on tackling health inequalities and distributing resources in relation to need.

Johnson (2000) reported that:

- For persons aged 45-64, each of the non-married groups generally showed statistically significant increased risk compared to their married counterparts (RR for white males, 1.24-1.39; white females, 1.46-1.49; black males, 1.27-1.57; and black females, 1.10-1.36).
- Older age groups tended to have smaller RRs than their younger counterparts.
- Elevated risk for non-married females was comparable to that of non-married males.
- For cardiovascular disease mortality, widowed and never-married white males ages 45-64 showed statistically significant increased RRs of 1.25 and 1.32, respectively, whereas each non-married group of white females showed statistically significant increased RRs from 1.50 to 1.60. RRs for causes other than cardiovascular diseases or cancers were high (for white males ages 45-64: widowed, 1.85; divorced/separated, 2.15; and never-married, 1.48).
- Labor force status was important in determining the elevated risk of non-married males compared to non-married females by race.

Kawachi (1996) reported that:

- A total of 511 deaths occurred during 122,911 person years of follow up.
- Compared with men with the highest level of social networks, socially isolated men (not married, fewer than six friends or relatives, no membership in church or community groups) were at increased risk for cardiovascular disease mortality (age adjusted relative risk [RR]=1.90; 95% CI 1.07-3.37) and deaths from accidents and suicides (age adjusted

RR=2.22; 95% CI 0.76-6.47). No excess risks were found for other causes of death.

- Socially isolated men were also at increased risk of stroke incidence (RR=2.21; 95% CI 1.12-4.35), but not incidence of non-fatal myocardial infarction.
- However, social networks may assist in prolonging the survival of men with established coronary heart disease.

Birch (1996) assessed the levels of correlation of indicators based on mortality data, socio-economic data, and combined data with a standardised indicator of self assessed health, in a cross-sectional analysis of population data for the 15 health regions in Quebec. The following results were reported:

- Variations in scores of a proxy based on socio-economic data among regions explain 37% of the observed variation in self-assessed health, 4% more than the level of variation explained by the standardised mortality rate scores.
- A weighted combination of both mortality and socio-economic based proxies explains 56% of variation in self-assessed health.
- Justification of "deprivation weights" reflecting variations in socio-economic status among populations should be based on empirical support concerning the performance of such weights as proxies for relative levels of need among populations.
- The socio-economic proxy developed in this study provides a closer correlation to the self-assessed health of the populations under study than the mortality-based proxy.
- The superior performance of the combined indicator suggests that the development of social deprivation indicators should be viewed as a complement to, as opposed to a substitute for, mortality-based measures in needs-based resource allocation exercises.

In the study by *Song (2000)*, classification by socio-economic status (SES) was based on monthly salary. It emerged that:

- The lowest SES group had significantly higher risk of mortality from most causes compared with the highest SES group in the order of:
 - external causes (RR=2.26)
 - avoidable (RR=1.65)
 - all causes (RR=1.59)
 - non-avoidable mortality (RR=1.54).
- With the adjustment of known risk factors, significantly higher risks of mortality in lowest SES group were attenuated but persisted.
- Looking at the deaths from partly avoidable causes, significantly higher risks of mortality in the lowest SES group was observed from cerebrovascular disease but not from coronary heart disease.
- In conclusion, socio-economic differentials in non-avoidable as well as avoidable mortality, persisting even under the control of risk factors, suggest that mortality is influenced not only by the quality of health care and different distribution of risk factors but also by other aspects of socio-economic status that are yet unknown.

In the study by *Mackenbach (1994)*, data on living standards (gross domestic product, car access, unemployment rates), and some potential confounders (population density, agricultural employment, industrial employment, country) were available for 133 different regions. The key findings were:

- It is only after taking into account potential confounders that higher living standards are associated with lower mortality.
- Unemployment rates have the strongest association: each additional percentage in unemployment in the regional population is associated with an increase in mortality by 0.81%. There is important variation between countries in the living standards-mortality relationship.
- The latter ranges from relatively strong in the UK to absent in Italy.
- Overall, the results of this study show that there is an association between living standards and mortality at the regional level in the EC, but that this association comes to light only controlling for confounding variables.
- It seems that the mortality increasing effects of urbanisation and industrialisation have obscured the mortality lowering effects of high living standards.
- In addition, factors specific to countries (such as dietary habits) act as confounders.

In the study by *Morris (1994)*, five years after initial screening, information on employment experience was obtained with a postal questionnaire. It was reported that:

- 1,779 men experienced some unemployment or retired during the five years after screening, and 4,412 remained continuously employed.
- Men who experienced unemployment in the five years after initial screening were twice as likely to die during the following 5.5 years as men who remained continuously employed (RR=2.13; 95% CI 1.71-2.65).
- After adjustment for socio-economic variables (town and social class), health related behaviour (smoking, alcohol consumption, and body weight), and health indicators (recall of doctor diagnoses) that had been assessed at initial screening the relative risk was slightly reduced to 1.95 (95% CI 1.57-2.43).
- Even men who retired early for reasons other than illness and who appeared to be relatively advantaged and healthy had a significantly increased risk of mortality compared with men who remained continuously employed (RR=1.87; 95% CI 1.35-2.60).
- The increased risk of mortality from cancer was similar to that of mortality from cardiovascular disease (adjusted RR=2.07 and 2.13 respectively).

Reijneveld (1994) analysed data for age group 1-64 years for all (n = 22) boroughs of Amsterdam for the period 1986-91. The key findings were:

- Correction of indicators of socio-economic status for the age structure of the population hardly affected the ranking of Amsterdam boroughs by socio-economic status.

- All rank correlations between crude and age standardised socio-economic status measures were above 0.95.
- Rank correlations between SMR and these socio-economic status measures also hardly changed after correction for the age structure of boroughs except for education.
- Mean income per earner was the socio-economic status indicator most strongly associated with the SMR.
- Educational level had the strongest association with age.
- Therefore, a correction for the age structure of the population will be more important if small areas differ little with regard to socio-economic status, if they vary considerably in age structure, or if a given indicator of socio-economic status shows a strong cohort effect or age association.

Charlton (1996) reported that:

- Urban areas (particularly purpose-built inner city estates and deprived industrial areas) tend to be the least healthy.
- Rural and prosperous areas are healthiest and the biggest health gains have been made in these.
- Based on 1992 mortality rates, out of every 100 boys born in 'ports and industry' areas, 16 would survive to age 85 whereas 24 would do so in the 'most prosperous' areas.
- The corresponding figures for girls were 33 and 43.
- The 'most prosperous' areas also had the most similar male and female life expectancies, with the difference narrowing throughout the period 1981-1992.
- In 1990-92 people in 'ports and industry' areas had the highest male mortality levels for malignant neoplasms, lung cancer, circulatory diseases, ischaemic heart disease and cerebrovascular disease.
- People in 'inner London' had the highest levels for respiratory diseases and injury and poisoning.

Drever (1995) used a modified form of the Department of Environment's 1991 deprivation index to study interaction between socio-economic and geographic variables in mortality in more than 350 English local authorities in 1989-93. The main findings reported were:

- The familiar geographic pattern of higher mortality in the north and west and lower mortality to the south and east of the country has continued into the 1990s and there has been no significant widening or narrowing in the mortality gap between the worst and the best regions during the 1980s.
- The local authorities with higher mortality are still predominantly in urban areas.
- There is a very strong relationship between mortality and deprivation at the local authority level measured by the new index, with a tendency for higher mortality to be associated with greater deprivation.
- This relationship is most marked for males, but is still strong for females.

Relationship with population-based interventions

Mortality and morbidity, as “hard” end points, are traditionally regarded as preferable to softer outcome measures based on intermediary end points, when assessing the effectiveness of population or community-based interventions. *McCormick (1988)* stated in relation to the evaluation of population-based coronary heart disease interventions that ‘Overall, age-adjusted mortality must remain the final arbiter of benefit because it removes any biases from the ascription of the cause of death’. Critics of community-based cardiovascular disease interventions have focused mainly on the lack of statistically significant net effects on CHD or total mortality.

Lindholm (2000) presents arguments against the use of mortality rates as outcome indicators of the effectiveness of population-based interventions. Instead, the authors argue, established causal risk factors for the disease should be preferred as outcome measures. The arguments presented are as follows:

- The process from an intervention strategy to changes in risk factors to changes in morbidity and mortality usually takes many years, during which more risk and protective factors are gradually introduced.
- The introduction of new factors and the passage of time may lead to a dilution of the real effect of the intervention evaluated (‘dilution bias’).
- Many community-based interventions against CHD have targeted the main risk factors smoking, high BP and increased cholesterol; however, more than 200 other potential risk factors for CHD have been identified each of which may be influenced by different events in the community.
- Total mortality is affected by a plethora of social factors.

Lindholm (2000) identifies six types of dilution bias (biases diluting the ‘real effect’ of an intervention) relating to the evaluation of population-based interventions:

- changes in non-intervening factors (these distort the effect of an intervention because of the necessary non-randomised nature of community interventions)
- single disease measurement (most evaluations focus on a single disease measure although many behavioural lifestyle changes affect the risks of several diseases)
- population mobility (people move from the intervention area to the control area)
- dissemination effects to other areas (successful interventions are adopted by others)
- social diffusion to following generations (the exposed adult population influences the lifestyles of following generations)
- time lag (the effect of a risk factor reduction will have a lag time and be distributed during a long follow up time).

Lindholm (2000) concludes that:

- The end results of community-based primary interventions are diluted over time and by other social factors.
- Dilution bias creates great problems in an evaluation where morbidity and mortality are the ultimate outcome measures.
- The problems of dilution bias increase with time, and evaluation studies with mortality outcome measures require very long follow up periods.

- The larger number of events obtained with intermediate outcome variables (such as changes in established causal risk factors) as compared with outcome measures based on mortality events, increases statistical power thereby making conclusions more reliable.
- Overall, changes in risk factors that are targeted by a community-based primary intervention may be more correct outcome measures than morbidity or mortality.

4. STUDIES ADDRESSING MORTALITY RATES FOR SPECIFIC CONDITIONS

The review has concentrated on the conditions that have been included in the national performance assessment framework and the NCHOD outcome indicator reports published in 1999:

- circulatory diseases
- suicide
- avoidable deaths
- diabetes
- asthma.

Circulatory diseases

The studies examining mortality in patients with circulatory diseases that have been reviewed are:

- *Chaturvedi (1996)* determined whether ethnic differences in cardiovascular disease mortality persist in people with non-insulin-dependent diabetes mellitus in an analysis of routine UK mortality data for 1985-1986 for people aged 45 years and above with a mention of diabetes anywhere on the death certificate.
- *Rietsma (1999)* examined the relation between trends over time in mortality and hospital morbidity caused by various cardiovascular diseases in the Netherlands for the period 1975 to 1995.
- *Wolfe (1993)* determined differences in incidence and case fatality of stroke in three district health authorities in south east England with differing standardised mortality ratios (SMR) for stroke in residents aged under 65 years in whom death from stroke is generally considered 'avoidable'.
- *Williams (1999)* examined racial variations in CHD mortality rates (1968-1992) of residents aged 35-84 in the state economic areas (SEAs) surrounding the ARIC (Atherosclerosis Risk in Communities) study in the US.
- *Payne (1993)* reported on a local confidential inquiry into avoidable factors in deaths among all patients under 75 years from a health authority population who died from stroke, hypertensive disease, or hypertension related causes between November 1990 and October 1991.
- *Capewell (1999)* determined the extent to which increases in the uptake of effective treatments could further reduce coronary heart disease mortality in Scotland.
- *Bradley (1997)* assessed general practice care for patients following a myocardial infarction (MI) in a structured review of general practice records of patients identified from hospital administration data.
- *Vartiainen (1998)* estimated the extent to which changes in blood pressure, smoking and serum cholesterol concentration explain the observed increase in socio-economic differences in mortality from ischaemic heart disease (IHD) in Finland during the past 20 years.
- *Karter (1998)* compared trends in ischaemic heart disease (IHD) and stroke mortality in California among the six major sex-racial or -ethnic groups for persons aged 35 and older during the years 1985 to 1991.

- *Suadicani (1997)* attempted to determine if some newly identified cardiovascular risk factors in concert with established factors might contribute further to explaining the large social inequalities in the risk of ischaemic heart disease (IHD) observed in Western populations.
- *Davey-Smith (1998)* investigated the associations of individual and area-based socio-economic indicators with cardiovascular disease risk factors and mortality in a prospective population-based study of 6961 men and 7991 women between 1972 and 1976 in the towns of Renfrew and Paisley.
- *Geyer (2000)* investigated the relative contribution of 'material resources' (income), 'qualification' and 'occupational position' for explaining social differentials in mortality.
- *Byers (1998)* aimed to examine the correspondence between seven established risk factors for coronary heart disease (CHD) and CHD mortality rates among 49 states in the United States in 1991-1992.
- *Luoto (1998)* studied how combinations of three unhealthy behaviors (smoking, physical inactivity, and use of dairy fat) and an index describing their number were associated with the risk of cardiovascular mortality in a society showing remarkable improvement in health behaviours.
- *Bryce (1994)* examined studies of geographical variation in declining coronary heart disease mortality in England and assessed the change in spatial inequality in CHD mortality among the population aged 35-74 for 190 district health authorities over the period 1982-1989.
- *Haapanen-Niemi (1999)* assessed the avoidable proportion of coronary heart disease deaths associated with smoking, a high level of total cholesterol, systolic hypertension, overweight, and a low level of leisure-time physical activity.
- *Birkhead (1999)* considered issues relating to mortality from myocardial infarction in a Report to the Department of Health by a Working Group on health outcome indicators for acute myocardial infarction.
- *Rudd (1999)* considered issues relating to mortality from stroke in a Report to the Department of Health by a Working Group on health outcome indicators for stroke.

Chaturvedi (1996) compared mortality rates where a cardiovascular underlying cause was given between South Asians, African-Caribbeans, and those born in England and Wales. It was reported that:

- Mortality from heart disease was approximately three times higher in diabetic South Asian born men and women than in those with diabetes born in England and Wales.
- This ethnic difference was greatest in the younger age group.
- Conversely, stroke mortality rates in African-Caribbeans were 3.5 to 4 times higher than those in the England and Wales population.
- Despite this high mortality from stroke, ischaemic heart disease death rates were not high in African-Caribbean men.
- The high risk of heart disease should be targeted for intervention in South Asians, and the high rates of stroke targeted in African-Caribbeans.

Rietsma (1999) reported that:

- All cardiovascular diseases combined were responsible for 39% of all deaths and 16% of all hospital admissions in 1995.
- From 1975 to 1995, age adjusted cardiovascular mortality declined by an annual change of -2.0% (95% CI -2.1% to -1.9%), while in the same period age adjusted discharge rates increased annually by 1.3% (95% CI 1.1% to 1.5%).
- Around 60% of the gain in life expectancy in this period was related to lower cardiovascular mortality.
- For mortality, major reductions were seen in CHD (annual change -2.9%) and in stroke (-2.1%), whereas the increase in hospital admissions was mainly caused by chronic manifestations of CHD (5.1%), heart failure (2.1%), and diseases of the arteries (1.8%).
- The gap between men and women at risk of dying from CHD became smaller for those aged ≤ 65 years.
- These findings of a decrease in cardiovascular mortality and an increase in admission rates for chronic conditions support the hypothesis that the longer survival of many patients with heart diseases is leading to a growing pool of patients at increased risk for subsequent cardiovascular complications in Western countries.

In the study by *Wolfe (1993)*, 386 patients (aged <75 years) having a first ever stroke between August 1989 and August 1990 were assessed and followed up over one year. It was found that:

- There was a significant difference in the incidence rate between the three district health authorities in those aged under 65 ($p < 0.01$); there was no significant difference between districts in the 65-74 year old age group.
- The SMRs for stroke in those aged <65 year in these three health districts reflect the local incidence of stroke.
- The overall case fatality was 26% at three weeks with no significant difference between the districts, suggesting that differences in services between the districts did not lead to changes in prognosis.

Williams (1999) compared five year average annual, gender- and age-specific CHD mortality rates across race groups. The main findings were:

- Five year average annual CHD mortality declined 2.6% for white men and women and 1.6% and 2.2% for black men and women, respectively.
- The black-white mortality rate ratio increased over time for men and women.
- The black-white mortality age crossover (higher black than white mortality in young men, lower black than white mortality at older ages) had disappeared by the end of the observation.
- CHD mortality was markedly greater in black than white women at all ages and time periods.
- These persistent and increasing racial disparities in CHD mortality occur concurrently with racial differences in risk factors, the incidence of myocardial infarction, and case fatality rates.

In the study by *Payne (1993)*, details of care before death were assessed by two experts against agreed minimum standards of good practice for detecting and managing hypertension. It emerged that:

- Adequate information was obtained for 88% (123/139) of eligible cases.
- Agreement between the assessors was mostly satisfactory.
- 29% (36/123, 95% CI 21%-37%) of all cases and 44% (36/81, 95% CI 34%-55%) of those with definite hypertension had avoidable factors that may have contributed to death.
- These were most commonly failures of follow up and continuing smoking.
- Assessment against standards of minimum good practice showed that care was inadequate but not necessarily deemed to have contributed to death, in a large proportion of patients with definite hypertension.
- Common shortcomings were inadequate follow up, clinical investigation, and recording of smoking and other relevant risk behaviours.

Capewell (1999) used a cohort-based mortality model combining effectiveness data from published meta-analyses with available information on uptake of all coronary heart disease treatments in all patient categories in Scotland (population 5.1 million).

Findings were:

- In 1994, medical and surgical coronary disease treatments prevented or postponed an estimated 2,722 deaths (minimum estimate 1373, maximum estimate 5986).
- Increasing treatment uptake to 100% of all eligible patients was considered unrealistic.
- Increasing uptake to 80% would have prevented or postponed a further 4,078 deaths (39% from increases in secondary prevention therapies, 29%, 13%, 10% and 9% from the treatments of heart failure, acute myocardial infarction, hypertension and angina respectively).
- In conclusion, many eligible patients are currently not receiving treatment that is effective in reducing coronary heart disease mortality.
- By implication, about 30,000 additional deaths could be prevented, annually, in the U.K.

Bradley (1997) identified a total of 266 survivors following MI (median time of 2.1 years since discharge) from the discharge data of 13 hospitals in Southern England and registered with 71 GPs belonging to the Wessex Research Network. The key findings were:

- 253 (95.1 %, 95% CI 91.8-97.4) had blood pressure documented after their MI.
- 216 of 234 patients eligible for aspirin (92.3%; 95% CI 88.1-95.4) had been recommended treatment.
- The provision of advice on smoking cessation was documented for 27 of 33 continuing smokers (81.8%; 95% CI 64.5-93.0).
- However, only 73 of 236 patients eligible to attend a structured rehabilitation programme (30.9%; 95% CI 25.0-36.8) were documented as having received rehabilitation.
- Of 89 patients with heart failure following MI, 33 (37.1%; 27.1-48.0) had no record of having been offered treatment with an ACE inhibitor.

- Total cholesterol measurement was documented for only 144 patients (54.1%; 95% CI 48.1-60.1).
- The authors estimate that there is still the potential to prevent between four and nine deaths in this group of 266 surviving patients in the next two years by further improving the quality of follow-up care.
- Preventive care in patients with proven ischaemic heart disease in general practice remains haphazard, even among doctors enthusiastic to participate in research and to audit their quality of care.

In the study by *Vartiainen (1998)*, predicted changes in mortality from IHD among people aged 30-59 years (calculated on the basis of risk factor levels assessed by cross sectional population surveys conducted between 1972 and 1987) were compared with the observed mortality changes in the total population by occupational group.

Findings of note include:

- In men, the changes in diastolic blood pressure, total serum cholesterol, and smoking predicted a 28% decline in the mortality from IHD among white collar workers, a 30% decline among blue collar workers, and a 33% decline in farmers.
- Observed declines in the same socio-economic groups were 61%, 40%, and 37%, respectively.
- In women, the predicted decline was 41% among white collar workers, 35% among blue collar workers, and 39% among farmers.
- The respective observed declines were 57%, 43%, and 20%.
- Less than half of the decline in IHD mortality among white collar men was explained by the risk factor changes, while they explained 75% of the decline among blue collar men and 89% of the decline among male farmers.
- Changes in risk factors did not explain the increasing difference in IHD mortality between the socio-economic groups, especially among men.

Karter (1998) reported that:

- Between 1985-1991, the mortality for IHD and stroke was generally highest for African Americans, intermediate for non-Hispanic whites, and lowest for Hispanics.
- Age-adjusted mortality for IHD declined significantly in all sex-racial or -ethnic groups except African-American women, and stroke rates declined significantly in all groups except African-American and Hispanic men.
- African Americans had excess IHD mortality relative to non-Hispanic whites until late in life, after which mortality of non-Hispanic whites was higher.
- Similarly, African Americans and Hispanics had excess stroke mortality relative to non-Hispanic whites early in life, whereas stroke mortality in non-Hispanic whites was higher at older ages.
- The lower IHD and stroke mortality among Hispanics was paradoxical, given the generally adverse risk profile and socio-economic status observed among Hispanics.
- A very high prevalence of self-reported cardiovascular disease risk factors in the period 1994-1996 (particularly hypertension, leisure-time sedentary

lifestyle, and obesity) is a serious public health concern, with implications for future trends in cardiovascular disease mortality.

Suadicani (1997) conducted a six year follow up (1985/6 to 1991) of 2,974 males aged 53-75 years (mean 63) without overt cardiovascular disease as part of the Copenhagen Male Study. Key findings included:

- During the six year follow-up, 184 men (6.2%) had a first IHD event.
- Compared to higher social classes (classes I, II and III), lower classes (classes IV and V) had a significantly ($p < 0.05$) increased risk of IHD (age-adjusted RR=1.44; 95% CI 1.1-1.9; $p = 0.02$).
- After multivariate adjustment for age, blood pressure, serum lipids, physical activity, and smoking, the RR dropped to 1.38 (95% CI 1.0-1.9; $p = 0.05$).
- Some newly identified risk factors were significantly associated with increased risk of IHD as well as with low social class:
 - a low serum selenium concentration
 - a low level of leisure time physical activity in midlife
 - long-term exposure to soldering fumes
 - abstention from or a low consumption of wine and strong spirits.
- After adjustment for these factors also, the RR dropped to 1.12 ($p = 0.54$).
- The results of this study suggest that potentially modifiable risk factors associated with lifestyle and working environment are strong mediators of social inequalities in risk of ischaemic heart disease.

Davey-Smith (1998) found that:

- Both the area-based deprivation indicator and individual social class were associated with generally less favourable profiles of cardiovascular disease risk factors at the time of the baseline screening.
- The exception was plasma cholesterol concentration, which was lower for men and women in manual social class groups.
- Independent contributions of area-based deprivation and individual social class were generally seen with respect to risk factors and morbidity.
- All cause and cardiovascular disease mortality rates were both inversely associated with socio-economic position whether indexed by area-based deprivation or social class.
- The area-based and individual socio-economic indicators made independent contributions to mortality risk.

Geyer (2000) analysed data on 84,814 employed men and women between 25 and 65 years of age who were insured between 1987 and 1995 for at least 150 days. It was found that:

- The three indicators were statistically associated, but not strong enough to warrant the conclusion that they share the same empirical content.
- The relative risk (hazard rate) for income by controlling for occupational position and gender for the highest as compared with the lowest category was 1.99 (95% CI 1.66, 2.39).
- The corresponding relative risk for income by controlling for qualification and gender was 2.03 (95% CI 1.68, 2.46).

- In both multivariate analyses, the effects of occupational position and qualification were no longer interpretable because of large confidence intervals.
- In sum, income related relative mortality risks were the comparably highest, while qualification and occupational position were no longer substantial.
- In conclusion, mortality related effects of income override those of the other socio-economic status indicators.

Byers (1998) surveyed by telephone a random sample of approximately 68,000 men and women ages 45-74. Data from these interviews were used to estimate state-specific prevalences of smoking, overweight, physical inactivity, hypertension, elevated cholesterol, diabetes, and alcohol abstinence. These seven CHD risk factors were also combined to create a CHD risk index for each state. The key findings were:

- The prevalences of most of the CHD risk factors correlated with CHD mortality rates in the expected directions, and correlations were similar for men and women.
- The CHD risk index correlated strongly with CHD mortality for both men ($r = 0.75$) and women ($r = 0.80$).
- About 60% of the variance in CHD mortality between the states in the United States (56% for men and 64% for women) is attributable to differences between the states in the prevalence of seven established risk factors for CHD.
- Health agencies should consider the potential benefits of increased efforts to reduce the prevalence of modifiable CHD risk factors in their populations to reduce CHD mortality.

Luoto (1998) analysed data from random samples of annual adult health behaviour surveys from 1978 to 1991 including 8,869 men and 10,105 women aged 45-64 years. Deaths were followed up to 1993. The study period was divided into four phases on the basis of number of deaths and timing of health behavior changes. In the models age, education, chronic morbidity, and body mass index were adjusted for. It was reported that:

- Each unhealthy behavior was found to be a risk factor for cardiovascular mortality when the whole study period was examined.
- Among men, daily smoking was a significant predictor of cardiovascular mortality in the first three phases, among women in the first and third phase.
- Among men physical inactivity became significant only in the last phase, among women in all except the last phase.
- The combinations of physical inactivity with use of dairy fat or with smoking were more significant for women than for men.
- The combination of smoking and use of dairy fat was significant only for men.
- The association of the index with cardiovascular mortality was slightly stronger among women than among men.
- The predictive values of unhealthy behaviors on cardiovascular mortality changed by period depending on their frequency.

- The combinations of unhealthy behaviors are to be preferred over the index in description of lifestyle determinants of cardiovascular mortality.

Bryce (1994) reported the following:

- CHD mortality rates decreased in England in the 1980s.
- However, the change in standardised mortality rates varied around the country.
- This geographical variation is typical of other countries that have recently experienced a reduction in the CHD epidemic.
- It appears that trends in declining CHD mortality rates vary between age and sex groups in the population.
- Overall health gain across the country is being achieved at the cost of greater inequality in health between areas, particularly for older people.

Haapanen-Niemi (1999) estimated population attributable risks for Finnish men aged 30-63 years (from six studies with 1,340-7,928 subjects) who were followed up for between seven and 30 years. The author reported that:

- The theoretical estimates of population attributable risks derived from published studies were as follows:
 - smoking 10-33%
 - high total cholesterol 9-21%
 - hypertension 6-15%
 - overweight 3-6%
 - low level of leisure-time physical activity 22-39%.
- These estimations, based on observed mortality rates and risk factor prevalences, suggest that, even if modest estimates are used, the burden from coronary heart disease deaths can be substantially reduced by converting the risk factors to more healthy levels.
- The results also suggest that efforts to increase physical activity deserve as much consideration as those aimed at influencing more traditional risk factors.

Birkhead (1999) presented the following details in relation to mortality from coronary heart disease. In 1990 coronary heart disease (CHD) accounted for 30% of male and 23% of female deaths. 79% of the male deaths from CHD and 93% of female deaths from CHD occurred over the age of 65. Nevertheless, CHD accounted for 40% of male deaths under 65 years and 19% of female deaths. It should be noted that mortality rates in England from myocardial infarction are higher:

- in social class V than in social class I
- in those living in the north of England than in the south
- in those born in the Indian sub-continent than those born in England.

England and the other parts of the UK have some of the highest standardised mortality rates for coronary heart disease in Western Europe. These have been declining gradually over the last twenty years.

Age-specific mortality rates for acute myocardial infarction (AMI) allow for the impact of this condition on premature deaths to be identified and also for the way the recording of the underlying cause of death varies with age. For patients aged 65 and

over there is evidence of significant over-recording of myocardial infarction as the underlying cause of death. Simultaneous reporting of the mortality rate for all underlying causes in the category of coronary heart disease (including AMI), will act as a proxy for the burden of ischaemic heart disease from which AMI arises.

Rudd (1999) presented the following details in relation to mortality from stroke. In 1990 stroke accounted for 9% of male and 15% of female deaths. More than 90% of these deaths were in people aged over 65 years. It should be noted that:

- mortality from stroke is higher in the winter and lower in the summer months
- mortality rates from stroke are higher in social classes IV and V than in social class I
- mortality rates are higher in the North of England than in the South
- for several decades the mortality rates have been declining in Western countries but recently this fall may have slowed
- age standardised death rates in England have fallen by about 20% between 1984 and 1992 but because of the increased number of elderly, total stroke deaths only fell by 7% during the same period.

Suicide

The studies examining mortality from suicide that have been reviewed are:

- *Baxter (1999)* estimated the long-term risk of suicide in a sample of 7,921 individuals identified from the Salford Psychiatric Case Register. Mortality by suicide or undetermined external cause during a follow-up period of up to 18 years was determined using the NHS Central Register.
- *Ringback (1998)* examined avoidable mortality during the period 1986-1990 for more than 30,000 psychiatric patients discharged from any hospital of Stockholm County between 1981 and 1985.
- *Kelleher (1996)* explored the changing relationship between rates of suicide and undetermined death in Britain and Ireland in a longitudinal analysis of official statistics relating to unnatural deaths between 1976 and 1992.
- *Kposowa (2000)* examine the effect of marital status on the risk of suicide, using a large nationally representative sample from the National Longitudinal Mortality Study, based on the 1979-1989 follow up.
- *Prete (1999)* investigate whether either the condition of being unemployed, or changes in unemployment rates are associated with suicide risk by analysing administrative data on 20,457 deaths by suicide registered in Italy among economically active people from 1982 to 1994.
- *Kelly (1995)* examined the effect of occupation and geography on suicide mortality in England and Wales for the period 1982-1992.
- *Simon (1998)* examined suicide mortality among members of a large health plan in Washington State, who were treated for depression during 1992, 1993, and 1994.
- *Canetto (1995)* reviewed the national and international epidemiological data on suicide mortality and then discussed the implications for primary prevention.
- *Moscicki (1995)* presents the epidemiology of suicide and discusses the known risk factors for suicide.

- *Sorenson (1996)* examined immigrant and ethnic group factors in trends in youth suicide in California.
- *Pirkis (1998)* reports on a systematic review of the literature in relation to the role that mental health care providers and general practitioners have to play in suicide reduction.
- *Appleby (1999)* described the clinical circumstances in which psychiatric patients commit suicide in a national clinical survey in England and Wales of 10,040 suicides notified to the study between April 1996 and March 1998.
- *Fombonne (1998)* tested hypotheses on the possible links between the secular increase in the rates of suicide, depression, conduct disorder, crime and substance misuse, using a data set on 6,091 subjects aged 8-18 years (58.4% boys) referred to psychiatric services over a 21 year period (1970-1990).
- *Rost (1998)* tested the hypothesis that, because there are fewer per capita providers trained to deliver mental health services in rural areas, depressed rural individuals would receive less out-patient treatment and report higher rates of hospital admittance and suicide attempts than their urban counterparts.
- *Beautrais (1998)* used a case-control design to compare 129 young people who made serious suicide attempts with 153 randomly selected community controls on a series of measures of lifetime, prior year, and prior month contacts with psychiatric services.
- *Ferrada-Noli (1997)* compared the suicide statistics for two high-income areas and two low-income areas of Stockholm county (with, respectively, low and high proportions of immigrant residents) in relation to health and socio-economic factors to ascertain whether differences in such indicators might explain the overrepresentation of immigrants previously found in cases of definite and undetermined suicide.
- *Heila (1998)* compared communication of suicidal intent (CSI), as well as previous suicide attempts known by the next of kin and/or an attending health care professional during the latest treatment relationship, among suicide victims with DSM-III-R schizophrenia (n=86; n=64 in the active illness phase) and others (n=1109; n=666 without any evidence for psychosis) as part of the National Suicide Prevention Project in Finland, a nationwide psychological autopsy study.
- *Cantor (1998)* explored the conceptual basis of limiting access to potential methods of suicide as a public health measure in a review of the literature.
- *Anderson (1999)* reviewed the literature surrounding the issue of deliberate self-harm and suicide in young people.
- *Berglund (1998)* conducted a review on the influence of alcohol drinking and alcohol use disorders on psychiatric disorders and suicidal behaviour.
- *McQuillan (2000)* reviewed the literature on the risk factors related to teenage suicide in the United States and Puerto Rico.
- *King (1998)* discusses the implications of adopting a human developmental perspective for suicide prevention.
- *Schweitzer (1995)* investigated the prevalence and demographic correlates of suicidal ideation and behaviours among 1,678 undergraduate university students in Australia and the utilisation of mental health services by this population.
- *Altamura (1999)* investigated the distribution of suicide as to month and seasons by analysing data on suicides in Cagliari (Italy) for the period 1990-1994.

- *Cavanagh (1999)* carried out a retrospective case-control comparison of 45 cases of suicide/undetermined death with 40 living controls using psychological autopsy in South East Scotland.
- *Hawton (1999)* investigated the characteristics of a series of 174 (148 males and 26 females) consecutive cases of suicide (or accidental death, excluding traffic accidents, where the circumstances strongly suggested suicide) in people aged under 25 years,
- *Repper (1999)* undertook a review of the UK literature on suicide and parasuicide at population and individual levels in order to inform the role of a specialist 'suicide prevention nurse' based in an Accident and Emergency department.
- *Mino (1999)* attempts to give an overview of studies of the relations between substance abuse, suicidal ideation, suicide, and drug-related death.
- *Links (1999)* reviewed randomised controlled trials of psychosocial interventions by family doctors for management of people after suicide attempts.
- *Jamison (2000)* discusses the relationship between suicide and common psychiatric disorders.
- *Goldney (2000)* discusses issues related to the prevention of suicide from a global perspective.
- *Baldessarini (1999)* reports on the main findings and conclusions from an international symposium on the epidemiology, psychobiology, and effects of medical treatment on suicidal behaviour.
- *Jamison (1999)* summarises current knowledge on the effects of medical interventions on suicidal behaviour.
- *Simpson (1999)* discusses the risk of suicide in patients with bipolar disorder.
- *Angst (1999)* reviewed the literature on suicide risk in patients with major depressive disorder.

Baxter (1999) reported that:

- Suicide risk was increased more than ten-fold in mentally ill people of both genders: the rate ratio for males was 11.4; for females it was 13.7.
- The risk was highest in young patients, but high risk continued into late life.
- The diagnoses with the highest risk were schizophrenia, affective disorders, personality disorder and (in males) substance dependence.
- Risk was also associated with recent initial contact and number of admissions but not co-morbidity.

Ringback (1998) reported that:

- Standardised rate ratios were calculated for psychiatric patients compared to the general population of Stockholm County for indicators of avoidable mortality, suicide, other mortality ('unavoidable') and causes possibly related to treatment with psychotropic drugs.
- As expected, the psychiatric patients had the most pronounced elevated risk for suicide. i.e. 6- to 24-fold compared to the general population, and noticeably more elevated for women.
- It is also noteworthy that the relative mortality risks for diagnoses amenable to medical interventions and potential side-effects of

psychotropic drugs are higher than for other causes of death ('unavoidable').

- The relative risks for avoidable mortality were 4.7 for men and 3.8 for women and for diagnoses possibly related to side-effects of psychotropic drugs, 7.2.
- The relative risks for 'unavoidable' mortality were 3.4 for men and 3.2 for women. The excess avoidable mortality rates for psychiatric patients and the elevated suicide risk, especially for female patients, are warning signals of shortcomings in psychiatric care that warrants further investigation.

In the study by *Kelleher (1996)* rates of suicide and undetermined deaths were age adjusted to the standard world population. The main results were:

- The official Irish male suicide rate is now much higher than that of England and Wales while the female rates are broadly similar.
- The rate of undetermined deaths has risen amongst English males and remained stable for females but has significantly fallen off among both Irish males and females.
- The proportion of deaths classified as 'undetermined' is now very much less in Ireland than in England and Wales.
- National plans for suicide prevention in either country cannot be properly audited unless improved procedures are put in place to increase the validity and reliability of the official suicide figures.

In the study by *Kposowa (2000)* adjustments were made for age, sex, race, education, family income, and region of residence in estimating the effect of marital status. It was found that:

- For the entire sample, higher risks of suicide were found in divorced than in married persons.
- Divorced and separated persons were over twice as likely to commit suicide as married persons (RR=2.08, 95% CI 1.58-2.72).
- Being single or widowed had no significant effect on suicide risk.
- When data were stratified by sex, it was observed that the risk of suicide among divorced men was over twice that of married men (RR=2.38, CI 1.77-3.20).
- Among women, however, there were no statistically significant differentials in the risk of suicide by marital status categories.
- The study observed that failure to control for relevant socio-economic variables could produce misleading results.

Preti (1999) reported that:

- Suicide rates among the unemployed are clearly and constantly higher than those among the employed: up to three times higher among men, and twice as high among women.
- Among the unemployed a clear and significant rise in suicide rates in both sexes took place over the study period; suicide rates among the employed showed a less marked increase.
- The rise in suicide rates was accompanied by a concurrent rise in unemployment rate percentage. Men seem to be affected most by this

change in unemployment rate percentage; women are subject to less evident influences and variations.

- In conclusion, different suicidal behaviour trends among unemployed compared with employed people indicate that unemployment (and above all the prospect of not having access to a working role) acts as a contributing factor for suicide.
- Unemployment, even if symptomatic of a mental disorder, should therefore always be taken into consideration as a risk factor for suicide.

Kelly (1995) reported that:

- For both men and women the highest risk occupations are mostly in Social Class I and II.
- The occupations at highest risk, which include several medical-related professions, and the method of suicide they choose, suggest that easy access to means of suicide is an important factor.
- Suicide rates for men aged 15-44 are generally higher in Inner London, rural areas, resort and retirement areas, and urban manufacturing areas.

Simon (1998) used computerised death certificate data to identify all deaths and all suicide deaths in the study sample before January 1995. It was reported that:

- During the study period, 35,546 individuals received some treatment for depression and accounted for 62,159 person-years of follow-up.
- Of 850 deaths, 36 (4.2%) were classified as definite or possible suicides.
- Overall suicide mortality rate was 59 per 100,000 person-years, and was significantly higher among men than women (118 vs. 36 per 100,000 person-years, respectively).
- Risk per 100,000 person-years was:
 - 224 among patients who received any in-patient psychiatric treatment
 - 64 among those who received out-patient specialty mental health treatment
 - 43 among those treated with antidepressant medications in primary care
 - 0 among those treated in primary care without antidepressants.
- These data suggest that overall suicide risk among patients treated for depression is considerably lower than previous estimates based on specialty and in-patient samples.
- Risk is strongly related to treatment history - a likely indicator of illness severity.

Conclusions from the review by *Canetto (1995)* were:

- Suicide mortality appears to be highest among individuals (e.g., young adult married females in some Papua New Guinea regions; older adult, isolated, White males in the United States) for whom such behavior is culturally sanctioned.
- Thus, an important target for primary prevention may be local cultures of gender and suicide.

Conclusions from the study by *Moscicki (1995)* include:

- Mental and addictive disorders are the most powerful of the multiple risk factors for suicide in all age groups.
- Since risk factors for suicide rarely occur in isolation, prevention efforts are more likely to succeed if multiple risk factors are targeted.

Sorenson (1996) reviewed 32,928 California death certificates from 1970 to 1992.

Findings were:

- Although foreign-born persons are consistently under-represented in the suicide deaths of 15- to 34-year-olds (risk ratio = 0.60), any foreign-versus U.S.-born difference by ethnicity appears to be decreasing.
- Specifically, although Hispanics born outside the United States consistently are at significantly lower risk of suicide than U.S.-born Hispanics, the discrepancy between the two groups has diminished over time.
- In a comparable trend, non-Hispanic white persons born outside the United States were at higher risk of suicide than their U.S.-born counterparts until 1990, when their risk became similar.
- Black and Asian/other foreign- and U.S.-born persons have been at statistically similar risk since 1970.
- A man using a firearm at home was the typical pattern for both the foreign- and U.S.-born.

Pirkis (1998) reported that:

- Among those in the general population who commit suicide, up to 41% may have contact with psychiatric in-patient care in the year prior to death and up to 9% may commit suicide within one day of discharge.
- The corresponding figures are 11 and 4% for community-based psychiatric care and 83% and 20% for general practitioners.
- In conclusion, among those who die by suicide, contact with health services is common before death.
- More work is needed to determine whether these people show characteristic patterns of care and/or particular risk factors which would enable a targeted approach to be developed to assist clinicians in detecting and managing high-risk patients.

Findings from the study by *Appleby (1999)* include:

- 10,040 suicides were notified to the study between April 1996 and March 1998, of whom 2370 (24%; 95% CI 23-24%) had had contact with mental health services in the year before death.
- Data were obtained on 2177, a response rate of 92%.
- In general these subjects had broad social and clinical needs.
- Alcohol and drug misuse were common.
- 358 (16%; CI 15-18%) were psychiatric in-patients at the time of death, 21% (CI 17-25%) of whom were under special observation.
- Difficulties in observing patients because of ward design and nursing shortages were both reported in around a quarter of in-patient suicides.
- 519 (24%; CI 24-26%) suicides occurred within three months of hospital discharge, the highest number occurring in the first week after discharge.

- 914 (43%; CI 40-44%) were in the highest priority category for community care.
- 488 (26% excluding people whose compliance was unknown; CI 24-28%) were non-compliant with drug treatment.
- 486 (28%; CI 26-30%) community patients had lost contact with services.
- Most people who committed suicide were thought to have been at no or low immediate risk at the final service contact.
- Mental health teams believed suicide could have been prevented in 423 (22%; CI 20-24%) cases.
- Several suicide prevention measures in mental health services are implied by these findings, including measures to improve compliance and prevent loss of contact with services.
- In-patient facilities should remove structural difficulties in observing patients and fixtures that can be used in hanging.
- Prevention of suicide after discharge may require earlier follow up in the community.
- Better suicide prevention in psychiatric patients is likely to need measures to improve the safety of mental health services as a whole, rather than specific measures for people known to be at high risk.

Fombonne (1998) conducted a detailed analysis of a random sample of 80 case notes. Key findings include:

- Suicidal behaviours increased significantly among pubertal male adolescents only (n = 1313). In this sub-sample, substance misuse accounted for the increase over time.
- The rates of both suicidal behaviours and of substance misuse almost doubled between 1979 and 1990 in this patient group.
- The case note analysis showed that solvent and alcohol misuse had also increased over the study period.
- Moreover, among the subjects misusing substances, alcohol was the only substance with a strong and positive association with suicidal behaviours.
- Substance misuse pre-dated suicidal behaviours in most patients.
- In conclusion, a link has been found between the increase over time of suicidal behaviours in adolescent boys and a contemporaneous increase in substance misuse.
- The strength and direction of the association suggests that alcohol misuse is the causal factor.

Rost (1998) recruited 74% of eligible participants (n=470) from a 1992 telephone survey and followed up 95% of subjects for one year. The author reported that:

- Although there were no rural-urban differences in the rate, type, or quality of out-patient depression treatment, rural subjects made significantly fewer specialty care visits for depression.
- Depressed rural individuals had 3.06 times the odds of being admitted to the hospital for mental health problems (p=0.08) during the year.
- Rural subjects reported significantly more suicide attempts during the one year period (p=0.05).

Beautrais (1998) found that:

- Of those who made serious suicide attempts:
 - 78.3% had a lifetime history of contact with health services for psychiatric reasons
 - 72.1% reported contact within the year preceding the suicide attempt
 - 58.9% reported contact within the month preceding the suicide attempt
 - 29.5% had a lifetime history of psychiatric hospital admission.
- Within the year preceding the suicide attempt:
 - 21.7% had been admitted to a psychiatric hospital
 - 67.4% had out-patient consultations for psychiatric problems.
- Multiple logistic regression suggested that the best psychiatric service predictors of risk of serious suicide attempt were:
 - admission within the preceding year ($p < 0.005$)
 - out-patient consultation within the preceding month ($p < 0.0001$).
- Young people making serious suicide attempts had vastly elevated rates of a range of psychiatric contacts including hospital admissions and out-patient consultations.
- These findings imply that the development of improved treatment and management strategies for young people with psychiatric morbidity may be a very effective approach to reducing youthful suicidal behaviours.

Ferrada-Noli (1997) summarised the findings as follows:

- The suicide rate was higher in the low-income areas, irrespective of ethnicity, and highest in the immigrant population of the low-income areas that accounted for 82% of all immigrants in the areas studied.
- The suicide rate was inversely correlated with the respective figures for mean municipality-income indices.
- Over the four year study period, the annual suicide rate increased among immigrants and decreased among native Swedes.
- Of all categories investigated, immigrants from the low-income areas were characterised by the highest suicide rate (39 per 100,000) and the lowest mean annual income among the suicide victims, and native Swedes from the high-income areas by the lowest suicide rate (16.2) and the highest mean income.
- The low-income areas manifested also lower mean duration of hospitalisation in primary care and psychiatric facilities, although the frequency of psychiatric consultations, was higher in low- than in high-income areas.
- Interrelations among low income, immigrant status, and poor benefit of psychiatric care suggest that proneness to suicidal behaviour among immigrants may have a social psychiatric explanation.

Heila (1998) summarised the results as follows:

- More victims with schizophrenia (84%) had a history of previous CSI, and/or had made previous suicide attempt(s) than others (70%).

- Also, victims with active illness schizophrenia (56%) had more CSI and/or had made suicide attempts during their last three months than victims with no psychosis (41%).
- CSI and/or suicide attempts occur at least as often in people with schizophrenia as in those without schizophrenia, even in the active phase of the illness.
- This contradicts the common belief that suicides among people with schizophrenia are impulsive and occur unexpectedly.

Cantor (1998) summarised the findings as follows:

- Both physical availability and socio-cultural acceptability are important determinants of choice.
- There is considerable evidence of an association between method availability and method specific suicide rates.
- There is also evidence that restriction of method availability is often associated with a reduction in method specific suicide rates.
- There is some evidence that restrictions on method availability under certain conditions may reduce overall suicide rates.
- Suicide methods employed by young Australians are changing, with a disturbing rise in frequency of hanging and car exhaust suicides slightly offset by a decline in firearm suicides.
- Opportunities exist for further reducing firearm suicides and addressing exhaust suicides by practical measures.
- There are also obvious options for changing prescribing practices with respect to more lethal medications (e.g. tricyclic antidepressants).
- However, the rise in hanging seems problematic from this perspective and in need of ecological study.

The review by *Anderson (1999)* highlights important issues to be addressed in practice:

- In particular, the evidence supports the influence of mental illness in deliberate self-harm and suicide, particularly depression and substance abuse.
- However, a clearly important factor is an individual's experience of family and social life.

Conclusions from the review by *Berglund (1998)* were:

- Epidemiological and clinical studies confirm high co-morbidity of substance use disorders and other mental disorders.
- Alcohol abuse worsens the course of psychiatric disorders.
- Light to moderate alcohol consumption has no documented positive effect on the course. Levels of risk consumption of alcohol in psychiatric disorders have not been well defined.
- One fifth to one third of increased deaths rate among alcoholics is explained by suicide.
- In countries with high alcohol consumption, the suicide rate is also high and is increasing with total increased alcohol consumption.

- Co-morbidity is common among suicide victims, and substance use disorders are most frequently combined with depressive disorders.
- Interpersonal loss within six weeks before suicide is more often present among alcoholics than non-alcoholic suicide victims.

McQuillan (2000) concluded that there is an interplay of multiple risk factors in adolescent suicide including:

- depression
- homosexuality (due to the hostility that is often experienced by the person)
- sexual abuse
- lack of coping
- social and problem-solving skills stemming from family dysfunction
- feelings of isolation and helplessness
- contagion
- gender differences
- alcohol and drug abuse
- psychiatric disorders
- biological factors
- natural disasters.

King (1998) emphasises the need to:

- consider multiple pathways to suicide prevention
- place renewed emphasis on prevention strategies that have their impact earlier in the life course and earlier in the course of mental disorder
- collaborate with prevention specialists and advocates in related fields.

Schweitzer (1995) used a modified Suicide Ideation Scale (SIS) and questionnaire. It was reported that:

- 62% of students surveyed showed some suicidal ideation and 6.6% reported one or more suicide attempts.
- Over half of the group who reported suicide attempts did not use any type of mental health services.
- Suicidal ideation was highly correlated with previous use of mental health services.
- In examining the relationship between suicidal ideation and demographic variables, suicidal ideation was not significantly different for gender or parental marital status but was related to living arrangements, racial groups, religious affiliation and father's education.
- The results suggest that a higher proportion of students reported suicidal ideation and behaviours than that documented in related studies undertaken in the USA.
- While these findings draw attention to a higher level of suicidal ideation in students who utilise mental health assistance, more than half of those who reported suicide attempts did not use any kind of mental health service.

Altamura (1999) reported the following findings:

- Two seasonal rhythms, i.e. an annual and a semi-annual rhythm, accounted for 25% of the variation in the total number of suicides.
- The peak number of suicides occurred in February with a second less significant peak in June and July.
- Lows were found in November and December.
- Age and gender did not significantly affect the seasonal rhythms in suicide.

Cavanagh (1999) presented the following results:

- Cases and controls did not differ significantly in severity of mental disorder.
- The main factors independently associated with undetermined death or suicide were:
 - a history of deliberate self-harm (adjusted OR=4.1)
 - physical ill health (adjusted OR=7.8)
 - engagement by mental health services (adjusted OR=0.01).
- Other antecedents associated with increased risk (criminal record, police involvement, financial problems and failure to vote) and those associated with decreased risk (contact with a doctor and in-patient care) did not exert effects after controlling for confounding.
- In conclusion, controls were receiving more care of whatever kind.
- Treatment of mental disorder co-morbid with physical illness and a history of deliberate self-harm may be especially important.
- Factors that separate those with mental disorder at high risk from those at lesser risk relate to care levels provided, which may be a function of engagement by and with health services.
- The role of mental health professionals is beneficial in suicide prevention.

Hawton (1999) examined coroners' inquest notes, general practitioners' records and psychiatric case notes. Findings presented include:

- More individuals were of lower social class and unemployed than in the local population.
- Hanging and carbon monoxide poisoning were the most frequent methods of suicide, and coproxamol was the drug most often used in overdoses.
- Previous self-harm had occurred in 44.8%, nearly half of these having carried out multiple episodes and 80% having self-harmed within the previous year.
- Little support was found for an earlier finding of increasing frequency of general practitioner visits shortly before death.
- Only 22.4% of individuals were in the care of psychiatric services.
- The authors conclude that diverse strategies are required to prevent suicide in the very young.

Conclusions from the review by *Repper (1999)* include:

- Three distinct groups of A&E attendees at particular risk of suicide were identified:
 - patients attending A&E following deliberate self-harm
 - attendees with specific physical problems

- attendees with a known history of mental health problems.
- Action to reduce suicide needs to be taken at all levels of the organisation.
- The role of the specialist 'suicide prevention nurse' working in A&E needs to include support, training and development as well as specific time limited therapy with a highly targeted group of patients at specific risk.

Mino (1999) summarises findings from the review as follows:

- Research in this field is hampered by the absence of clear definitions, and results of studies are rarely comparable.
- There is, however, consensus about suicidal ideation being a risk factor for suicide attempts and suicide.
- Suicidal ideation is also a predictor of suicide, especially among drug users.
- Suicidal ideation is correlated with:
 - absence of family support
 - severity of the psychosocial dysfunctioning
 - multi-drug abuse
 - requests for treatment.
- Every clinical examination of a drug user, not only of those who are depressed, should address the possible presence of suicidal ideation, as well as its intensity and duration.

Links (1999) reported that:

- Suicide attempts are more common than suicides.
- Up to two thirds of patients who take their lives by suicide have seen a family physician in the month before their death.
- Principles of care after a suicide attempt include:
 - actively engaging the patient
 - involving the family
 - restricting access to means of suicide
 - developing intervention plans to deal with the psychopathology that has placed the patient at risk.
- In conclusion, family doctors have a crucial role in preventing suicide through aftercare and ongoing monitoring of patients who have attempted suicide.

Jamison (2000) presents the following findings:

- Suicide, which is both a stereotypic yet highly individualised act, is a common endpoint for many patients with severe psychiatric illness.
- The mood disorders (depression and bipolar manic-depression) are by far the most common psychiatric conditions associated with suicide.
- At least 25% to 50% of patients with bipolar disorder also attempt suicide at least once.
- With the exception of lithium (which is the most demonstrably effective treatment against suicide) remarkably little is known about specific contributions of mood-altering treatments to minimising mortality rates in persons with major mood disorders in general and bipolar depression in particular.

- Suicide is usually a manifestation of severe psychiatric distress that is often associated with a diagnosable and treatable form of depression or other mental illness.

Goldney (2000) reports that:

- Each year about a million people worldwide take their lives, and a further unknown number, but probably no less than 20 million, attempt suicide.
- In addition, for every person who engages in suicidal behaviour, another five or six will be associated with them in some way, making a conservative total of 100 million people worldwide who are affected each year.
- There is no one approach to suicide prevention.
- Reports support the notion of the universality of suicide.
- Despite considerable attention paid to the media, its influence on suicide is very limited.
- Although there have been pessimistic reviews, there are persuasive data from innovative research designs that indicate that we can prevent suicide.

Baldessarini (1999) summarises the findings as follows:

- Despite striking advances in the medical treatment of mood disorders in the past half-century, rates of suicidal acts have changed little in the general population.
- Evidence of reduction of long-term rates of suicidal acts in specific at-risk populations remains very limited, particularly persons with major affective illnesses and other common, primary or co-morbid psychiatric and substance use disorders.
- It is plausible that reduction of psychiatric morbidity should limit suicidal risk, but very little is known about specific effects of most psychiatric treatments or other interventions aimed at suicide prevention.
- An exception is substantial evidence of lower suicidal risk during long-term lithium treatment that was not equalled with carbamazepine.
- However, diagnosis and timely therapeutic interventions reach only a minority of psychiatrically ill persons at risk for suicide.
- Renewed efforts are strongly urged to:
 - improve public and professional awareness of risk factors for suicide
 - enhance earlier access to appropriate clinical assessment and increasingly safe and effective treatments for affective and psychotic disorders
 - encourage and support research to clarify specific benefits and risks of medical treatments and social interventions aimed at preventing suicide.

Jamison (1999) presents the following:

- Knowledge of effective means of preventing suicide, based on research evidence, is strikingly limited but there are indications that specific treatments may reduce suicidal risk in patients with major affective disorders.

- Experts believe that suicide is amenable to ethical scientific investigation and that evidence supporting suicide risk-reduction can be developed.
- Studies to test the effects of specific interventions on suicidal risk are encouraged.
- There is a need for greater public and professional education to:
 - understand suicide as a result of mood and other psychiatric disorders
 - improve their early recognition
 - enhance timely access to effective treatment by the psychiatric and general medical community.

Simpson (1999) reports that:

- Patients with bipolar disorder have a high risk of committing suicide but determining the exact risk is complicated.
- The lifetime suicide risk in bipolar disorder was believed to be 15% for many years; however, more recent evidence suggests that the lifetime suicide risk may be lower.
- The group of bipolar patients at highest risk of suicide are young men who are in an early phase of the illness, especially those who have made a previous suicide attempt, those abusing alcohol, and those recently discharged from the hospital.
- The risk is also increased in patients who are in the depressed phase of bipolar illness, who have mixed states, or who have psychotic mania.
- Lithium prophylaxis appears to decrease suicide attempts.

Conclusions from the literature review by *Angst (1999)* were:

- Most research has been performed on in-patient psychiatric populations, and extended follow-ups are rare.
- Mood disorders were found to be highly associated with suicide, especially in patients with major depressive disorder.
- Depression is an important factor in suicides of adolescents and the elderly, but those with late-onset depression are at higher risk.
- Both co-morbidity with other disorders, such as anxiety and agitation, and rapid changes in the depressive state, for instance after release from the hospital, increase the risk for suicide.

Avoidable mortality

Avoidable mortality is a selection of causes of death considered to be amenable to health care and thereby used as an indicator of the quality of health care. Variations in 'avoidable' mortality may reflect variations in the quality of care but they may also be due to variations in incidence or severity of diseases.

The studies examining avoidable mortality that have been reviewed are:

- *Albert (1996)* measured variations in the Holland and Charlton classifications of avoidable death causes and estimated the effect of the Spanish national health system on avoidable mortality in the Valencian Community 1975-1990.
- *Treurniet (1999)* studied the association between regional variations in avoidable mortality and variations in disease incidence for the period 1984-1994, and

analysed whether the proportion of in-hospital deaths can explain the regional variations in incidence-adjusted mortality for selected conditions.

- *Westerling (1996a)* examined whether regional variation in avoidable mortality could be explained by the proportion of deaths outside hospital in a study of mortality in 26 administrative health areas in Sweden during 1987-1990.
- *Westerling (1996b)* analysed socio-economic differences in potentially avoidable mortality in Sweden for the period 1986-1990 for the age group 21-64 years.
- *Westerling (1992a)* analysed trends in avoidable mortality by cause of death in Sweden during the period 1974-1985 for age groups 0-64 years.
- *Westerling (1992b)* analysed avoidable mortality in Sweden for the period 1974-1985 using a European Community (EC) Working Group list of avoidable death indicators. The list includes causes of death that in certain age groups were defined as indicators of the outcome of medical care intervention or for some conditions, indicators of the national health policies.
- *Suarez-Varela (1996)* examined mortality data for Valencia from 1982 to 1990 to determine whether or not the availability of medical care resources in the area influenced the occurrence of avoidable deaths.
- *Simonata (1998)* analysed trends of avoidable mortality in Europe for the period 1955-1994, emphasising causes of death amenable to primary prevention through reduction of exposures, secondary prevention through early detection and treatment, and tertiary prevention through improved treatment and medical care.
- *Holden (1998)* determine the pattern of deaths and potentially preventable factors in four general practices over a 40 month period.
- *Wood (1999)* examined the rates of mortality among different social classes and socio-economic groups of British Columbian males from causes of death amenable to medical intervention, excluding causes of death restricted to women as well as perinatal deaths.
- *Pampalon (1993)* examined the general features of and regional variations in avoidable mortality in Quebec, and made comparisons between two time periods (1969-73 and 1982-90).
- *Pilibosian (1999)* reported modifiable risk factors for mortality related to leading causes of death in 1996 in South Carolina.
- *Rene (1995)* examined mortality from 12 causes of death considered preventable by medical intervention in Texas from 1980 to 1989.
- *Onwuachi-Saunders (1999)* examined the preventability of deaths among persons aged 21 years and younger in Philadelphia that occurred in 1995.
- *Kerr (1999)* ranked the underlying causes of child deaths in Texas for the period 1989-1991.
- *Boman (1999)* conducted a retrospective analysis of causes of death and other characteristics of avoidable deaths in patients admitted to hospital after trauma in two areas of Sweden, and estimated and analysed changes in the avoidable death rate between 1988 and 1996.
- *Chiara (2000)* reviewed all trauma deaths occurring in the urban area of Milan during one year.
- *Luallen (1998)* investigated the potential usefulness of Georgia's child fatality review scheme legislated in 1990 for identifying preventable deaths from injury and sudden infant death syndrome (SIDS).

- *Rivara (1996)* described the changes in paediatric injury mortality from 1978 to 1991 and determined the number of preventable deaths with currently available intervention strategies.
- *Nissen (1997)* studied mortality and avoidable death in a cohort of 1,168 people with severe self-injurious behaviour (SIB) in the Netherlands.
- *Barry (1992)* presented data from the second European Community Atlas of Avoidable Death.
- *Gaizauskiene (1995)* analysed avoidable mortality in Lithuania as an index of the quality of health care and to assess trends in avoidable mortality from 1970-90 among those aged 0-64 years.
- *Dannenberg (1994)* reviewed the causes of death from intentional and unintentional injuries in women.
- *Kemp (1997)* reviewed the current epidemiology of childhood accidents and their prevention, and made recommendations for the future.

Albert (1996) used the classification by Holland to divide avoidable mortality into two groups - medical care indicators (MCI), which show the effectiveness of health care, and national health policy indicators (NHPI), which show the status of primary prevention. Key findings were:

- Between 1975 and 1990 avoidable mortality (only assessed by MCI) fell 63%, whereas the remainder of the mortality (non-MCI causes, that is all the non-avoidable causes together with the NHPI group) fell by 17%.
- Assuming that the mortality due to non-MCI causes indicates the overall effect of the environmental, social, nutritional, and genetic influences, then the difference between this and the MCI group provides an estimate of the actual effect of the intervention of the health system.
- The authors conclude that in the study community, the health system was responsible for approximately 47% of the total reduction in mortality from avoidable causes in the period studied.

Treurniet (1999) used linear regression to examine the relationship between mortality and incidence on the one hand, and between incidence adjusted mortality and in-hospital mortality on the other. The following results emerged:

- Significant regional mortality variations were found for cervical cancer, cancer of the testis, hypertensive and cerebrovascular disease, influenza/pneumonia cholecystitis/lithiasis, perinatal causes and congenital cardiovascular anomalies. Regional mortality differences in general were only partly accounted for by incidence variations.
- The only exception was cervical cancer, which no longer showed significant variations after adjustment for incidence.
- The contribution of in-hospital mortality variations to total cause-specific mortality variations varied between conditions: the highest percentage of explained variance was found for mortality from CVA (60.1%) and appendicitis (29.2%).
- Incidence data are a worthy addition to studies on avoidable mortality.
- It is to be expected that the incidence adjusted mortality rates are more sensitive for quality of care variations than the crude mortality variations.

Westerling (1996a) calculated the proportion of deaths outside hospital at the national level for certain conditions for which the acute medical management may be important to outcome. All death registrations in those aged under 70 years between 1987 and 1990 which gave diabetes, asthma, ischaemic heart disease, cerebrovascular diseases, or ulcer of the stomach or duodenum as the underlying cause of death were analysed. The key findings were:

- For asthma (58%) and ischaemic heart disease (54%), most deaths occurred outside hospital.
- For most causes of death, however, no correlation was found among the health areas between the proportion of deaths outside hospital and the SMR for mortality irrespective of the place of death.
- A high death rate was associated with a high proportion of deaths outside hospital, for diabetes in one area in the north of Sweden and for ulcer of the stomach and duodenum in one large municipality.
- In most cases, however, no evidence was found that regional variation in mortality could be explained by death outside hospital.

Westerling (1996b) reported the following:

- For all indicators studied, the death rates for those not in work were higher than for people at work.
- The largest differences were found for chronic bronchitis, diabetes, bacterial meningitis, ulcer of the stomach and duodenum, chronic rheumatic heart disease, asthma and hypertensive and cerebrovascular disease.
- For these causes of death the risk of dying was between 3.1 and 7.5 times greater in the non-working population than in the workforce.
- The differences in avoidable mortality between blue collar workers and white collar workers and the self-employed were, however, much smaller.
- For most of the indicators no significant differences were found.
- For ulcers of the stomach and duodenum, however the death rate for blue collar workers was 2.8 times higher than those for other categories in work.
- The greatly increased risk of mortality among the non-working population may be due to a 'healthy worker' effect.
- The measurement of socio-economic differences in mortality may be dependent on the time period chosen between occupational exposure and mortality outcome.

Westerling (1992a) reported the following:

- Total mortality declined during the 12 year period studied.
- Avoidable causes of death were grouped into preventable and treatable causes based on the classification by Rutstein of conditions which may serve as negative indicators of the quality of health care
- In females 22% of deaths and in males 18% of deaths had underlying causes that were included in the Rutstein list.
- Deaths from avoidable causes in the Rutstein list were concentrated to a limited number of causes of death and cause of death groups, such as neoplasms and diseases of the respiratory system.

- Both preventable and treatable conditions were found among the most common avoidable causes of death.
- In men, treatable diseases declined more during the 12 year period studied than did total mortality.
- When lung cancer was excluded, preventable diseases declined for both sexes.
- Certain avoidable causes of death decreased compared to total mortality, while some others showed an increase.
- The death rate increased for some avoidable causes of death such as pneumonia other than viral.
- In women death rates increased for chronic bronchitis and emphysema as well as for malignant neoplasms of trachea, bronchus, and lung, while for boys aged 1-14 years bronchitis NOS and asthma showed an increasing death rate.
- The study indicates that the avoidable mortality method is sensitive enough to describe important changes in the mortality pattern.
- The explicit definition of treatable and preventable causes of death constitutes a methodological development in epidemiological analysis of this type.

Westerling (1992b) presented the following findings:

- About 10 out of 14 medical health care indicators occurred in less than 50 cases per year.
- Death rates decreased over the 12 year period studied for most avoidable death indicators. However for women the death rate for malignant neoplasms of the trachea, bronchus and lung increased significantly.
- Swedish total mortality for ages 5-64 years was lower than the EC standards 1974-1978 and 1980-1984.
- Most of the avoidable causes of death had a relatively low standard mortality rate (SMR) when compared to both the EC standard and to the Swedish SMR for total mortality.
- For asthma the Swedish SMR was higher.

Suarez-Varela (1996) identified variations in mortality from avoidable causes, grouped according to the differences in levels of urbanisation and health care resources, in the 537 municipalities of the Valencian community. Linear regression analysis revealed that:

- Only in a small number of avoidable causes did the mortality trend for males differ significantly from zero ($p < 0.005$) in relation to different levels of urbanisation and health care resources.
- A direct association between these two variables was observed in males with regards to pneumonia, tuberculosis, chronic rheumatic heart disease, and bacterial infection.
- In females, a relationship between avoidable mortality rates and the differences in urbanization and health care resources was found in cervical cancer, pneumonia, abdominal hernias, and cholecystitis.

- Mortality from asthma and cardiovascular disease (in both males and females) declined faster in urbanised, high income areas than in rural areas.
- While these results demonstrate the considerable mortality risk associated with living in urban areas, very little correlation was found between health service access and mortality.

Simonata (1998) analysed five year death rates (standardised to the world population) for 21 countries of Europe for people aged 5-64 at time of death. It emerged that:

- Between 1955-59 and 1990-94, the reduction in mortality was somewhat greater for avoidable causes than for all causes: 45.8% vs. 45.1% for women and 39.3% vs. 32.6% among men.
- Reductions in mortality were greater for causes amenable to improved medical care: 77.9% among women and 76.3% among men.
- The smallest reduction in mortality was seen in women for causes amenable to secondary prevention (11.0%), and in men for causes amenable to primary prevention including tobacco related conditions (16.6%).
- From a geographical point of view, there were slight differences in trends between European regions, but overall the patterns were similar.

Holden (1998) reported the following:

- A total of 1263 deaths occurred among registered patients during the period of the audit.
- Preventable factors contributing to deaths were considered to be attributable to:
 - patients (40%) (mainly cigarette smoking, poor compliance, and alcohol problems)
 - general practice teams (5%) (mainly delayed referral, diagnosis and treatment, and failure to prescribe aspirin to patients with vascular disease)
 - hospitals (6%) (mainly delayed diagnosis and perceived treatment problems)
 - the environment (3%) (mainly falls, principally resulting in fractured neck of femur).

In the analyses by *Wood (1999)*, the population at risk was based on 20% samples of occupational data for men from the 1981, 1986 and 1991 censuses conducted by Statistics Canada. Key findings include:

- For almost every cause of death examined, the rate of mortality was higher in individuals of lower social and socio-economic classes than in individuals of the upper social and socio-economic classes.
- These results were consistent regardless of the social class component, education, occupation, or income was being measured.
- The mortality gradient was most notable in deaths due to hypertensive heart disease, tuberculosis, asthma and pneumonia and bronchitis.
- Specific measures aimed at improving survival from these conditions in lower social classes could help to amend the social class disparity.

Results from the study by *Pampalon (1993)* include:

- Avoidable mortality has dropped substantially in Quebec, except in the case of asthma, and now displays excellent scores at the international level.
- Only three causes of death show significant regional variations:
 - tuberculosis
 - hypertensive and cerebrovascular diseases
 - perinatal mortality.
- These variations are mainly associated with socio-economic factors but also with health services.

Findings from the study by *Pilibosian (1999)* include:

- Almost 70% of 34,035 deaths were due to chronic diseases.
- Results indicate that small modifications in individual lifestyles could prevent or delay nearly 50% of deaths in South Carolina annually.
- Tobacco use, diet and physical activity, and misuse of alcohol contribute to the largest number of deaths.
- Other modifiable behaviours contributing to the 50% mortality are microbial agents, toxic agents, firearms, sexual behaviour, motor vehicle accidents, and illicit use of drugs.
- The implication in these findings is that these risk factors for mortality are mainly modifiable.

Rene (1995) reported that:

- Between 1980-1989, an average of 1,543 deaths per year was attributed to these 12 selected causes of avoidable death in Texas.
- 32% of deaths were due to hypertensive heart disease, 30% to pneumonia and bronchitis, 11% to cervical cancer, and 6% to rheumatic fever.
- Pneumonia and bronchitis were the leading causes of death among those aged 15 to 44 years.

Findings from the study by *Onwuachi-Saunders (1999)* were:

- In 1995, 607 children ages 21 years and younger died in Philadelphia from:
 - natural causes (61.6%)
 - unintentional injuries (16.3%)
 - homicide (18.6%)
 - suicide (2.3%)
 - undetermined causes (1.2%).
- More than a third (37.2%) of all deaths were considered preventable.
- Of the injury deaths (n=224), 95% were judged to be preventable.
- Preventable fire/burn injury deaths (n=29) were associated with lack of a smoke detector, non-supervision of children, and faulty home appliances.
- Violent deaths were associated with substance abuse, gang involvement, chronic truancy, academic failure, and access to weapons.

Kerr (1999) found that:

- External causes (injuries) accounted for 66% of child deaths, while five other causes accounted for at least 100 deaths each: motor vehicle accidents, homicide, suicide, drowning, and burns.
- Of the deaths that had potential for primary prevention, more than 95% involved accidents, suicide, and homicide.
- Of the smaller number of deaths that had potential for secondary prevention, treatment of infectious conditions had the greatest potential.
- From 1987 through 1996, child deaths from all causes averaged 2,498 per year (871 from natural causes and 1627 from external causes)
- Mortality rates that increased were those from:
 - all causes in the group aged 15-19 years
 - natural causes in the group aged 10-19 years
 - suicide in the group aged 10-14 years;
 - homicide in all but the group aged 5-9 years.
- These trends suggest that primary prevention of child deaths in Texas should focus on external causes, particularly motor vehicle accidents, homicides, and suicides.

Boman (1999) reported the following:

- 70 (21%) out of 335 deaths in patients admitted to hospital after trauma were classed as avoidable.
- Among these 70 deaths:
 - 15 (21%) died of head injuries
 - 17 (24%) of thoracic, abdominal, or pelvic injuries
 - 38 (54%) of medical complications.
- The number of deaths after trauma decreased considerably from 1988-90 to 1994-96, but the proportion who died in hospital remained almost constant.
- The proportion of avoidable deaths decreased from 22% to 17%, mainly because the proportion of deaths from medical complications was halved.
- The standard of Swedish in-hospital trauma care has improved, particularly with a reduction in post-traumatic complications.

Chiara (2000) reported that:

- Overall trauma deaths were 255 with 78.0% blunt and 16.1% penetrating traumas. Burns accounted for 5.9%.
- Central nervous system injury and combined central nervous system injury and haemorrhage caused 171 (67.0%) deaths.
- 91 deaths occurred at the scene, 48 during transportation, 34 in the emergency room, and 33 were in-hospital deaths.
- Victims found dead (49 individuals) were excluded from further analysis.
- Two multidisciplinary commissions reviewed patient reports and classified 56.3% of deaths as non-preventable, 32.0% as possibly preventable and 11.6% as frankly preventable.
- The Injury Severity Score decreased from DOS to in-hospital deaths ($p < 0.05$).
- The preventability rate was higher for in-hospital deaths ($p < 0.05$).

Luallen (1998) examined childhood deaths in Georgia in 1991 by aetiology, county, risk factors, and preventability. Findings of note include:

- Injury or SIDS caused 33.2% of childhood deaths in Georgia in 1991.
- Child fatality review was most sensitive for investigating death from intentional injury (40.5%) and SIDS (35.3%).
- Review teams reassigned the cause of five deaths (2.0%) to child abuse or neglect.
- Overall, 29.0% of deaths were judged preventable.

Rivara (1996) reviewed the literature to determine the effectiveness of injury prevention strategies and estimated the number of preventable injury deaths in 1991 among children and adolescents aged 0-19 years. Findings include:

- The injury death rate declined by 26% over the 14 year period.
- Death rates of unintentional injuries decreased by 39%, with declines in all categories of unintentional injuries.
- Homicides increased by 67% and suicides by 17%; nearly all of this increase was in deaths from firearms.
- If currently available prevention strategies were fully used, 6,640 deaths could have been prevented, a further 31% decrease.
- The increasing problem of intentional injury will partly counterbalance the success in unintentional injury control.

Nissen (1997) reported that:

- Fifty-seven people died over a five year period (1990-1995).
- The observed mortality in the cohort studied was higher than expected.
- The age-specific mortality was highest in the 30-39 year old age-group.
- Diseases of the respiratory system were found to be the most prevalent cause of death, followed by those of the nervous system and sensory organs.
- In six people (12%), the general practitioner and staff member considered severe self-injurious behaviour to be related to death.
- The causes of death were thought to be avoidable in two cases.

Barry (1992) reported that:

- For all causes of death except asthma there was a decrease in mortality in the period 1980-1984 compared with 1974-1978.
- Taking Europe as the standard (100) population the standardised mortality ratio (SMR) in Ireland in the period 1980-1984 for tuberculosis was 160, for asthma 180 and maternal mortality 58.
- Ireland had the highest mortality for tuberculosis in both time periods.
- Asthma mortality increased in all countries except Scotland between 1974-1978 and 1980-1984.
- Ireland had one of the highest declines in maternal mortality over the two time periods.

Gaizauskiene (1995) reported that:

- 27% of all deaths in this age group were avoidable.
- Avoidable deaths were grouped into preventable and treatable ones.
- Treatable causes of death accounted for 54%, and preventable, 46% of avoidable mortality.

- Time trends showed that general mortality and mortality from avoidable causes of death in this age group were almost stable between 1970 and 1990.
- Mortality from treatable causes of death fell, while deaths from preventable causes increased.
- The results in the preventable group were greatly affected by deaths from malignant neoplasms of trachea, bronchus, and lungs.
- Differences were noted between the sexes in total mortality as well as in avoidable mortality.

Dannenberg (1994) presented the following findings:

- Injuries are the leading cause of death for females aged one to 34 years and a major source of preventable mortality in middle-aged and elderly women.
- In the United States, 43,000 women die from injuries annually.
- The leading causes of injury death in women are:
 - motor vehicle-related injuries (34%)
 - suicide (14%)
 - falls (14%)
 - homicide (12%).
- Injuries of particular concern include:
 - fatal and non-fatal falls in elderly women
 - homicides among young black women
 - suicides among young white women
 - work-related homicides among female convenience store workers
 - fatal and nonfatal injuries in women associated with domestic violence.
- Strategies to prevent most types of injuries are either known or being investigated.

Conclusions from the review by *Kemp (1997)* were:

- Accidents are the most common cause of death in children over one year of age.
- In 1992, 559 children died in United Kingdom as a result of accidents, including 240 from road traffic accidents and 100 from burns and scalds.
- Every year 50 children drown.
- Up to one in four children in urban areas attend accident and emergency departments, and 5-10% of these are admitted to hospital.
- Accident risk factors include:
 - low social class
 - psychosocial stress
 - unsafe environment
 - child developmental disorders.
- Research has shown that prevention is best achieved by making the child's environment safer, often through legislation.

Diabetes

The studies examining mortality in patients with diabetes that have been reviewed are:

- *Griffin (1998)* assessed the effectiveness of care in general practice for people with diabetes in a meta-analysis of randomised trials comparing general practice and shared care with follow up in a hospital out-patient clinic.
- *Henricsson (1997)* assessed retinopathy and change of treatment to insulin therapy as risk factors for mortality in diabetic patients participating in a control and screening programme for retinopathy.
- *Lipton (1999)* determined whether the risk of death from type 1 insulin-dependent diabetes mellitus (IDDM) was similar among young non-Hispanic black, non-Hispanic white, and Hispanic patients in a retrospective study of death certificates for Chicago residents (aged 1-24) with any mention of diabetes during 1987 through 1994.
- *Kamel (1999)* reviewed the literature on mortality from non-insulin dependent diabetes mellitus among older people.
- *Raymond (1995)* examined causes of death due to insulin treated diabetes mellitus determined from record linkage of population-based diabetes registers in Leicestershire, UK.
- *Rajaram (1998)* discussed diabetes among African American women from a socio-cultural perspective.
- *Stephenson (1992)* examined trends in diabetes-related mortality in England and Wales between 1975-6 and 1985-6, and regional and ethnic differences in diabetes-related mortality in 1985-6.
- *Mather (1998)* compared mortality and morbidity in a cohort of South Asian and European people with diabetes in London, UK, in an 11 year follow-up of a population-based sample of 730 South Asians (mean age 55 in 1984) and 304 Europeans (mean age 67 in 1984) with diabetes aged 30 years and above in 1984.
- *Nilsson (1998)* examined the relationship between self-reported diabetes mellitus, gender, attained level of education, and socio-economic resources to all cause mortality risk in a simple random sample of 39,055 subjects, aged 25 to 74 years.
- *Robinson (1998)* investigated the relationship between measures of social deprivation and mortality in adults with diabetes, by analysing data from 2,104 randomly selected adults (>16 years of age) with Type 1 and Type 2 diabetes mellitus from eight hospital out-patient departments.
- *Weng (1997)* established linkage of records between 'Diabeta' (the diabetes database in St Thomas' Hospital which contains over 7,000 diabetic patient records collected since 1973) and the National Health Services Central Register (NHSCR) in order to accurately measure mortality in a diabetic population.
- *Gatling (1997)* used a population-based cohort from ten general practices in East Dorset, to compare the mortality rate of diabetic patients compared to non-diabetic controls during eight years of follow-up.
- *Sprafka (1993)* studied risk factors for mortality in a population-based cohort of 540 Type 2 diabetic individuals followed up over ten years.
- *Laing (1999a)* measured cause-specific mortality, by age, in a UK cohort of 23,752 patients with insulin treated diabetes diagnosed under the age of 30 years, identified between 1972 and 1993 and followed to 1997.
- *Laing (1999b)* measured all cause mortality, by age, in a UK cohort of 23,752 patients with insulin-treated diabetes diagnosed under the age of 30 years, identified between 1972 and 1993 and followed to 1997.

- *Cundy (2000)* reports observational data on perinatal mortality over a 12 year period (1985-1997) in Type 2 DM from a population in Auckland with a high background rate of this disorder.
- *Bourdel-Marchasson (1998)* describes the five year mortality and its risk factors in a cohort of elderly people (aged >65 years) with and without known diabetes mellitus living in south-west France.
- *Sinclair (1997)* conducted a comprehensive literature review to examine the evidence in relation to the association between diabetes and mortality risk in elderly diabetic patients.
- *McNally (1995)* investigated the relative risk of death by calendar date of diagnosis in a population-based incident cohort of 845 (463 males and 382 females) patients diagnosed with IDDM (Type 1) before the age of 17 years in Leicestershire between 1940 and 1989.
- *De Grauw (1995)* assessed cardiovascular mortality among 265 newly diagnosed (during 1967-1989) Type 2 diabetic patients from four Dutch general practices, matched to control patients for practice, sex, age, and social class.
- *Swerdlow (1996)* analysed cause-specific mortality among 5,783 members of the British Diabetic Association living in England and Wales during 1966-1970 and followed up from 1966-1970 to December 1992.
- *Home (1999)* considered issues relating to mortality from diabetes in a Report to the Department of Health by a Working Group on health outcome indicators for diabetes.

Griffin (1998) reported the following results:

- Five trials identified included 1,058 people with diabetes, overall mean age 58.4 years, receiving hospital out-patient follow up for their diabetes.
- Results were heterogeneous between trials.
- In shared care schemes featuring more intensive support through a computerised prompting system for general practitioners and patients:
 - there was no difference in mortality between care in hospital and care in general practice (odds ratio 1.06, 95% CI 0.53-2.11)
 - glycosylated haemoglobin tended to be lower in primary care (weighted difference in means of -0.28%, -0.59% to 0.03%)
 - losses to follow up were significantly lower in primary care (odds ratio 0.37, 95% CI 0.22-0.61).
- Schemes with less developed support for family doctors were associated with adverse outcomes for patients.
- Unstructured care in the community is associated with poorer follow up, worse glycaemic control, and greater mortality than in hospital care.

The study by *Henricsson (1997)* included a total of 3,220 diabetic patients, 483 with an age at diagnosis <30 years, and 2,737 with an age at diagnosis ≥ 30 years. It emerged that:

- Two hundred and sixty-three diabetic patients (8.2%) died during the mean follow-up time of 3.4 years, 13 (2.7%) of those with younger-onset (<30 years) and 250 (9.1%) of those with older-onset (> or = 30 years) diabetes.
- Of them, 148 (56.3%) died from cardiovascular and 23 (8.7%) from cerebrovascular disorders.

- After adjusting for differences in age and sex, more severe retinopathy and the use of anti-hypertensive drugs were associated with a decreased overall survival rate as well as an increased mortality from cardiovascular and cerebrovascular diseases.
- Duration of diabetes, but not change of treatment to insulin therapy, was associated with higher cardiovascular mortality in patients whose diabetes was diagnosed after the age of 30 years.
- It was concluded that severe retinopathy, use of antihypertensive drugs, and poor glycaemic control predicted death from cardiovascular disease in diabetic patients participating in an ophthalmological screening programme.

Lipton (1999) found that:

- Deaths in those with diabetes were compared with the mortality experience of the underlying population using race-specific standardised mortality ratios.
- A total of 30 diabetes-related deaths occurred in the eight year interval.
- The average annual case fatality rate for all ethnic groups combined was 247.2 per 10,000 (95% CI 166.9-353.5).
- There were no gender differences in mortality risk.
- Race-specific rates were:
 - 447.8 per 10,000 (95% CI 283.9-671.7) for non-Hispanic black patients
 - 175.6 (95% CI 56.9-409.2) for Hispanic patients
 - 48.2 (95% CI 5.8-174.0) for non-Hispanic white patients.
- Compared with the underlying population, ethnic-specific standardised mortality ratios were elevated significantly for non-Hispanic black and Hispanic patients but not for non-Hispanic white patients.
- The nine-fold greater risk of death for non-Hispanic black compared with non-Hispanic white youth with diabetes may indicate gaps in access to comprehensive diabetes care.

Kamel (1999) reported that:

- Diabetes mellitus is one of the most common chronic diseases affecting older persons in the United States, occurring in 18% of persons aged 65-75 years and in as many as 40% of persons over 80 years of age.
- The prevalence of diabetes mellitus varies considerably by ethnic group and is higher among most minority groups in the United States than among non-Hispanic white persons.
- Published data also show increased complications and mortality rate from diabetes in the minority groups.

In the study by *Raymond (1995)*, record linkage software was used to link a locally maintained population-based mortality register and all insulin-treated diabetes mellitus cases notified to the Leicestershire diabetes register (n = 4680). It was reported that:

- A total of 370 deaths were identified for the period of 1990-92 inclusive - 56% were in men and 44% in women, with a median age of 71 years.

- Approximately 90% of deaths were subjects with NIDDM.
- Diabetes was mentioned on 215 (58%) death certificates.
- The all causes SMRs were significantly raised for men and women for all ages less than 75 years.
- Ischaemic heart disease (ICD9 410-414) accounted for 146 (40%) deaths - 41% of male and 38% of female deaths; cerebrovascular disease (ICD9 430-438) accounted for 39 (10%) deaths.
- SMRs for IHD were significantly raised for all age groups between 45 and 74 years.
- The authors conclude that using record linkage of two local, population-based registers to analyse mortality in diabetic people overcomes the problems associated with using as a sample, death certificates where diabetes is mentioned (since under-recording of diabetes as a cause on death certificates has been widely reported) and should provide a more accurate estimation of the true mortality rates.

Rajaram (1998) pointed out that:

- Diabetes is the fourth leading cause of death among African American women.
- One in four black women (23.4%) older than age 55 has diabetes.
- Resulting from historical and socio-cultural factors, black women have relatively lower income and education levels and consequently, poorer health and restricted access to quality health care.
- In a sense, being black, female, elderly, and chronically ill places this group in quadruple jeopardy.

Stephenson (1992) compared data from death certificates mentioning diabetes in 1975-6 with those for 1985-6 for different age groups. It was reported that:

- Between 1975-6 and 1985-6, the age-standardized rate of mentioning diabetes rose by 2.7% (95% CI 1.4%-4.1%) in men of all ages, and fell by 11.7% (95% CI 10.6-12.8%) in women of all ages.
- By contrast, the rate of mentioning diabetes in those below 45 years fell by 30.7% (95% CI 23.0-37.7%) in men and by 26.7% (95% CI 16.5-35.6%) in women.
- Deaths in which the underlying cause was ischaemic heart disease (IHD), and where diabetes was also mentioned on the death certificate, rose by 14.4% (95% CI 11.5-16.8%) in men and did not change significantly in women of all ages, but fell by 18.4% (95% CI -35.1 to 2.6%) in men, and 23.5% (95% CI -49.1 to 15.2%) in women below age 45.
- This was less favourable than the trend in the general population, where IHD mortality fell by 9.7% in men and 8.3% in women of all ages, and by 31.1% (95% CI 28.6 to 33.5%) in men and 40.5% (95% CI 35.0 to 45.5%) in women under 45 years.

Mather (1998) reported that:

- By 1995, there were 414 deaths (242 among South Asians and 172 among Europeans). The all cause mortality rate ratio (South Asian vs. European) was 1.50 (95% CI 0.72-3.12) for those aged 30-54 years at baseline.

- Ethnic differences in mortality rates were abolished or reversed in people aged 65 years and above at baseline.
- The mortality rate ratio for circulatory deaths was 1.80 (95% CI 1.03-3.16, $p < 0.05$) and for heart disease was 2.02 (95% CI 1.04-3.92, $p < 0.05$) in those aged 30-64 years at baseline.
- 77% of South Asian deaths were caused by circulatory disease, compared with 46% of European deaths.
- South Asian survivors were 3.8 times (95% CI 1.8-8.0, $p = 0.001$) more likely to report a history of myocardial infarction than Europeans.
- South Asian adults with diabetes show a markedly increased predisposition to cardiovascular disease compared with Europeans, especially in younger people.

In the study by *Nilsson (1998)*, participants were followed up for a maximum of 16 years, from baseline (1979-1985) to 1995.

- Diabetic males (2.2% of the male study group) had a relative risk (RR) for total mortality of 2.24 (95% CI 1.96-2.57), adjusted for age, education, marital status, housing tenure, and car ownership, compared with non-diabetic males.
- The corresponding figure for females with diabetes (1.9%) was $RR = 3.67$ (95% CI 3.16-4.27).
- Diabetic women had the highest age-adjusted mortality risk for coronary heart disease (CHD) of 8 compared with non-diabetic women; the corresponding RR for men was just below 3 ($p < 0.0001$).
- Among diabetic people, low-educated subjects had a 40% excess all cause mortality compared with high-educated subjects, adjusting for sex and age.

Robinson (1998) reported that:

- 38% of subjects had Type 1 diabetes (diagnosed before the age of 36 years and treated with insulin); 55% were male and 85% Caucasian.
- During a mean follow-up period of 8.4 years, 293 (14%) of the subjects died, the most commonly recorded cause of death being cardiovascular disease.
- Duration adjusted odds ratios (OR) were calculated separately for Type 1 and Type 2 subjects.
- Mortality rates were higher for:
 - men compared with women (Type 1: $OR = 1.27$, 95% CI 0.61-2.62; Type 2: $OR = 1.79$, 95% CI 1.27-2.52)
 - those of lower vs. higher social class (Type 1: $OR = 1.34$, 95% CI 0.61-2.96; Type 2: $OR = 2.0$, 95% CI 1.41-2.85)
 - those who left school before 16 years of age compared with those who left school at or after 16 years of age (Type 1: $OR = 3.98$, 95% CI 1.96-8.06; Type 2: $OR = 2.86$, 95% CI 1.93-4.25)
 - those unemployed compared with those in employment (Type 1: $OR = 3.10$, 95% CI 1.67-5.79; Type 2: $OR = 2.88$, 95% CI 2.12-3.91)
 - those living in council housing compared with those living in other types of housing (Type 1: $OR = 2.57$, 95% CI 1.35-4.91, Type 2: $OR = 2.76$, 95% CI 2.05-3.73).

- those subjects who had a least one diabetic complication at baseline and reported one or more hospital admissions in the previous year
 - those with poor glycaemic control (Type 2 only).
- After adjusting for duration of diabetes, hospital admissions, and the presence of diabetic complications, the following were significant ($p < 0.001$) risk factors for mortality:
 - unemployed
 - male
 - poor glycaemic control (Type 2 only)
 - less well educated.
- These results suggest that there are important indicators of social deprivation which predict mortality over and above diabetic health status itself.

Weng (1997) reported that:

- Linkage of data between the NHSCR and 'Diabeta' resulted in 91% of records in the hospital database ('Diabeta') being updated.
- 86% of deaths among diabetic patients had not been notified to the hospital and were not recorded on 'Diabeta'.
- Provision of patients' NHS numbers to 'Diabeta' enabled mortality to be accurately assessed in this diabetic population, demonstrating the usefulness of the NHS number as a key patient identifier to enable information exchange within the NHS-wide network.
- Since diabetes was recorded as a cause of death in only 36% of patients' death certificates, analyses of death certificates alone do not provide an accurate estimate of mortality among diabetic patients.

In the study by *Gatling (1997)*, 917 diabetic patients were identified from a total population of 90,660. Of these, 693 (75%) had non-insulin-dependent (Type 2) diabetes and 224 (25%) had insulin-dependent (Type 1) diabetes. A control group of 917 non-diabetic subjects were selected, matched by age and sex. Key findings include:

- After 8 years, significantly more diabetic patients had died than controls (334 vs. 219; OR=1.99, 95% CI 1.60-2.47).
- Compared with controls, the odds ratio of all causes of mortality for diabetic men was 1.89 (CI 1.4-2.54) and for diabetic women 2.16 (CI 1.57-2.96).
- Compared with controls, the odds ratio for mortality from circulatory disease was significantly increased for diabetic patients 2.0 (CI 1.5-2.6) but mortality for respiratory disease or neoplasms was not significantly different (OR=0.7, CI 0.4-1.2 and OR=0.7, CI 0.6-1.0, respectively).
- Control data were lower than would be expected from national database data, highlighting the importance of selecting appropriate controls for estimating the impact of a chronic disease.

Sprafka (1993) reported that:

- Diabetes was not mentioned anywhere on the death certificate in 46% of 274 decedents.

- Diseases of the circulatory system (ICD9-390-459) accounted for the majority (62%) of deaths in this cohort.
- Ten year survival was poorer than expected for both men and women compared to the age- and sex-matched Minnesota population.
- Standardized mortality ratios for selected causes of death indicated excess for cardiovascular disease, coronary heart disease, and cerebrovascular disease.
- Baseline variables associated with all causes of mortality included age and a history of macrovascular disease.
- These findings indicate that mortality data significantly underestimate the magnitude of diabetes and that individuals with diabetes have poorer survival than non-diabetic individuals.

Laing (1999a) examined cause-specific mortality rates and standardised mortality ratios by age and sex. The following was reported:

- During the follow-up period, 949 deaths occurred.
- At all ages, mortality rates were considerably higher than in the general population.
- Acute metabolic complications of diabetes were the greatest single cause of excess death under the age of 30 years.
- Cardiovascular disease was responsible for the greatest proportion of the deaths from the age of 30 years onwards.

Laing (1999b) calculated age- and sex-specific mortality rates, attributable risks and standardised mortality rates. Findings include:

- During follow-up (average of 13.4 years per patient) 949 deaths occurred in patients between the ages of 1 and 84 years, 566 in males and 383 in females.
- All cause mortality rates in patients with diabetes exceeded those in the general population at all ages and within the cohort were higher for males than females at all ages except between 5 and 15 years.
- The standardised mortality ratio was higher for females than males at all ages, being 4.0 (95% CI 3.6-4.4) for females and 2.7 (95% CI 2.5-2.9) for males overall, but reaching a peak of 5.7 (95% CI 4.7-7.0) in females aged 20-29, and of 4.0 (95% CI 3.1-5.0) in males aged 40-49.
- Attributable risks, or the excess deaths in persons with diabetes compared with the general population, increased with age in both sexes.

In the study by *Cundy (2000)*, perinatal mortality was classified as either foetal death (20 weeks' gestation to term) or early neonatal death (up to one month post-partum). Results include:

- There were 434 pregnancies in women with Type 2 DM, 160 pregnancies in women with Type 1 DM, and 932 in women with gestational diabetes mellitus (GDM).
- The perinatal mortality in Type 2DM was 46.1 per 1,000, significantly higher than the rates for the general population (12.5), Type 1 DM (12.5) and GDM (8.9) ($p < 0.0001$). Congenital malformations accounted for only 10% of the perinatal mortality.

- There was a seven fold increase in the rate of late foetal death and 2.5 fold increase in the rates of intermediate foetal and late neonatal death.
- Subjects with Type 2 DM were significantly older and more obese than subjects with Type 1 DM, and presented later to the diabetes service.

Bourdel-Marchasson (1998) used a health questionnaire to collect data on potential mortality risk factors during a baseline evaluation in 1988, from 68.9% of a randomly selected sample of over-65s. Findings include:

- A total of 237 subjects (8.5%) had diabetes.
- After five years, 623 people (22.3%) had died; 30.0% of the diabetic group versus 20.3% of the non-diabetic group.
- This excess mortality was significant only in the 65-75 year age range (RR=1.8; 95% CI 1.2-2.8, p=0.04).
- Cardiovascular mortality rate did not differ between the diabetic and non-diabetic groups (RR=1.2; 95% CI 0.8-2.0).
- Death related to neoplasia was significantly higher in the known diabetic group (RR=2.2, 95% CI 1.2-3.3, p=0.01).
- In the final model, integrating diabetes as a mortality risk factor in the total cohort, known diabetes at the baseline examination was an independent risk factor for mortality (RR=1.4; 95% CI 1.0-1.8, p=0.01), in addition to tobacco use, hypertension and functional dependency.
- These results confirm suggestions that diabetes increases mortality in the over-65 age group.

Sinclair (1997) reported that:

- The studies in elderly study populations comprised mainly NIDDM.
- The review demonstrated that diabetes is a significant contributor to mortality and reduced life expectancy in elderly subjects.
- Demographic trends in our population indicate that diabetes will continue to be a challenging health problem.

In the study by *McNally (1995)*, the median age at diagnosis of IDDM was ten years and the median duration of diabetes was 15 years. The mortality status of subjects was determined as of 31 December 1991, representing 14,346 person-years of follow-up. The following was reported:

- 44 patients had died by December 1991 (median age of 31 years).
- Calendar date of diagnosis was found to be an important predictor of mortality.
- Adjusting for attained age there was evidence of a decline in relative risk of death with calendar date of diagnosis of 3.4% per annum, equivalent to a 84% (95% CI 21-97) fall from 1940 to 1989.
- The data are consistent with a large fall in mortality between the 1940s and 1950s representing over 50% of the total reduction in mortality between 1940 and 1991.
- Neither sex nor age at diagnosis were significant predictors of mortality.
- Over the study period 1940-89 the SMR (male and female combined) fell from 981 (541-1556) to 238 (60-953) relative to the general population.

In the study by *De Grauw (1995)*, subjects were followed up for an average of 6.8 years. Key results include:

- Compared to the non-diabetic control patients, the Type 2 diabetic patients showed higher cardiovascular mortality rate (risk ratio 1.54, 95% CI 1.07-2.23).
- The cumulative survival rates were significantly different ($p < 0.01$) between patients and controls in the age group 65-74 years.
- The higher mortality in Type 2 diabetic patients was completely due to an excess of cardiovascular death (risk ratio 2.05, 95% CI 1.24-3.37).

Findings from the study by *Swerdlow (1996)* include:

- During the follow-up 3,399 (58.8%) subjects died.
- The relative risk of all cause mortality in the cohort compared to the general population was 2.31 in women and 1.58 in men (both $p < 0.001$).
- Relative risks were greater for women than men at almost all ages and for each major diabetes-related cause of death.
- Absolute excess ('attributable') mortality rates were also greater in women than in men, except at ages < 50 .
- Half the deaths in each sex were from circulatory diseases and only 3.4% were from renal disease.
- The relative risks of mortality for all causes and circulatory diseases were particularly great at younger ages, but changed little with duration of follow-up.
- At ages < 40 the relative risks for all-causes were 3.75 in men and 5.51 in women and for ischaemic heart disease were 10.44 and 25.25 respectively (all $p < 0.001$).
- At these ages one third of deaths were due to acute complications of diabetes, suicides and accidents, whereas at older ages these accounted for only 4% of deaths.
- In conclusion, the mortality rates at young ages in the cohort were around twice those in Sweden, Norway and Israel, suggesting that many of the deaths in England and Wales are preventable.
- The results also indicate a particular need for investigation and amelioration of cardiovascular risk factors in English and Welsh patients, especially women.

Home (1999) presented the following details in relation to diabetes. The prevalence of clinically diagnosed diabetes in England was once thought to be around 2%, but more recent studies suggest much higher prevalence values, depending to some extent on racial mix. In addition, many patients with diabetes, particularly NIDDM will be undiagnosed, so that true prevalence will be underestimated. The prevalence of diabetes is higher in the lower socio-economic groups, and the prevalence of NIDDM may be at least twice as high amongst people of Asian and Afro-Caribbean than European origin.

Variations in mortality due to diabetes mellitus may be partly explained by variations in the prevalence of clinically diagnosed diabetes or in its severity. Given that these variables are currently unmeasured across the whole population, geographical

differences cannot easily be interpreted as reflecting differences in health service provision.

There is a close association between glucose intolerance, obesity, hypertension, dyslipidaemia, peripheral vascular disease and ischaemic heart disease. These conditions frequently occur together in the same individual and cause considerable mortality and morbidity. Coronary artery disease is at least twice as common in patients with diabetes as in the normal population.

Asthma

The studies examining mortality in asthma patients that have been reviewed are:

- *Jones (1997)* analysed the relationship between geographical isolation from large acute hospital services and mortality from asthma for 401 local authority districts in England and Wales for the period 1988-92.
- *Jones (1999)* examined the relationship between asthma mortality and access to primary and secondary services within the rural region of East Anglia in a geographically based descriptive study. Regression analysis was used to examine the relationship between health service accessibility, and mortality from asthma during the period January 1985 to December 1995.
- *Burr (1999)* reported on a confidential inquiry set up in 1994 to investigate deaths attributable to asthma in residents of Wales under the age of 65 years.
- *Bucknall (1999)* undertook a confidential review of general practice and hospital records and interviews with general practitioners of patients dying in mainland Scotland between 1994 and 1996 with a principal diagnosis of asthma.
- *Mohan (1996)* determined the factors contributing to death from asthma in patients aged under 65 years in East Anglia in the early 1990s in a confidential enquiry ongoing since January 1992.
- *Model (1995)* carried out a two year district-wide study to assess whether there were preventable factors in the management of patients dying from asthma, and also to assess the accuracy of death certification of asthma.
- *Somerville (1995)* reviewed the circumstances surrounding death among 63 Mersey residents, (aged 16-65 years) who died in 1989 and 1990 from asthma (ICD code 493).
- *Guite (1999)* undertook a study to identify whether severity of asthma, its treatment, or associated co-morbidity were associated with increased risk of death from other causes.
- *Fleming (2000)* investigated the relative differences in seasonal patterns of asthma by age as they impact on episodes of care in general practice, hospital admissions, and deaths over the period 1990-1997.
- *Wareham (1993)* reported on attempts to establish a continuing confidential enquiry into deaths from asthma in the Norwich health district.
- *Robertson (1992)* reported on an investigation into the circumstances surrounding death in all patients aged 20 years or less who died from asthma in the State of Victoria over a three year period from May 1986.
- *Capewell (1993)* reviewed the epidemiology and management of asthma in Scotland over the last few decades.
- *Kaplan (1993)* reviewed death certificates of persons younger than 35 years who died from asthma during the period 1978-87 in Pennsylvania.

- *Richards (1993)* compared the demographic characteristics of all 413 asthmatic patients (aged 15-49 years) from one New Zealand area health board population who required management in an intensive care unit for a severe life threatening attack between 1981 and 1987 with those of all cases (aged 15-49 years) from the New Zealand population who died of asthma (n=466) between 1980 and 1986.
- *Pearson (1999)* considered issues relating to mortality from asthma in a Report to the Department of Health by a Working Group on health outcome indicators for asthma.

Jones (1999) found that:

- After controlling for confounding factors, there was a significant tendency for asthma mortality to increase with travel time to hospital, with a relative risk of 1.07 for each 10 minute increase in journey time (p=0.04).
- There was no consistent trend for mortality to increase with travel time to general practitioner surgeries.

The following results were obtained by *Jones (1997)*:

- Asthma mortality was found to be strongly associated with the proportion of district households where the head was of social class IV or V (adjusted RR=1.61, 95% CI 1.12-2.33), and the proportion of households without access to a car (adjusted RR=1.59, 95% CI 0.97-2.62).
- After controlling for these factors, there was a tendency for mortality to rise with increasing distance from hospital, with a relative risk of 1.01 for an increase in distance of one kilometre (95% CI 1.00-1.02).
- The findings suggest that problems of accessibility of care may mean that the control of asthma amongst sufferers living in districts most remote from major health service units might be less than optimal, and this could result in a number of potentially avoidable deaths.

The report by *Burr (1999)* included the following findings:

- During the period of the inquiry 92 cases were notified as being ascribed to asthma, or (in 1996) having a mention of asthma on the death certificate.
- 80 of these 92 deaths were investigated further and details were considered by a small panel of doctors who endeavoured to identify factors that may have contributed to the deaths.
- Asthma was considered to be the underlying cause of 52 deaths.
- Although disease severity was usually a major factor, some aspect of the patient's behaviour or circumstances seemed to have contributed to 31 deaths, while in 15 cases there was probably a deficiency in medical care.
- The authors conclude that some preventable asthma deaths still occur, particularly in relation to inadequate treatment.
- Factors associated with patients' behaviour and circumstances are more difficult to tackle but, if doctors are aware of high risk patients, increased vigilance may prevent some deaths.

In the study by *Bucknall (1999)* panel assessment of the cause of death was carried out. Data from the 15-64 year age group were compared with similar data from an earlier study by the British Thoracic Society. It emerged that:

- Over the three year period 95 deaths of 235 studied (40%) were confirmed as being due to asthma.
- A fall in the calculated rate of "deaths assessed as due to asthma" was found from 2.51 (95% CI 2.34-2.68) per 100,000 population in 1979 to 1.26 (95% CI 1.19-1.33) per 100,000 population in 1994-6.
- Fewer individual adverse factors were identified in clinical management, with appropriate routine management in 59% and management of the final attack satisfactory in 71%.
- Patient factors such as poor compliance, lack of peak expiratory flow (PEF) measurements, and overuse of reliever medication without inhaled corticosteroids, and psychosocial problems, notably depression, were confirmed as important contributing factors.
- Four of five patients under 16 years of age who died were found to have problems with routine management.
- This population-based study documents important improvements in the standard of asthma care as well as a significant decline in the rate of deaths due to asthma over a period during which the organisation of care has changed and the chronic nature of the disease has been acknowledged.
- Strategies which might have a further impact include:
 - the greater use of PEF recordings, particularly during acute attacks, to document recovery
 - prescription monitoring of the underuse of inhaled corticosteroids
 - consideration of the use of combined preparations where persistent overuse of bronchodilators is occurring
 - increased input for young patients whose routine management is proving difficult.

In the study by *Mohan (1996)*:

- A review of the clinical and pathological data of the 50 patients reported in the first three years suggested that 36 of these deaths were attributable to asthma.
- Thirty-one patients died out of hospital (three en route to the hospital), two in the accident and emergency department, and only three in hospital.
- Adverse social factors were found in 25 out of 34 patients, and adverse psychological characteristics in 23 of the 31 patients where these could be assessed.
- Only seven appeared to have no adverse psychological or social factors.
- Routine medical care was considered appropriate in 20 patients, and inappropriate in 14. Twenty four had received appropriate advice and education.
- Nine of the 21 patients, where this could be assessed, and half the relatives, failed to respond appropriately to worsening asthma symptoms during the fatal attack.
- No potentially preventable factors were identified in two women who died of end stage asthma.
- This enquiry demonstrates that inadequacies in the medical care of asthma continue to occur, although less frequently than in previous asthma mortality studies.

- In addition, 79% of the patients had experienced psychosocial factors that appeared important in contributing to their deaths.

Model (1995) presented the following findings:

- 18 deaths occurred in which asthma was the certified cause of death.
- In ten asthma was the actual cause of death.
- Due to inaccuracies of certification, seven deaths were due to other causes.
- In the remaining case it was not possible to differentiate between asthma and chronic obstructive airways disease.
- Among the ten deaths asthma was considered to be mild in three.
- In three, death occurred too rapidly for help to have been available.
- Preventable factors were present in four cases.
- In three deaths, either the patient, the doctor or both failed to appreciate the severity of the condition and the need for urgent help or hospitalization.
- The fourth patient had failed to seek any medical care.
- Education is needed to improve both the clinical and post mortem accuracy of death certification.

In the study by *Somerville (1995)*, casenote summaries were assessed by a chest physician and diagnostic criteria for asthma were applied to each case. Key findings include:

- In 43 (68%) out of 63 cases asthma was the true cause of death; 41 out of 43 had had asthma diagnosed in life.
- Mean age (47 years) and median age of onset of asthma (10 years) were similar to those found in previous studies, but the proportion of men (58%) was higher.
- Only 6 (14%) deaths occurred after more than a few hours in hospital; for the rest, hospital contact was either too late (19%) or did not occur (67%).
- Of 22 out of 43 (51%) patients considered at high risk of a respiratory death, 15 had poorly controlled symptoms for at least a year before their deaths.
- Avoidable factors were present in 29 out of 43 (67%) cases; most commonly lack of assessment, inadequate doses of steroids and over-reliance on bronchodilators.
- Asthma deaths occur mostly outside hospital; thus to replace deaths, resources should be directed at the community to improve the recognition of asthma by patients, their families and the primary care team.

Guite (1999) compared 85 deaths from all causes occurring within three years of discharge from hospital in a cohort of 2,242 subjects (aged 16-64 years) admitted for asthma with a random sample of 61 controls (aged <45 years) and 61 aged (>=45 years) from the same cohort. Findings of note include:

- Deaths from asthma were associated with:
 - history of clinically severe asthma (OR=6.29; 95% CI 1.84-21.52)
 - history of chest pain (OR=3.78; 95% CI 1.06 to 13.5)
 - biochemical or haematological abnormalities at admission (OR=4.12; 95% CI 1.36 to 12.49)
 - prescription of ipratropium bromide (OR=4.04; 95% CI 1.47 to 11.13)

- failure to prescribe inhaled steroids on discharge (OR=3.45; 95% CI 1.35 to 9.10).
- Deaths from chronic obstructive pulmonary disease (COPD) were associated with:
 - lower peak expiratory flow rates (OR=2.56; 95% CI 1.52 to 4.35, for each 50 l/min change)
 - history of smoking (OR=5.03; 95% CI 1.17 to 21.58)
 - prescription of ipratropium bromide (OR=7.75; 95% CI 2.21 to 27.14)
 - failure to prescribe inhaled steroids on discharge (OR=3.33; 95% CI 0.95 to 11.10).
- Treatment with ipratropium bromide at discharge was associated with an increased risk of death from asthma even after adjusting for:
 - peak flow
 - COPD and cardiovascular co-morbidity
 - ever having smoked
 - age at onset of asthma.

Fleming (2000) analysed age-specific weekly rates of new episodes of asthma presenting to general practitioners, numbers of hospital admissions (in England) and deaths (in England and Wales) by the multiplicative decomposition method to separate secular from seasonal trends. Three week moving averages were plotted. Relevant findings include:

- In the 15-44 age group there were marked mid summer peaks of general practice episodes and deaths but admissions to hospital were at about the annual average; in September/October there were peaks of episodes and admissions whereas deaths peaked in November.
- In the 45-64 age group a peak in general practice episodes of asthma was evident in mid summer when admissions were about average and deaths were at a minimum.
- In those age over 65 years, general practice episodes of asthma, admissions to hospital, and deaths followed similar 'U' shaped patterns with substantial peaks in mid winter.
- In conclusion, the seasonal pattern of asthma evolves with age.
- There are important differences in the seasonal pattern of general practice episodes, admissions to hospital, and deaths.

Wareham (1993) reviewed the routine asthma management in 24 residents of the Norwich health district (aged between 16 and 65 years) who had died between 1988 and 1991 with asthma as the principal cause of death. Findings of note include:

- Twenty one of the patients (88%) died away from hospital.
- Overall the routine asthma management was appropriate in all respects in only four patients.
- In five cases the drug treatment was considered inappropriate.
- In ten cases (42%) there was no written evidence that the patient had received advice and education.
- Only six cases had a written management plan.
- In 17 patients (71%) the fatal attack of asthma developed rapidly (in under three hours).
- The medical care during the final attack was found to have been inappropriate in six cases.

- Seventeen cases (71%) had psychological or social factors that were considered to have been of potential importance.
- The authors point out that in a district-based confidential enquiry into asthma deaths:
 - the enquiry should be continuing
 - the quality of care given to those patients who died should be compared against a recognised standard
 - there should be a structured system for feeding back the conclusions of the enquiry to the local medical community.

Robertson (1992) reported the following:

- During the three year study period, 51 deaths due to asthma were reported.
- 33% of these were judged to have a history of trivial or mild asthma, and 32% had no previous hospital admission for asthma.
- However, 36% were judged to have had severe asthma, 43% were taking regular inhaled beclomethasone or sodium cromoglycate, and 10% were taking regular oral steroids.
- 22% had a previous admission to an ICU.
- Death occurred outside hospital in 40 (78%) subjects.
- In the final attack 63% had sudden onset and collapse within minutes, 12% were found dead, and 25% had acute progression of an established attack.
- The investigators assessed 39% of the deaths to have had potentially preventable elements. The preventable factors included:
 - inadequate assessment or therapy of prior asthma (68%)
 - poor compliance with therapy (53%)
 - delay in seeking help (47%).
- The majority of subjects in this survey could not be classified as "high risk."

Capewell (1993) reported that:

- The epidemic of asthma deaths in mid-60s was undeniable and may have reflected good symptomatic control by bronchodilators, which made doctors and patients neglect the underlying risk of asthma death.
- A gradual increase in asthma mortality in western countries over the 1970s and 1980s is apparent, including almost 5% annual increase in England and Wales between 1974 and 1984 which then levelled off.
- This may again reflect excess dependence on bronchodilator treatment and under-usage of steroid treatment.
- In contrast, the mortality rate in Scotland had been relatively static over the last two decades, although hospital discharge rates have doubled.

Kaplan (1993) reported that:

- Blacks had nearly a sevenfold greater risk of death from asthma than whites.
- The highest death rates were found among black males and residents of the State's two largest urban areas, Philadelphia County and Allegheny County.

- A total of 67% of asthma deaths occurred outside of the health care system or in a hospital emergency department.
- Although reasons for excess deaths among black urban residents are not well understood, inadequate access to health care may play a role.

Richards (1993) reported that:

- The age distributions of the two groups were dissimilar, with the severe life threatening attack group having an excess of asthmatic patients under 30 years old.
- The distribution of events by calendar month was uniform in both groups, but there was an unexpected increase in frequency of attacks on Sundays in both groups.
- Over the study period, mortality fell from 5.3 per 100,000 to 3.5 per 100,000 but the admission rate to intensive care increased from 10.8 per 100,000 to 17.9 per 100,000.
- At least 24% of asthma deaths occurring in the health region during the study period had previously experienced a severe life threatening attack.
- The authors conclude that the similarities between the groups suggest that asthmatic patients who experience severe life threatening attacks are likely to come from the same subgroup of the asthma population as those who die.

Pearson (1999) presented the following details in relation to mortality from asthma. Asthma is certified as the underlying cause of death in over 1,600 deaths per year, accounting for about 0.3% of all deaths, in England. The majority of asthma deaths occur outside hospital unassociated with an admission, and deaths occur mainly in elderly people, with 60% occurring in people aged 65 and over.

There is no clear geographical pattern of mortality in England although health authorities with high mortality in people under 65 are more likely to be in the north rather than the south of the country. Standardised mortality ratios for asthma, comparing people in different social classes, are significantly lower in classes I and II than in others for both men and women.

Variations in asthma mortality may be partly explained by variations in the prevalence of asthma and its severity. Given that the latter variables are unmeasured for the whole population, geographical differences in this indicator can not easily be interpreted as reflecting differences in health service provision.).

5. STUDIES EXAMINING TECHNICAL ISSUES IN COMPILING MORTALITY RATES

The main technical issues that need to be addressed in compiling mortality rates are:

- diagnostic specificity
- risk adjustment for factors such as age, sex and socio-economic factors
- accuracy of death certification and changes in certification practice
- statistical power.

Diagnostic specificity

With regard to the evaluation of community-based interventions, most studies use outcome measures for a single disease, for example CHD, stroke, cancer, diabetes or accidents. Greater statistical power can be obtained by grouping diagnoses into classifications such as avoidable deaths or deaths in specified age groups.

Interventions focusing on behavioural lifestyle changes affect the risks of several diseases, with smoking being a prime example (*Lindholm 2000*). The bias associated with measuring a single disease can be overcome by choosing several diseases in the outcome analysis for these sorts of intervention.

Risk adjustment

Age standardisation techniques are an essential part of presenting mortality data but have not been included in this review. The very many socio-economic factors that may influence mortality rates highlight the need to consider confounding when interpreting them.

Accuracy of death certification and changes in certification practice

The analysis of trends over time with respect to mortality data, where it is broken down across different types of death, may be influenced by changes in certification practice as well as the accuracy of recording and coding.

Studies of death certification that have been reviewed for the purposes of this study include:

- *Goldacre (1993)* analysed linked abstracts of hospital records and death certificates for people who died within four weeks of hospital admission (or within one year for some diseases) to determine the extent to which individual diseases, when recorded as being present shortly before death, were certified as causes of death.
- *Westerling (1995b)* studied the effect of using multiple causes of death i.e. all causes of death mentioned on the death certificates, compared to using the underlying cause of death only for analyses of regional variation among small areas in mortality for asthma, diabetes, hypertensive disease and cerebrovascular disease.

- *Rooney (1996)* describes the implementation of a computerised system for coding the cause of death from death registrations in England and Wales since the beginning of 1993, and the impact this has had on national cause of death statistics.
- *Devis (1997)* analysed delays in the registration of death and discusses their effect on mortality statistics.
- *Maudsley (1996)* conducted a literature review to document and analyse aspects of death certification that are relevant to public health.
- *Maudsley (1993)* conducted a postal questionnaire survey to assess the knowledge, attitudes and behaviour of house officers (n=174) and general practitioners (n=131) in the Mersey Region in relation to death certification.
- *McKelvie (1993)* compared the causes of deaths (part I and II) recorded on death certificates with findings at autopsy for all 132 patients undergoing autopsy in one Melbourne hospital in 1992 to identify deficiencies in the completion of death certificates.
- *Crombie (1995)* examined the concurrence in the variation of monthly numbers of deaths in summer and winter from four main underlying causes (respiratory, circulatory, neoplastic, and all others) in four countries (England and Wales, The Netherlands, Denmark and Portugal).
- *Reid (1998)* carried out a region-wide review of the hospital and general practice records of 210 subjects with physician-diagnosed asthma who died in 1991 and 1992 to assess the accuracy of asthma death certification in the UK.
- *Wright (1994)* investigated the accuracy of death certification in Northern Ireland for the years 1981-1984.
- *Guite (1996)* reviewed details of all deaths amongst 2,382 subjects aged 16-64 years within three years of discharge following hospital treatment for asthma in the South East Thames region to determine the extent to which asthma deaths are wrongly attributed to another cause on UK death certificates.
- *Smyth (1996)* determined the accuracy of death certification and registration in asthma and chronic obstructive pulmonary disease (COPD) in a review of all death certificates in Northern Ireland for 1987 where asthma or COPD were listed in part I or part II.
- *McCull (1998)* investigated the validity of routine hospital and mortality hip fracture data in the Wessex Region for patients aged over 65 years with a hip fracture episode between 1993-1995.
- *De Henauw (1998)* validated the Belgian vital statistics for coronary heart disease (CHD) on the basis of an independent acute myocardial infarction (AMI) register of deaths among those aged 25-69 years during the period 1983-1991 carried out as part of the WHO-MONICA project.
- *Lappala (1999)* examined the validity of stroke diagnosis in the National Hospital Discharge Register and the Register of Causes of Death among 546 middle-aged men in Finland.
- *Mahonen (1999)* compared the diagnoses obtained from the routine mortality statistics with the standardized World Health Organization (WHO) MONICA classification in suspect coronary heart disease (CHD) deaths registered in the FINMONICA myocardial infarction (MI) register during 1983-1992.
- *Birkhead (1999)* considered issues relating to the diagnostic accuracy of acute myocardial infarction in a Report to the Department of Health by a Working Group on health outcome indicators for acute myocardial infarction.

- *Tunbridge (1999)* considered issues relating to the diagnostic accuracy of diabetes in a Report to the Department of Health by a Working Group on health outcome indicators for diabetes.
- *Fairbank (1999)* considered issues relating to the diagnostic accuracy of fractured proximal femur (FPF) in a Report to the Department of Health by a Working Group on health outcome indicators for FPF.
- *Charlwood (1999)* considered issues relating to the diagnostic accuracy of suicide in a Report to the Department of Health by a Working Group on health outcome indicators for severe mental illness.
- *The Department of Health (2000)* considered the accuracy of coding of suicide in the recent set of national performance indicators.
- *The Department of Health (2000)* considered the accuracy of coding of accidental death in the recent set of national performance indicators.

Goldacre (1993) analysed data covering a population of 1.9 million people in six districts in the Oxford Regional Health Authority area. Three broad patterns of death certification were distinguished:

- The first group comprised diseases that were usually recorded on death certificates when death occurred within four weeks of hospital care of them, and which were also usually certified as the underlying cause of death. Examples included:
 - lung cancer (on 91% of such death certificates)
 - breast cancer (92%)
 - leukaemia and lymphoma (90%)
 - anterior horn cell disease (89%)
 - multiple sclerosis (89%)
 - myocardial infarction (90%)
 - stroke (93%)
 - aortic aneurysm (87%)
 - spina bifida (89%).
- The second group comprised diseases which, when present within four weeks of death, were commonly recorded on death certificates but often not as the underlying cause of death. Examples included: tuberculosis (on 76% of such certificates; underlying cause on 54%)
 - thyroid disease (49%; 21%)
 - diabetes mellitus (69%; 30%)
 - hypertension (43%; 22%).
- The third group comprised conditions which, when death occurred within four weeks of their treatment, were recorded on the death certificate in a minority of cases only. Examples include:
 - fractured neck of femur (on 25% of such certificates)
 - asthma (37%)
 - anaemia (22%).

Other findings and conclusions reported were:

- There was convergence in certification practice towards the common cardiovascular and respiratory causes of death.
- There was also evidence that conditions regarded as avoidable causes of death may not have been certified when present at death in some patients.

- It was recognised that the quality of information yielded from death certificates is not uniformly high due to various factors e.g. the doctor certifying the death may not consider the condition to be sufficiently relevant, or the doctor is disinclined to record certain conditions on death certificates.
- When uses are made of mortality statistics alone, it is important to know which category of certification practice the disease of interest is likely to be in.
- Linkage between morbidity and mortality records, and multiple cause analysis of mortality, would considerably improve the ability to quantify mortality associated with individual diseases.

Westerling (1995b) calculated SMRs for the different Swedish health administrative areas for each of the selected underlying causes of death as well as for multiple causes of death for the period 1987-1991, and analysed correlations between SMR for underlying and multiple causes. It was reported that:

- The highest level of correlation of the SMR between multiple and underlying causes of death was found for cerebrovascular disease (0.96) and the lowest for hypertensive disease in the age group 0-64 years (0.51).
- For hypertensive disease, diabetes and asthma, when using multiple causes of death some further areas were found to have high SMR and the level of significance was higher.
- Significantly high SMR using underlying causes of death were, however, not shown to be false when multiple causes of death were used.
- In the case of cerebrovascular disease little additional information was gained.
- By including multiple causes of death in small area analysis more statistical outliers can be detected and the risk of false warning signals due to random effect can be limited.
- Analyses of underlying causes of death and multiple causes of death should preferably be combined.

Rooney (1996) reports that:

- Overall the automated system has been effective and reliable at deriving ICD-9 codes for the underlying cause of death and other conditions mentioned on the certificate.
- The automated system does not deal adequately with external causes of death, which are certified after coroner's inquest, and ONS has reverted to coding these clerically.
- Automation increases the consistency and international comparability of cause of death coding.
- However, automation has led to discontinuities in time trends between 1992 and 1993.
- The largest effect was related to expected changes in the application of ICD-9 selection rule 3.
- Selection rule 3 as published in ICD-9 states that 'If the underlying cause... can be considered a direct sequel to another reported condition, whether in part I or part II, select this primary condition'.

- Three main patterns are seen in the age standardised mortality rates for the period 1980 to 1994:
 - a steady rise or secular trend from 1980 to 1994 without any evidence of artefact
 - a clear plateau or trough, with abrupt changes coinciding with the changes in mortality coding in 1984 and 1993
 - an abrupt rise or fall in 1993 without any evidence of a preceding change in the opposite direction in 1984.
- There is a deep trough between 1984 and 1992 in the mortality rates for the respiratory diseases; this is particularly dramatic for pneumonia which decreased by more than half in 1984 and rose almost back up to previous levels in 1993.
- The ICD-9 chapters which show the least effect of coding changes are those with the highest mortality rates, including cardiovascular diseases and neoplasms (conditions usually regarded as directly lethal and so which are usually selected as the underlying cause).
- For chronic, degenerative, and disabling conditions (e.g. diabetes, dementia, and rheumatoid arthritis), the certifier often gives an acute terminal condition such as pneumonia or pulmonary embolism as the underlying cause in part I.
- Between 1984 and 1992, endocrine, mental, neurological, and musculoskeletal disorders mentioned largely in part II were selected by ONS coders in preference to the terminal conditions given by the certifier.
- Therefore changes in the application of selection rules can have profound effects on the estimate of the contribution which chronic, degenerative, and disabling conditions make to mortality; this has important ramifications for public health policy, particularly in an ageing population.

Devis (1997) presented the following findings:

- The longest delays arise when deaths are the subject of a coroner's inquest, in particular deaths in road traffic accidents.
- These delays mean that it may be many months before an acceptable proportion of deaths occurring in a year have been registered, so affecting how early a reliable extract of annual data can be taken.
- It also shows that the difference in the number of deaths occurring and the number registered in a year is strongly influenced by the weekdays on which holidays fall at the New Year.

Maudsley (1996) concludes that:

- The question "How inaccurate are cause of death data?" is harder to answer than the literature suggests.
- Deriving a useful estimate of the accuracy of cause of death data is difficult because of inter-study differences in:
 - definition
 - measurement (how and by whom?)
 - the practical importance of error
 - the standards used
 - the focus (e.g. death certificate or mortality data)
 - observing everyday practice or simulation exercises

- diagnostic and/or semantic issues.
- The traditional perspective on improving the quality of death certification has not worked.
- There is a need for re-orientated thinking rather than just urging more education.
- Evidence-based educational interventions are needed.
- The flaws in the theoretical framework of cause of death and the routine nature of death certification are unavoidable, but require consideration.
- Certifiers need practical feedback mechanisms, integral to continuing quality assurance at all levels and fostering an understanding of the construction of mortality data.

Maudsley (1993) reported that:

- Response rates were 68.4% for house officers and 72.5% for GPs.
- Most house officers (78.8%) and GPs (85.3%) reported that they made the best possible cause of death statement but, respectively, 62.4% and 59.3% of these might modify a statement in some circumstances.
- Significantly more house officers (70.3%) than GPs (44.2%) acknowledged room for improvement and were amenable to more training (86.6% versus 52.5%), but significantly fewer felt sufficiently instructed (23.7% versus 52.6%).
- Most respondents (>90%) considered accurate death certification important, but 46.2% of house officers had not read the death certificate book instructions.
- Knowledge was variable, especially concerning underlying cause of death.
- Written cause of death statements were broadly similar in style and standard between groups.
- Experience did not appear to improve death certification practice.
- Better and co-ordinated undergraduate and early post-graduate education (which should be continuing and audited), and practical accessible guidance on death certificate completion, might improve standards of practice and performance within the existing framework.

In the study by *McKelvie (1993)*, clinical information about previous medical and surgical history and ante-mortem investigations was assessed in addition to autopsy findings. The key results were:

- In 1992, 132 hospital autopsies were performed (autopsy rate of 24.2%).
- Of these patients, 68% were aged 65 years or over, and 30% were aged 75 years or over.
- Major discrepancies between the cause of death listed on the certificates and autopsy findings were found in 16 cases (12%).
- Other deficiencies of death certification included:
 - listing the mode of death (e.g., cardiac failure) without an underlying cause in 14 cases (11%)
 - failure to cite recent major surgery in 17 of 20 cases (85%)
 - failure to specify site or organism in 33 of 40 cases (82.5%) of infection or sepsis.

- This study confirmed findings of previous studies with respect to missed major diagnoses, but identified other deficiencies in certification of causes of death, which could compromise accuracy of statistics obtained from death certificates.

Crombie (1995) considered the hypothesis that most non-respiratory concurrent deaths are miscoded respiratory deaths and that a large proportion of the winter mortality currently attributed to circulatory disorders should be attributed to respiratory disorders. It was reported that:

- Time series analysis of monthly data was performed to remove auto-correlation, seasonality, and secular trends.
- Associations between paired causes of death were examined.
- Monthly deaths (for ages 65 years and over) related to underlying cause were examined for each of the four countries
- All combinations of monthly deaths related to underlying cause were strongly associated in all four countries.
- Associations involving deaths from neoplasm were weakest.
- Concurrent deaths in England and Wales accounted for 31.1% of respiratory, 16.0% of circulatory, 3.5% of neoplastic, 14.1% of deaths from other causes and 14.2% for all deaths combined.
- The equivalent percentages for concurrent deaths from all causes were 8.4% in the Netherlands, 9.3% in Denmark, and 16.8% in Portugal.
- Concurrence, which was present in each of the underlying causal groups in each of the four national data sets examined, suggests a common cause separate from the underlying cause that has been used in the presentation of mortality statistics.
- If the person concerned had not died at that time, as a result of this cause, he would not have died from the recorded underlying cause.
- Most of these non-respiratory concurrent deaths are miscoded. As a consequence, a large proportion of winter mortality currently attributed to circulatory disorders should be attributed to other causes, probably respiratory.
- More intensive research into the contribution made by acute respiratory diseases is proposed.
- The proportion of concurrent deaths varied in the four countries thereby limiting the validity of simple comparisons of national mortality statistics.

Reid (1998) reported that:

- The reviewing panels reached a conclusion about the cause of death in 191 out of 210 cases.
- Of 86 death certificates listing asthma as the primary cause of death, the panels considered that only 31 (36%) of these were actually due to asthma, the remainder (64%) being false positives.
- The proportion of false positives ranged from 45% for subjects aged less than 65 years to 75% for those aged 65 years and over.
- As seen in other studies (Whallet 1993; Smyth 1996; Wright 1994; Ormerod 1980), diagnostic transfer from COPD appeared to be responsible for many of the false positive asthma death certifications.

- Of note is that the panels considered asthma to be of no relevance to death in 61 (91%) out of 67 cases where asthma had been certified as a contributory cause of death.
- The panel agreed with the certifying physician that asthma was not relevant to death in 29 (78%) of 37 cases.
- The number of false negative certifications was 5% (5 out of 104 deaths in which asthma had been certified either as a contributory rather than as a primary cause (67) or as irrelevant (37)), although the study design did not support a meaningful assessment of false negative inaccuracy.
- The number of asthma deaths miscoded as COPD, cardiovascular disease, or other causes could not be estimated from this study.
- The authors acknowledge that about one third of the panels' decisions were reached by majority rather than unanimous verdict, which, they point out, implies that assessing the relevance of asthma to death is often difficult.
- This study concludes that asthma death certification provides a markedly inaccurate picture of asthma mortality, particularly in elderly subjects.
- Since about 60% of certified deaths from asthma occur in those aged 65 years or over, the high false positive certification rate (75%) found in this age-group has profound implications for the interpretation of national mortality statistics.
- Thus, it is speculated that if the magnitude of this source of inaccuracy has increased over the last two decades, the apparent increase in asthma mortality may be largely artefactual.
- The authors suggest that while the 1979 and 1984 changes in international coding practice (ICD 9, implementation of rule 3) artificially increased the death rate from asthma in those aged <45 years and >75 years respectively, this provides insufficient explanation for the observed mortality trends.

Wright (1994) examined death certificates which mentioned asthma for all age groups, and death certificates which mentioned chronic obstructive airway disease, emphysema, or chronic bronchitis for age groups less than 55 years. Death as a result of asthma was confirmed or otherwise by a panel, based on information from medical records, questionnaires to the general practitioner, and interviews with a close relative of the deceased. Reported findings were:

- A total of 174 deaths from asthma was identified.
- 123 (70.7%) out of 174 deaths had been registered, while the remainder had been coded under another diagnosis i.e. 29% were false negatives.
- The proportion of false positives was estimated at 35% for all ages but only 13% in those under 65 years of age.
- The annual number of confirmed deaths differed little from the figures of the Registrar General.
- During the period studied, the number of false positive registrations was balanced by the number of false negatives, suggesting that the registered totals reflect actual asthma mortality.

In the study by *Guite (1996)*, details of deaths were reviewed by an expert panel to assess the proportion of asthma deaths identified by the panel that were attributed to

another cause of death on the death certificate (false negatives). The main findings were:

- Eighty five deaths from all causes were identified in a mean follow up period of two years and three months.
- In 61 cases (72%) there was sufficient information for the expert panel to be confident about the cause of death.
- The panel identified 22 deaths from asthma, four of which were certified as non-asthma deaths (two as deaths from chronic obstructive pulmonary disease (COPD) and two as deaths from cardiovascular disease).
- The proportion of false negative death certificates was four of 22 (18%, 95% CI 5 - 40).
- In conclusion, there is evidence that asthma deaths in the UK are wrongly certified as deaths from both chronic obstructive pulmonary disease and diseases of the cardiovascular system.

Smyth (1996) investigated all death certificates mentioning asthma, those mentioning COPD for ages less than 56 years, and a 50% sample of those mentioning COPD aged 56-75 years. The accuracy of the registered cause of death was assessed by a panel of two respiratory physicians based on general practitioners' case notes, hospital records, necropsy findings, and additional data collected by questionnaire. Findings of note include:

- Of 50 registered asthma deaths 43 were confirmed as being due to asthma.
- In nine registered deaths from COPD in cases aged less than 56 years one was confirmed as COPD, two as asthma, and six as other respiratory conditions.
- Of 105 registered deaths from COPD in cases aged 56-75, 42 were confirmed as COPD, 27 as asthma, eight as other respiratory conditions, and 28 as other causes.
- Although few errors in registration were found, 21% of certificates mentioning asthma and 38% of certificates mentioning COPD but not asthma in part I were subject to variable application of the classification rules by the registering officers.
- For all deaths under 75 years of age in Northern Ireland in 1987 where either asthma or COPD was mentioned anywhere on the death certificate, the estimated sensitivity and specificity of the registered cause of death in predicting the true cause of death were 29% and 98.6% for asthma and 69% and 70% for COPD.
- In summary, in a population of subjects where asthma or COPD was mentioned anywhere on the death certificate, the registered cause of death is a relatively poor indicator of the true cause of death for both asthma and COPD
- Many deaths certified and registered as COPD could have been called asthma using current standards of clinical diagnosis.
- In studies investigating risk factors for deaths from asthma, case finding should consider deaths registered as COPD.

McColl (1998) compared the number of individual regional and district admissions and deaths with those presented in the Public Health Common Data Set. It appeared that:

- National comparative indicators for hip fracture overestimated individual admissions in Wessex by 17% (in health authorities by 1-56%).
- National comparative indicators for hip fracture mortality underestimated individual deaths in Wessex by 48%.
- It is possible to adjust routine national HES data to take account of multiple episodes within a single admission

The study by *De Henauw (1998)* was based in two geographical areas of Belgium, Ghent and Charleroi. Official mortality statistics in Belgium reflect the "underlying" causes of death. Key findings include:

- Out of a total of 741 (Ghent) and 934 (Charleroi) well documented MONICA fatal cases of AMI, 492 (66.4%) and 641 (68.6%), respectively, were labelled in official mortality statistics as CHD (ICD 410-414); 438 (59.1%) and 385 (41.2%), respectively, were officially labelled as AMI (ICD 410).
- A substantial fraction of the MONICA AMI cases (27.1% in Ghent and 38.2% in Charleroi) was coded as "other forms of CHD" (ICD 411-414) or as "other forms of heart disease" (ICD 420-429).
- The remaining MONICA AMI cases (13.8% in Ghent and 20.6% in Charleroi) were classified in either very aspecific (for example, atherosclerosis, ICD 440) or totally unrelated ICD codes (e.g. neoplasm, ICD 140-239).
- It is concluded from the results in this paper that a substantial part of all deaths caused by CHD in Belgium are labelled with incorrect ICD codes and are therefore misclassified in the official mortality statistics for Belgium.
- This is partly caused by a "drainage" of cases towards less specific CHD related ICD categories. A considerable fraction, however, seems to be absolutely misclassified.

Lappala (1999) presented the following results:

- In all, 375 events with cerebrovascular disease as hospital discharge diagnosis and 218 events with cerebrovascular disease as the underlying cause of death were reviewed using specific criteria modified from the classifications of the National Survey of Stroke and the WHO MONICA Study.
- For hospital stroke diagnoses, there was agreement on diagnosis for:
 - all strokes in 90%
 - subarachnoid hemorrhage in 79%
 - intracerebral hemorrhage in 82%
 - cerebral infarction in 90%.
- The respective agreement rates for stroke as the underlying cause of death were 97%, 95%, 91%, and 92%.
- The data were insufficient for review in 1% and 3% of the stroke events, respectively.
- Age and observation year had no effect on validity.
- In conclusion, the validity of stroke diagnosis was good in registers of hospital diagnoses and causes of death justifying their use for endpoint assessment in epidemiological studies.

In the study by *Mahonen (1999)*, all CHD deaths from routine mortality statistics (ICD 410-414) were registered in the MI register. It was reported that:

- Of the CHD deaths in routine mortality statistics 1.7% in men and 4.8% in women did not fulfill the MONICA criteria for CHD death ($p < 0.001$ for the difference between the sexes).
- In men 4.7% and in women 7.3% ($p = 0.004$) of the deaths registered in the MI Register and classified as CHD deaths by MONICA criteria had another underlying cause of death than CHD in routine mortality statistics; this proportion increased over time in both sexes ($p = 0.002$ in men and $p = 0.77$ in women).
- The CHD mortality trends obtained separately from the routine mortality statistics and from the FINMONICA MI Register were very similar.
- In conclusion, the high CHD mortality in Finland reported by the routine mortality statistics is real.
- It is possible that some CHD deaths have escaped registration, but the decline seen in the CHD mortality is also real.

Birkhead (1999) reported that:

- The definition of myocardial infarction varies according to the discipline of the doctor describing it and the purposes for which the information is being collected.
- Using a definition of AMI based on standardised clinical criteria will underestimate significantly the true incidence of myocardial infarction as it does not include people:
 - with a post-mortem diagnosis only
 - who die suddenly without a post-mortem but who have had symptoms and a history of heart disease
 - with a post-mortem diagnosis of acute or chronic myocardial ischaemia
 - with a post-mortem diagnosis of coronary disease but no acute syndrome.
- An outcome indicator based on mortality from AMI will rely on the validity and reliability of the recording of the underlying cause of death.
- A validation exercise conducted as part of the UK Heart Attack Study indicates that acceptably accurate population level estimates of mortality can be obtained in this way for residents under 65 - a conclusion supported by the results of the MONICA project.
- However for those aged 65-74, the UK Heart Attack Study found evidence of significant over-recording of AMI as the underlying cause.
- No data are available on the accuracy of recording in those 75 and over.

Tunbridge (1999) reported that:

- An outcome indicator based on mortality from diabetes will depend on the reliability of recording of the underlying cause of death on the death certificate.
- Considerable under-recording of diabetes as a cause on death certificates has been widely reported, ranging from 15-60%.
- The quality of this data is higher in patients under the age of 45 years.

- The recording of deaths caused by other conditions, which are more prevalent in patients with diabetes, need to be treated consistently across regions and over time.
- Analyses of causes of mortality in people with diabetes using data from death certificates mentioning diabetes provide unreliable estimates of mortality.

Fairbank (1999) reported that:

- An outcome indicator based on mortality from fractured proximal femur (FPF) will depend on the quality of the CMDS diagnoses which is unlikely to be uniformly high.
- Due to lax coding, a fractured neck of femur may be coded as ‘fracture of femur, part unspecified’ - S72.9 instead of the more specific alternatives.
- Including S72.9 in the numerator may mean that there is an over inclusion of some fractures, potentially exaggerating the size of the numerator.
- FPF is an example of where problems exist in relation to the certification of the condition as the underlying cause of death.
- Studies have revealed that approximately only 25% of deaths resulting from FPF (as stated in hospital records) were recorded as such on the death certificate.

Charlwood (1999) pointed out that the potential for under-recording of suicides by coroners is to some extent addressed by an inclusive definition of suicide incorporating all deaths associated with a cause of ‘intentional self-harm’ (ICD-10 X60-X84) or ‘event of undetermined intent’ (ICD-10 Y10-Y34) (Wing 1994).

The report on national performance indicators by *The Department of Health (2000)* highlighted the following in relation to the coding of death from suicide:

- The new automatic coding system implemented by ONS had a major impact on external causes of death, the overall effect of which was to produce a substantial artefactual reduction in deaths assigned to these causes.
- ONS undertook a detailed review of the reasons underlying these effects and identified some of the key factors involved.
- In the case of suicide, this was largely due to an incompatibility (relating to the way in which accelerated registrations were assigned) in the coding of suicide statistics pre and post the introduction of the automatic coding system.
- This has been addressed by excluding the relevant ICD code (E988.8).
- The recoding exercise has produced more reliable figures both for external causes as a whole, and for groups within the external causes chapter.

The report on national performance indicators by *The Department of Health (2000)* highlighted the following in relation to the coding of accidental death:

- The new automatic coding system implemented by ONS had a major impact on external causes of death such as accidents, the overall effect of which was to produce a substantial artefactual reduction in deaths assigned to these causes.

- ONS undertook a detailed review of the reasons underlying these effects and identified some of the key factors involved.
- The recoded data have produced more reliable figures both for external causes as a whole, and for groups within the external causes chapter.
- The mortality coding changes introduced in 1993 have a particular effect on the coding of accidental deaths among elderly people.

Statistical power

In the evaluation of community-based interventions aimed at reducing mortality, considerably large populations will generally be needed to demonstrate significant changes in mortality. This may require a follow period of many years and a major change in risk factors (*Puska 2000*). While reporting of annual mortality rates may be appropriate for regional or national figures, five yearly rates may allow more meaningful comparisons across smaller residential populations.

6. SUMMARY OF FINDINGS FROM LITERATURE REVIEW

In reviewing the literature we attempted to address the following questions:

- What are the general factors affecting admission rates?
- What factors influence admission rates when they are being used as outcome indicators for chronic medical conditions?
- How should admission rates be calculated when used as health outcome indicators?

General factors

Mortality rates are used for other purposes than health outcome indicators. In particular, they may be employed to highlight variations in access to health care and thus be part of a battery of statistics to illuminate social inequalities. It is not surprising therefore that mortality rates are influenced by a variety of socio-economic factors including:

- sex and age
- ethnicity
- education
- occupational and employment status
- marital status.

Outcome indicators for chronic medical conditions

The most appropriate uses of mortality rates as health outcome indicators are related to monitoring the success or failure of:

- health promotion and disease prevention initiatives
- primary and community care
- secondary care

The conditions addressed in this report are:

- circulatory diseases
- suicide
- avoidable deaths
- diabetes
- asthma.

Although national targets include cancer mortality and stillbirth and infant mortality rates, these were not included in this review as they are specialist areas each requiring a major piece of research work.

The important factors in interpreting the mortality rates for the conditions studied are similar to those for mortality rates in general.

Calculation of mortality rates

The key factor in the calculation of condition-specific mortality rates is whether to include only those deaths in which the condition has been coded as the underlying cause or whether to include all deaths due to the condition, regardless of where it is on the death certificate.

Factors involved include:

- accuracy of recording cause of death
- rules for coding cause of death.

A number of conditions have been studied but most work has been done on asthma whose mortality rates are extremely difficult to interpret because of technical issues.

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