# Trends in premature mortality in England and Wales, 1950–2004

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**Premature mortality is a major public health concern but there has been little consensus among researchers on how it should be defined and reported. In this article four means of measuring early deaths are considered using four different age thresholds to define prematurity. Using these four indicators, trends in premature mortality are reported for England and Wales from 1950 to 2004. All measures show that, however 'premature' is defined, levels of premature mortality have decreased markedly over time. This article discusses which mortality indicator and age threshold would be most appropriate for a measure of premature mortality for use in national mortality statistics for England and Wales.**

## Introduction

The need to tackle the leading causes of early death was recognised in the Government White Paper, *Saving Lives*: *Our Healthier Nation*,[1] where the Prime Minister noted that 'Too many people die too young from illnesses which are preventable'. To help assess the extent of this problem, ONS has been considering the production of indicators of both premature and avoidable mortality. However, the questions of which illnesses may be considered preventable, and before which age a death may be considered to be premature, are not straightforward.

Although much work has been done internationally in recent decades to measure levels of avoidable and premature mortality, there has been a lack of consensus between researchers on how these deaths should be defined.[2,3] This partly reflects the different purposes for which measurements of early or avoidable death have been used, such as examining the economic impact on societies, or attempting to identify deficiencies in health care provision. Definitions of premature mortality may also differ between societies and are likely to change over time.

Research into premature mortality was examined by ONS and summarised in a review of proposals for measuring premature and avoidable mortality, put out to public consultation between November 2005 and February 2006.[4] While considering the responses to the consultation, ONS has also examined trends in early deaths to help inform the definition of an indicator for use in national mortality statistics for England and Wales. This article considers four alternative methods of reporting these deaths. For each method results are presented for England and Wales from 1950 to 2004 for both sexes and four different age thresholds.

## Methods

Mortality data from 1950 to 2004 were taken from the routine certification and registration of deaths in England and Wales. 1950 was selected as the starting point for analysis because of the difficulties of data collection and interpretation throughout and immediately after World War Two. Mid-year population estimates were used with the deaths data to calculate three of the measures of premature mortality. From 1950 to 1991 these were estimates released by ONS on its CD-Rom of *Twentieth Century Mortality*.[5] The estimates from 1982 to 1991 were revised following the 2001 Census. The population estimates from 1992 to 2004 are available on the National Statistics website and also include revisions and corrections made following the 2001 Census.[6]

Premature mortality was analysed using four methods which are described in Box One. Four alternative ages before which a death could be considered premature were assessed for each of these methods: 70, 75, 80 and 85. Some researchers have questioned whether it is appropriate to include infant deaths in a measure of premature deaths[2] and for this reason some analyses were performed twice, with and without deaths under one year. All results were calculated for males and females separately.

### Box one Mortality indicators

1. **Proportions of premature deaths –** The number of deaths under a selected age threshold, reported as a proportion of total deaths.
2. **Directly age-standardised mortality rates –** These make allowances for differences in the age structure of populations. The directly age-standardised rate for a particular population is that which would have occurred if its observed age-specific rates had applied in a given standard population. Rates in this article were age-standardised using the European Standard Population. This is a hypothetical population standard, which is the same for both males and females, allowing standardised rates to be compared over time and between sexes.
3. **Potential Years of Life Lost –** A measure of prematurity in which deaths at younger ages are weighted more heavily than deaths at older ages. For this analysis deaths were considered to be evenly distributed between birthdays, therefore each death was assumed to occur mid-way between birthdays. When considering age 70 to represent the threshold for prematurity, a death at age 65 thus contributes 4.5 years to the total count of potential years of life lost. A death at age 15 however would contribute 54.5 years of life lost. The total years of life lost in a population is equal to the sum of years of life lost to all individuals who died prematurely. Potential years of life lost (PYLL) can also be expressed as age-standardised rates. In this article these rates represent the number of potential years of life lost if the population of England and Wales had the same population structure as the European Standard Population. Standardised years of life lost rates are presented as years of life lost per 10,000 population.
4. **Probability of Survival –** Estimates of the likelihood of a person surviving between two ages can be derived from life tables. The probabilities of survival reported in this article were derived from age-specific rates for each year between 1950 and 2004 and were based on the assumption that individuals would experience that year's age-specific mortality rates throughout their lives. The results are comparable over time and between the sexes and are presented as the probability of survival to each age threshold. Probability of survival from birth to age 70, for example, thus represents survival from age 0 to end of age 69.

The technical details of the method of calculation are included in Appendix A.

## Results

### Indicator 1: Proportions of premature deaths

Using each of the four age limits for defining premature deaths, between 70 to 85, it is obvious that the proportion of the total population dying below the limit will rise as the age threshold increases. These rises are not completely consistent over time however and differ between the sexes (Figure 1). For each age limit there was a large decrease in premature deaths between 1950 and 2004 for both sexes, although the declines were larger for females than males.

In 1950 over half of all male deaths were under age 70. By 2004 this had fallen to under a third, a decrease of two-fifths. Smaller percentage decreases occurred at the older age limits although in 2004 only four-fifths of all male deaths were before age 85 compared to 93 per cent in 1950.

The proportion of women dying before each age threshold was consistently lower than for men. In 1950 just over two-fifths of all female deaths were under 70 but by 2004 this had fallen to less than one-fifth. This percentage decrease of 56 per cent was also greater than the decrease of 42 per cent for males. Large decreases in the proportion of female premature deaths also occurred at older age limits. In 2004 only 59 per cent of female deaths were before age 85 whereas in 1950 87 per cent had been. The percentage decrease at age 85 between 1950 and 2004 was twice as great for females as for males (32 per cent compared to 16 per cent).

The pattern of decline in premature deaths also differed between the sexes. For males proportions of premature deaths at each age threshold remained relatively stable throughout the 1950s and 1960s before starting to decline in the 1970s. For females though a clear decline in premature deaths at each age limit happened across the entire time period being considered.

The proportions of premature deaths reported here do not take into account changes to the age structure of the population which occurred between 1950 and 2004. In 1950 7 per cent of the population of England and Wales was aged 70 and over but by 2004 this figure was 12 per cent. Moreover, persons aged 70 and over are expected to make up 15 per cent of the population of England and Wales in 2024 according to current projections.[7] This is at least partly due to fewer people dying prematurely, leading to higher proportions of birth cohorts surviving to older ages.

Age-standardised proportions can be calculated but as these are difficult to interpret, age-standardised mortality rates were considered as an alternative measure which would allow more meaningful comparisons over time.

### Indicator 2: Age-standardised mortality rates

The directly age-standardised death rates presented in Figure 2 take into account changes in the age structure of the population between 1950 and 2004. The trends presented do still largely mirror the picture of mortality presented for the proportions of premature deaths seen in Figure 1 but there are differences, such as the declines in premature mortality for males which are steeper when age-standardised rates are considered.

Total all age mortality rates fell by around half for both sexes between 1950 and 2004 and large decreases occurred in mortality rates at each age threshold. Rates for females were lower than for males for each age group and in each year. Unlike the proportions of premature deaths however, the percentage decreases in mortality rates between 1950 and 2004 were very similar for both sexes in each age group. Mortality rates

**Figure 1** **Proportion of all deaths before selected age limits: by sex, 1950–2004**

England and Wales

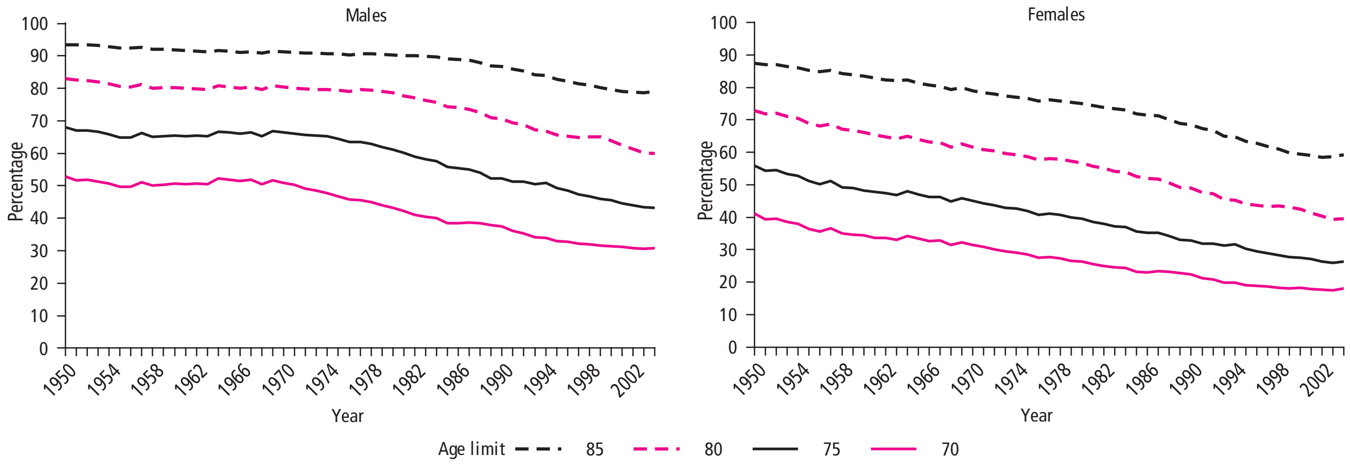
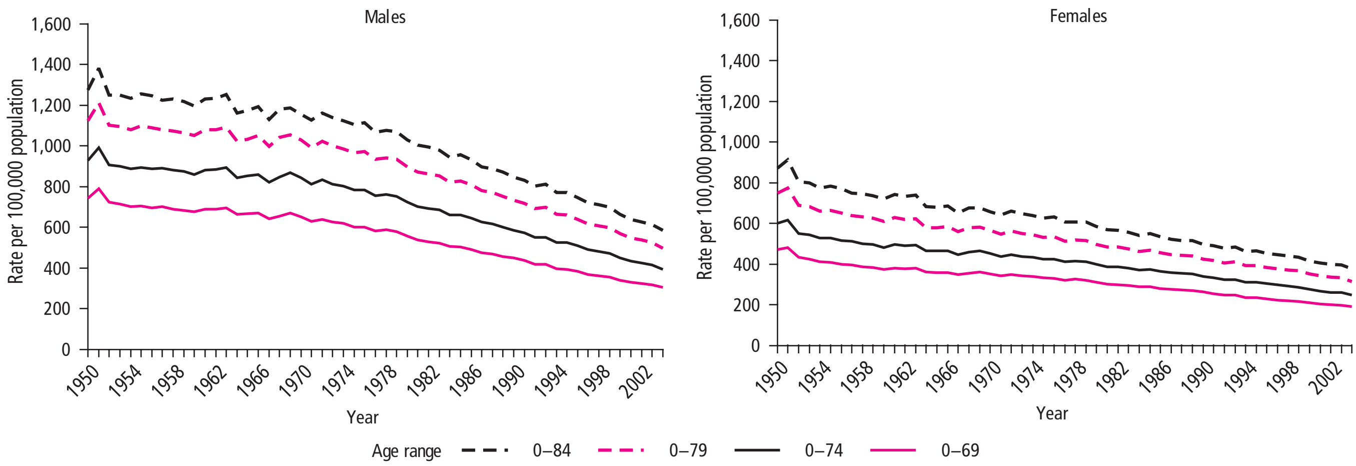



**Figure 2** **Directly age-standardised mortality rates for selected age ranges, by sex, 1950–2004**

England and Wales




for those aged under 70 decreased by three-fifths for both sexes between 1950 and 2004. Decreases in mortality rates when the age thresholds were raised were only slightly smaller. For both sexes death rates halved between 1950 to 2004 for those aged under 85.

There was a difference between the sexes though in their trends in falling mortality rates over time, as female rates decreased at a faster rate in the earlier part of the period considered. Between 1950 and 1969, for example, the death rate for males aged under 75 fell by 7 per cent but the decrease for females was over three times this at 23 per cent. Improvements in male mortality rates were concentrated in more recent years. For males aged under 75 mortality rates fell by 53 per cent between 1970 to 2004 (compared to 45 per cent for females).

ONS frequently uses age-standardised mortality rates to report on deaths but rarely uses Potential Years of Life Lost to do this (although one table in an annual reference volume does report PYLL in England and Wales).[8] This method has however been widely used by other researchers to report on early deaths.

## Indicator 3: Potential Years of Life Lost

In 2004 over 1.5 million potential years of life were lost in England and Wales by all persons who died before reaching age 70: 61 per cent by males (around 0.94 million) and 39 per cent by females (around 0.59 million) (Table 1). As with proportions of premature deaths and age-standardised mortality rates, large decreases in early deaths can be seen between 1950 to 2004 using this measure.

For males all deaths under age 70 accounted for over 2.4 million potential years of life lost (PYLL) in 1950 but by 2004 this figure had declined to 937,000. A similar decrease was seen for all female deaths before age 70 where PYLL fell by just over two-thirds from 1.8 million in 1950 to 589,000 in 2004. As expected, the number of years of life lost clearly increases as the age threshold rises. For both sexes the percentage decreases over time declined as the age threshold increased. Even when measured before age 85 though the number of PYLL for females more than halved and almost halved for males between 1950 to 2004 (53 and 47 per cent respectively).

As some researchers have questioned whether it is appropriate to include infant deaths in a measure of premature deaths[2] the PYLL results were calculated twice, with deaths under one year also excluded. This naturally reduces the potential number of years of life which can be lost. The 2004 total for deaths under 70, for example, decreased from 1.5 million to 1.3 million PYLL when infant deaths were excluded (from around 0.94 million to 0.82 million for males and from around 0.59 million to 0.49 million for females).

The proportion of the potential years of life lost due to infant deaths has changed markedly over time. In 1950, of all years of life lost before age 70, a third were due to infant deaths for both sexes. By 2004 infant mortality accounted for a far smaller proportion of PYLL before this age – 13 and 16 per cent for males and females respectively (Table 2). While improvements in infant mortality have clearly contributed to decreasing years of life lost over time Table 1 illustrates that PYLL has still declined markedly even when deaths under one year are excluded.

To take into account changes in the age structure of the population over time, potential years of life lost can also be expressed as standardised rates. These standardised years of life lost (SYLL) are presented as rates per 10,000 population in Figure 3. As this illustrates SYLL both including and excluding infant deaths figures are presented for only two of the age thresholds (under age 75 and under age 85) so that trends can be clearly seen. Between 1950 and 2004, the SYLL rate decreased for both age thresholds and both sexes. Rates were again consistently higher for males than females. In 2004 the rate for males was 540 years of life lost per 10,000 population (including infants) compared to a rate for females of only 340. The two sets of trends, for rates including and excluding infant deaths, moved closer together over time, again reflecting improvements in infant mortality. There was a downward trend for both sexes in SYLL rates throughout most of 1950–2004, but for males, as with age-standardised mortality rates, the rate of decrease was accelerated in the latter part of this period.

**Table 1** **Potential Years of Life Lost (thousands): by sex, selected years 1950–2004**

England and Wales

| | Includes Infants | | | | Excludes Infants | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Under 70 | Under 75 | Under 80 | Under 85 | 1–69 | 1–74 | 1–79 | 1–84 |
| **Males** | | | | | | | | |
| 1950 | 2,419 | 3,109 | 3,998 | 5,570 | 1,611 | 2,241 | 3,069 | 4,557 |
| 1960 | 2,076 | 2,758 | 3,638 | 5,213 | 1,412 | 2,045 | 2,875 | 4,380 |
| 1970 | 1,945 | 2,692 | 3,664 | 5,377 | 1,391 | 2,096 | 3,027 | 4,683 |
| 1980 | 1,477 | 2,108 | 3,000 | 4,674 | 1,178 | 1,786 | 2,656 | 4,298 |
| 1990 | 1,220 | 1,740 | 2,464 | 3,924 | 1,005 | 1,509 | 2,217 | 3,654 |
| 2000 | 1,001 | 1,403 | 1,985 | 3,209 | 874 | 1,267 | 1,840 | 3,050 |
| 2004 | 937 | 1,312 | 1,840 | 2,956 | 817 | 1,183 | 1,702 | 2,806 |
| Percentage decline 1950–2004 | 61 | 58 | 54 | 47 | 49 | 47 | 45 | 38 |
| **Females** | | | | | | | | |
| 1950 | 1,810 | 2,323 | 3,019 | 4,363 | 1,223 | 1,692 | 2,345 | 3,627 |
| 1960 | 1,352 | 1,794 | 2,415 | 3,693 | 869 | 1,275 | 1,860 | 3,087 |
| 1970 | 1,230 | 1,674 | 2,309 | 3,624 | 828 | 1,242 | 1,847 | 3,120 |
| 1980 | 920 | 1,302 | 1,874 | 3,130 | 690 | 1,055 | 1,610 | 2,842 |
| 1990 | 726 | 1,049 | 1,521 | 2,618 | 568 | 879 | 1,340 | 2,420 |
| 2000 | 620 | 876 | 1,263 | 2,192 | 520 | 768 | 1,148 | 2,067 |
| 2004 | 589 | 831 | 1,184 | 2,032 | 494 | 728 | 1,074 | 1,912 |
| Percentage decline 1950–2004 | 67 | 64 | 61 | 53 | 60 | 57 | 54 | 47 |

**Table 2** **Numbers and proportions of Potential Years of Life Lost (PYLL) due to infant deaths: by sex, selected years 1950–2004**

England and Wales

| | PYLL due to infant deaths (thousands) | | | | Percentage of total PYLL due to infant deaths | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Under 70 | Under 75 | Under 80 | Under 85 | Under 70 | Under 75 | Under 80 | Under 85 |
| **Males** | | | | | | | | |
| 1950 | 808 | 868 | 928 | 1,013 | 33 | 28 | 23 | 18 |
| 1960 | 664 | 714 | 763 | 833 | 32 | 26 | 21 | 16 |
| 1970 | 554 | 595 | 637 | 695 | 28 | 22 | 17 | 13 |
| 1980 | 300 | 322 | 344 | 376 | 20 | 15 | 11 | 8 |
| 1990 | 215 | 231 | 247 | 269 | 18 | 13 | 10 | 7 |
| 2000 | 126 | 136 | 145 | 158 | 13 | 10 | 7 | 5 |
| 2004 | 120 | 129 | 138 | 151 | 13 | 10 | 8 | 5 |
| **Females** | | | | | | | | |
| 1950 | 587 | 631 | 674 | 736 | 32 | 27 | 22 | 17 |
| 1960 | 483 | 519 | 555 | 605 | 36 | 29 | 23 | 16 |
| 1970 | 402 | 432 | 462 | 504 | 33 | 26 | 20 | 14 |
| 1980 | 230 | 247 | 264 | 288 | 25 | 19 | 14 | 9 |
| 1990 | 158 | 170 | 181 | 198 | 22 | 16 | 12 | 8 |
| 2000 | 100 | 107 | 115 | 125 | 16 | 12 | 9 | 6 |
| 2004 | 96 | 103 | 110 | 120 | 16 | 12 | 9 | 6 |

## Indicator 4: Probability of survival

Probabilities of survival from birth to each of the premature age thresholds are presented in Figure 4. To test the impact of infant deaths on probabilities of survival, results were calculated again but from age one. Unlike potential years of life lost, the probability of survival results proved less sensitive to deaths at very early ages and there were only relatively small differences between the two sets of figures. (In 2004 excluding infant deaths increased the probability of survival by less than 2 per cent for both males and females at all four age thresholds.) Results are therefore presented here just for probability of survival from birth.

The probability of survival naturally goes down as the age threshold increases. For each premature age limit, and in all years, females had a higher probability of survival than males. For both sexes though there were marked improvements in probabilities of survival between 1950 and 2004. Based on age-specific death rates for 1950 the probability of a male baby born in that year surviving to age 70 was only just over half. By 2004 the age-specific rates for that year indicated that this probability had increased to over three-quarters. Similar improvements were seen for probability of survival of females to age 70 – from two-thirds in 1950 to more than four-fifths in 2004.

For survival to older ages percentage improvements between 1950 and 2004 were even greater than with probability of survival to age 70. In 1950 the chance of a male baby surviving to age 85 was less than 1 in 10. By 2004 this had more than tripled to 3 in 10. For females probability of survival from birth to age 85 was less than a fifth in 1950 but by 2004 the probability was approaching a half.

As with the earlier measures of premature mortality the trends for probabilities of survival differed between the sexes with probabilities for males again remaining relatively stable until the 1970s. From 1950 to 1969 the probability of males surviving from birth to age 75 increased by just 3 per cent. For females the increase was almost five times this – 14 per cent. From 1970 to 2004 though the probability of males surviving from birth to age 75 increased by 63 per cent, compared to an improvement for females of 24 per cent.

**Figure 3** Standardised years of life lost per 10,000 population for selected age ranges, by sex, 1950–2004

England and Wales

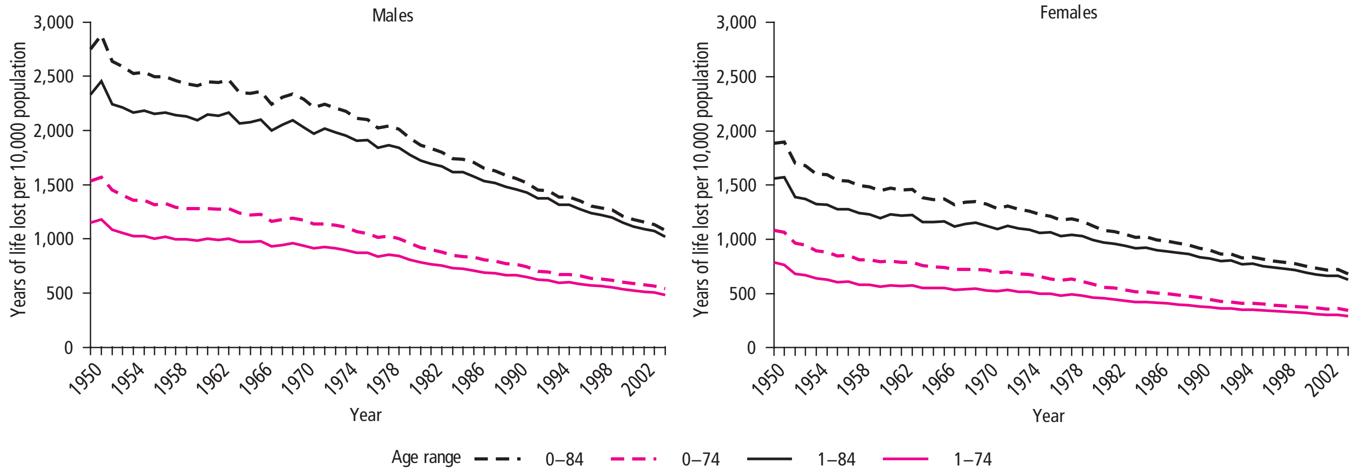
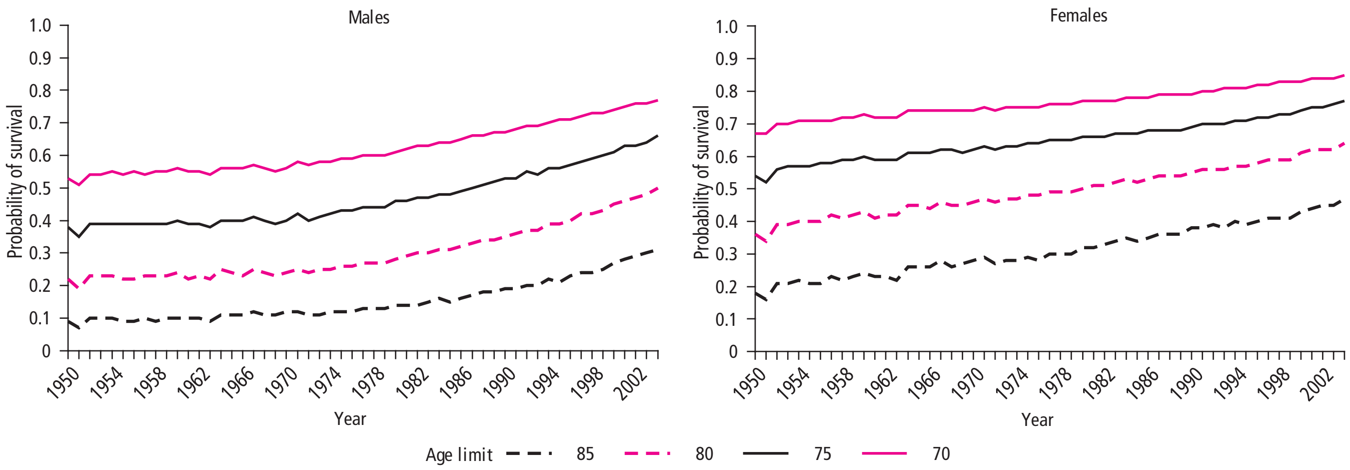



**Figure 4** Propability of survival to selected ages, by sex, 1950–2004

England and Wales



## Discussion

The analyses presented in this article have shown that there is a greater burden of premature mortality for males than females, but for both sexes marked improvements have taken place since 1950. This was seen in all of the measures of reporting premature mortality that were considered, however 'premature' was defined. Trends over time differed between the sexes, with premature mortality for females decreasing across the period 1950–2004, while improvements for males were concentrated in more recent decades.

Although ONS currently publishes a number of mortality indicators based on deaths at all ages (including life expectancy at birth), there is a risk that such measures may be dominated by the mortality and disease patterns of the elderly. A method of reporting on deaths at younger ages may therefore provide a valuable additional measure of mortality in considering variations in health status between the sexes and between different geographical areas or social groups.

Measures of premature mortality can also be used to examine changing patterns over time, as in this article, although they may have some limitations if they do not take into account when people were born (their birth cohort). Using a measure based on deaths occurring before present life expectancy at birth, for example, would use current mortality rates to quantify the mortality of people who were born in a range of periods – some recently but some in much earlier cohorts. For example, a woman who dies now aged 79 will be dying 1.9 years before current female life expectancy at birth. Using current mortality rates this death could be considered premature. However this woman would have been born in the 1920s and would have exceeded the expectation of life for her birth cohort by around ten years.[9] In addition a measure based on current mortality would not take into account potential future improvements in life expectancy. Thus potential years of life lost, for example, could be underestimated for a young person dying now.

A measure of premature mortality still remains a useful indicator of public health, even if based on current death rates. To assist in deciding what such a measure should look like, ONS launched a twelve-week public consultation in November 2005 on options for defining measures of premature and avoidable mortality.[4] Among the questions included for consideration were what age ranges should be used to measure premature deaths and if these should be different for males and females. There was little consensus among respondents in their replies to these questions. While some favoured an arbitrary age limit, such as those considered in this article, others favoured a threshold linked to life expectancy at birth. While some thought it logical to have different ages for males and females (given their different life expectancies) others proposed that it was more pragmatic to have the same age threshold for both sexes.

Given this diversity of opinion, the results presented in this article provide some evidence to assist the consideration of how premature deaths should be defined and reported in national mortality statistics for England and Wales. While each of the alternative measures we have reported have demonstrated results which generally correspond (e.g. greater premature mortality for males than females and marked decreases over time with similar trends lines) each method has different strengths and weaknesses as an indicator of early deaths.

### Choice of age threshold

For each measure of premature mortality four different age thresholds were also selected for consideration. These were arbitrary ages rather than limits which could be linked to an empirical measure, such as life expectancy at birth or life expectancy at age at death. Measures linked to life expectancy have been successfully used by some researchers, when, for example, examining levels of premature deaths from different causes in a selected time period.[10]

For measuring trends in premature mortality over time however, a life expectancy based measure has the disadvantage that a changing threshold would make meaningful measurements of change impossible. As life expectancies are derived from age-specific rates within a life table their relationship with any measure of premature mortality will not be independent. Life expectancy at birth can however be a useful guide as to what a fixed age threshold should be for measuring premature deaths.

In 2002–2004 life expectancy at birth was 76.5 years for males in England and Wales and 80.9 years for females.[11] Although this gap has been narrowing over time, there is still a difference of almost four and a half years which may suggest that the definition of premature deaths should not be the same for males and females. While the death of a woman aged 79 would be 1.9 years less than current female life expectancy at birth, a man who died aged 79 would have exceeded current male life expectancy at birth by two and a half years. This raises questions regarding what can be justifiably considered as a premature death which cannot be answered simply by reference to life tables.

Having different age thresholds for males and females however introduces its own difficulties. In this article, for example, we have been able to illustrate how the burden of premature mortality is much greater for males than females, and compared how time trends have also differed between the sexes. Having a higher age threshold for females would risk masking the fact that males generally continue to die at younger ages. Despite the potential difficulties it raises, ONS therefore favours having a measure of premature mortality which is based on the same age threshold for both sexes so that comparable results can be reported.

Four age thresholds have been considered in this article, and while time trends for each have been generally consistent, ideally a single age should be selected to define premature deaths to allow the production of regular and consistent outputs. ONS currently produces only one routine output of premature deaths: a table of potential years of life lost in England and Wales before ages 65, 75 and 85 (as well as years of 'working life' lost between ages 15–64).[8]

The choice of age may be partly governed by considerations of the proportion of deaths included/excluded depending on the threshold set. If premature deaths were measured before age 70, for example, in 2004 this would exclude 82 per cent of the total of female deaths. If improvements in premature mortality continue, a threshold of age 70 would gradually exclude ever higher proportions of deaths. This could limit the application of an indicator of early deaths in some circumstances, such as examining geographical differences if populations are small.

The Compendium of Clinical and Health Indicators currently includes a measure of prematurity for selected causes of deaths based on potential years of life lost before age 75.[12] These are published for sub-national areas in England, including local authorities and Primary Care Trusts. Government targets for reducing deaths from cancer and circulatory disease are also focussed on the under 75s.[1] Recent research into deaths amenable to health care intervention has also used age 75 as the limit below which deaths can generally be considered avoidable.[13]

While there are diverse opinions among public health researchers on the most appropriate age beneath which deaths should be considered premature, 75 has some currency as an age which is already being used for public health monitoring and which corresponds approximately with male life expectancy at birth.

### Choice of measure of premature mortality

Each of the four measures considered in this article have different strengths and weaknesses as a potential indicator of premature mortality. The proportions of deaths before selected age limits, for example, are straightforward to calculate, and easy to comprehend. They do not take into account differences in the age structures of populations, however, which would limit their usefulness in measuring change over time or looking at differences between populations, such as in different geographical areas. Although age-standardised proportions can be calculated these are harder to interpret and so were not included among the measures assessed here.

Directly age-standardised mortality rates do take account of differences in the age structures of populations and are already widely used for public health monitoring. Ideally an indicator of premature deaths would also be reported with a measure of variance so that the statistical significance of differences between populations could be considered. Confidence intervals are frequently published with directly age-standardised rates using existing methods.[14] While confidence intervals are not widely reported for potential years of life lost, methods of calculating them do exist. A measure of variance could also be calculated for probabilities of survival, derived from existing life table methods for calculating confidence intervals for life expectancy results.

Many analyses which have looked at premature deaths have reported these using potential years of life lost. Although widely used to measure the impact of deaths at younger ages its limitations as a measure have also been reported. The Centers for Disease Control in the United States, which introduced a table based on PYLL to its standard outputs in 1982, noted that as an indicator it was 'simple to compute and comprehend.'[15] This was also noted by Romeder and McWhinnie who developed a model of PYLL which measured deaths between ages 1 and 70.[2] They chose an arbitrary upper age limit for ease of understanding and excluded infant deaths as they regarded that too much weight would be given to them in the indicator. Others have argued, however, that is illogical to exclude infant mortality from a measure of premature deaths.[16]

Other researchers have contended that PYLL is neither simple to compute nor to comprehend and have also demonstrated that for some purposes, such as determining the leading causes of early death, PYLL can be easily manipulated as different results are achieved depending on the age ranges used.[3]

Gardner and Sanborn concluded that the concept of PYLL can only be comprehended if it is recognised as 'a method of assigning social value to each age at death'. Difficulty in assigning those values means that PYLL is a 'complex measure incorporating subtle value judgements that are often inapparent to the casual observer'.[3]

Like potential years of life lost, probabilities of survival have an advantage in that they present the impact of early deaths in a form that is more immediately striking than the use of age-standardised mortality rates. This is also true of a measure such as life expectancy at birth which makes the presentation of inequalities between areas or socio-economic groups more immediately apparent than the use of a more 'abstract' indicator such as mortality rates. The concept of life expectancy at birth however can be difficult to explain and interpret and presenting probabilities of survival, which are also derived from life tables, would present similar challenges.

The choice of an indicator may also be influenced by factors such as the impact of infant deaths. As Romeder and McWhinnie noted, infant deaths are heavily weighted in measures of PYLL, and this can be clearly seen in the two sets of results in Table 1 which both include and exclude deaths under one year. This could be a potential limitation if PYLL was to be used for comparing early deaths within small populations where the numbers of infant deaths can be highly variable. ONS however does not favour excluding infant deaths simply on the grounds that they would contribute too much weight. In life tables more weight is also given to deaths at younger ages than deaths at older ages, however the probabilities of survival calculated for this article proved less sensitive than PYLL to infant mortality.

Potential years of life lost has been commonly used by researchers as a measure to examine differences between causes of deaths, however there is a diversity of opinion regarding how easy a measure it is to comprehend and it can be particularly sensitive to infant mortality unless deaths under one year are excluded from its calculation.

In contrast to PYLL, directly age-standardised rates offer a method of reporting on early deaths for which there are standard methods of calculation which are widely used. It is also the method used to measure Government targets to reduce deaths from cancer and circulatory disease among the under 75s.[1] The Compendium of Clinical and Health Indicators also uses directly age-standardised rates to measure premature mortality for selected causes of death.[12] Directly age-standardised rates have a further advantage in that they can be used to compare premature mortality with deaths at all ages. This is not the case with either PYLL or probabilities of survival. These measures only provide an absolute measure of premature mortality and so trends, for example, cannot be compared with deaths at all ages.

Despite this limitation ONS favours a new additional measure of premature mortality using probabilities of survival derived from life tables. These may be challenging to explain, although as one of the Government's national targets is to reduce inequalities in life expectancy at birth,[17] the concepts of life table based indicators have gained wider currency. The probabilities of survival reported in this article give a striking illustration of how levels of premature mortality differ between the sexes and have changed over time. They therefore offer a means of reporting inequalities, between areas or socio-economic groups for example, which will be readily comprehensible.

## Conclusion

For national mortality statistics in England and Wales ONS favours measuring premature deaths using a definition which is the same for both sexes and which takes account of all deaths (including infants) before a single age threshold. Age 75, which is already being used for public health monitoring and is the basis for some government targets, appears the most favourable option for this at this stage.

All of the different means of reporting premature mortality considered in this article (apart from the first indicator, simple proportions) take into account differences in the age structures of populations and thus allow for comparisons to be made over time and between areas and the sexes. Directly age-standardised death rates are widely used for reporting mortality statistics but they do not offer a means of reporting on premature deaths which makes the scale of differences between populations readily apparent. They may however be of value if there is interest in comparing early deaths with mortality at all ages.

The presentation of probabilities of survival however offers a means of describing premature mortality which allows the impact of variations between populations, or over time, to be easily comprehended. Although this is a measure which gives greater weight to deaths at younger ages the evidence presented shows that it is not unduly influenced by infant mortality, unlike potential years of life lost.

Probabilities of survival for geographical areas or socio-economic groups, based on deaths under age 75, could be used to clearly present inequalities in premature mortality. Further work would be needed to assess their application in these circumstances, such as for reporting premature deaths for local authorities.

# Key findings

- However premature mortality is measured, marked improvements have taken place for both sexes in England and Wales between 1950 and 2004.
- At this stage ONS favours defining premature mortality as deaths under the age of 75 and it would prefer to report on these early deaths by the calculation of probabilities of survival.
- Based on mortality rates for 2004, two-thirds of males had a probability of surviving from birth to age 75. Females continue to generally die at older ages than males and 77 per cent in 2004 could expect to survive to age 75.
- These figures compare to 38 per cent of males and 54 per cent of females in 1950 – an increase of 73 and 54 per cent for males and females respectively.
- Patterns of improvement differed between the sexes with probabilities of survival for females increasing across the period 1950 to 2004, while improvements for males were concentrated in more recent decades.

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## Appendix A

### Calculation of probability of survival

Using standard life table notation, $l_x$ is the number of people alive at exact age x. $\frac{l_{x+n}}{l_x}$ is the probability of people surviving from their x[th] birthday to the (x+n) [th] birthday, so $\mathbf{l_{70}}$ is the number of persons living at age 70.

The probability of survival to age 70 was calculated using:

$$\frac{l_{70}}{l_0} = \frac{l_{70}}{100{,}000}$$