International Mortality and Smoking Statistics System (IMASS)

I. Characterizing and comparing mortality trends in 30 developed countries

IA. Lung cancer

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EXECUTIVE SUMMARY

Lung cancer mortality rates by sex, age, period of death and birth cohort for 30 developed countries are summarized in a variety of tables and figures. From the data presented, a number of conclusions are drawn, including the following:

1. Lung cancer rates are typically substantially higher in men than in women, except in the case of recent data for younger age groups in various countries including the USA and UK.

2. For men dying early in the period studied, many countries showed a tendency for rates to rise with age up to around age 70 and then fall. Suggestions that this might indicate a major genetic component of lung cancer can be countered by the observation that rates tended to rise over the whole age range studied (30 to 84) at the end of the period studied, and more importantly by the observation of a continuing rise with age when rates for specific birth cohorts were studied.

3. The highest age-standardized rate for males aged 30-84 was 208 in Hungary in 1996-2000 while the lowest was 6.7 in Japan in 1946-1950. For women, the highest was 67 in Denmark in 1996-2000, while the lowest was 2.3 in Japan in 1946-1950.

4. In males, lung cancer rates tend to have risen progressively in nearly all countries for cohorts born in 1871-1875, 1881-1885, 1891-1895 and 1901-1905. In the UK, rates have fallen progressively for cohorts born since then, up to the latest, born in 1961-65, for which data are considered. For most countries this long-term decline is not evident. Though some countries do show a decline starting later, for many countries (including Japan, Spain, Portugal, France, Greece, Hungary and other East European countries) the latest born cohorts have the highest risks.

5. In females, lung cancer rates in the UK rose progressively for cohorts born up to around 1921-1925 and then fell in later born cohorts. This pattern was not generally seen in other countries. While in some countries the rise with

increasing year of birth has flattened out in recent cohorts, in about half there is a rise in lung cancer rate over the whole range of cohorts studied.

6. In both sexes, the rank order of the countries as regards lung cancer rate has changed considerably over time (or later birth cohort).

7. In men, rates in UK, Finland, Austria and Netherlands used to be among the highest, but their decline in rank order has been relatively marked. Countries showing the most notable increases in rank order include Hungary and other East European countries, Greece, France, Spain and Portugal. Iceland, Japan, Norway and Sweden have always had relatively low rates compared to other countries.

8. In women, relatively high rankings seen in earlier birth cohorts have decreased in UK, Finland, Austria, Bulgaria and Greece. High ranks in recently born cohorts are seen in Iceland, Hungary, Denmark, Canada and the USA.

The relationship of these trends to trends in smoking habits will be considered in a further document.

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1. Introduction

2002 saw the publication of the second edition of "International Smoking Statistics" (ISS),[1] a collection of historical smoking data from developed countries. Subsequently, we created an Excel spreadsheet program, the "International Mortality and Smoking Statistics System" (IMASS), containing nationally-based data for 30 countries on mortality from major smoking-related diseases and on selected tobacco and smoking statistics derived from ISS. Facilities are provided in IMASS to help the user to explore the relationships in the data via a variety of plots and tabulations.[2]

Over the next few months, we are using IMASS to explore various aspects of the data collected. In Report I, we restrict attention to the mortality data and attempt to characterize and compare the mortality trends in the 30 countries. Report I is divided into four parts, parts A, B, C and D presenting and discussing the results for, respectively, lung cancer, ischaemic heart disease (IHD), chronic obstructive pulmonary disease (COPD) and non-acute respiratory diseases (NARD). Part A, this part, also describes materials and methods common to the whole of Report I. To some extent, Report I can be seen as a reference manual, as it presents the rates by age, sex and period for each disease and country.

2. Materials and methods

2.1 Countries included

The countries for which data are available are listed below. The country names relate to political boundaries as they existed pre-1990.

Countries considered in ISS and IMASS

1	Australia	11	Greece	21	Poland
2	Austria	12	Hungary	22	Portugal
3	Belgium	13	Iceland	23	Romania
4	Bulgaria	14	Ireland	24	Spain
5	Canada	15	Israel	25	Sweden
6	Czechoslovakia	16	Italy	26	Switzerland
7	Denmark	17	Japan	27	UK
8	Finland	18	Netherlands	28	USA
9	France	19	New Zealand	29	USSR
10	Germany	20	Norway	30	Yugoslavia

2.2 Scope of the mortality data

The mortality data used in Report I are derived from age-, sex- and cause-specific information made available by WHO on the Internet, and commonly start in the 1950s. Subject to availability, results are presented by 5-year periods, starting at 1946-50 and continuing to 1996-2000, and in the 5-year age groups 30-34, 35-39, … 80-84. Rates for ages below 30 are not included as lung cancer is extremely rare then and rates for age 85+ are not included as they are subject to considerable unreliability of diagnosis and span more than 5 years. Note that if data are not available for the full five years, the rate is calculated from the available years. Appendix 1 shows, for each country, the period of availability of mortality data used in this report.

2.3 Definitions of causes of death

Deaths are coded according to successive revisions of the International Classification of Diseases (ICD). Countries vary as to when (and if) they introduce the various revisions (see Appendix 1). In the 1950s the 6th revision was in use, and the latest 10th revision, published in 1992, is now in use by 13 of the countries. Except in the case of the 10th revision, which is used in full, data are provided to WHO according to various summary coding lists based on the ICD, and some countries use their own more limited versions.

Changes between the ICD revisions reflect differences in the understanding of the disease process and changes in terminology. For instance, stroke was a disease of the nervous system up to the 7th revision and of the vascular system subsequently, while COPD is a term of only relatively recent origin. These changes can make it difficult to extract consistently defined series of mortality data. The actual definitions used for the four disease groupings are detailed in Appendix 2.

As can be seen from Appendix 2, there is no real difficulty in obtaining a comparable disease definition from the data available for the various ICD revisions for lung cancer, the definition used always including cancers of the trachea, lung and bronchus.

For IHD, COPD and NARD, there are more severe problems of comparability, as discussed, respectively, in Parts B, C and D of this report.

It should also be noted that there are numerous 'rules' used when carrying out the coding, and that these may vary between countries and from time to time. For instance, the death coded is the underlying cause, but between 1985 and 1992 England and Wales adopted its own version of the rule to determine the underlying cause, resulting in a substantial drop in the death rate from pneumonia in that period. A discussion of other aspects of the validity of mortality data is given by Alderson.[3]

2.4 Individual country tables (Table L1)

Table 1 gives mortality rates by age, period and sex. Each page relates to a given country, with the pages numbered using a system whereby, for example, in Table L1.13, the letter L refers to data for lung cancer (alternatives being IHD (I), COPD (C) and NARD (R)), and the figure 13 refers to the country (here 13 = Iceland, see section 2.1). Results for males are given at the top of the page and results for females at the bottom. Rates for each sex are given per 100,000 per year to 2 decimal places for the full range of 5-year periods (1946-1950 to 1996-2000) and by 5-year age groups (30-34 to 80-84). For each period, the table also presents an overall estimate for age 30-84, adjusted by direct standardization to the age-distribution of the European Standard Population.[4]

2.5 Birth cohorts

Note that the diagonals of Table 1 can be interpreted as representing the experience of people born around the same time. For example, people aged 0-4 in 1916-20 would be 30-34 in 1946-50, 35-39 in 1951-55, … 80-84 in 1996-2000, and so rates in the diagonal from the top left to the bottom right of the table would characterize their experience. Note that, for other birth cohorts, the limited nature of the periods for which data are available will not allow coverage of the whole age range of interest. Thus the earliest birth cohort for which data are available is born in 1866-70, also providing data for only one age group (80-84 in 1946-50) and the latest is born in 1966-70, providing data for only one age group (30-34 in 1996-2000). Only the cohort born in 1916-1920 provides data for the whole age range considered (30-34 in 1946-50 to 80-84 in 1996-2000).

Some limitations to this birth cohort approach should be noted. First, people dying within a 5-year period and a 5-year age group actually include those born in a 10-year age range. For example, those dying at age 60-64 in 1961-65 include 64-year-olds dying in 1961, born in 1896, and 60-year-olds dying in 1965, born in 1905. A more rigorous method taking these overlapping cohorts into account has been used in some other work[5,6] but is not attempted here. Second, the approach ignores the fact that the data in the different cells of a diagonal do not relate to the exact same people, as immigration, emigration and mortality are ignored. Differential mortality, with more smokers than non-smokers dying early, may be an important feature for the oldest age groups, but is not considered here.

2.6 Individual country plots (Figure L1)

Figure 1 plots the mortality rates shown in Table 1 but by age and birth cohort rather than age and period of death. Here the x axis is the age group, the y axis the mortality rate (per 100,000 per year) on a logarithmic scale, with lines representing specific birth cohorts. To avoid too many lines appearing on the figure, lines are shown for every alternate birth cohort (1871-75, 1881-85 … 1951-55, 1961-65). The first and last cohorts have (at most) two points in the plot, the 1881-85 and 1951-55 cohorts four, the 1891-95 and 1941-45 cohorts six, the 1901-05 and 1931-35 cohorts eight and the 1911-15 and 1921-25 cohorts ten. For the same disease, plots for males (at the top of the page) and for females (at the bottom) are shown on the same scale (0.1 to 1000 for lung cancer, 0.1 to 10000 for other diseases) for comparability. For the same cause of death and country, corresponding pages of Table 1 and Figure 1 appear on facing pages.

2.7 Between country comparison tables (Tables L2 and L3)

Table 2 compares mortality rates in the 30 countries for various age groups for men or women born in a given 5 year period. It is divided into 10 pages, the first five pages (2.1 to 2.5) relating to males born in, successively, 1896-1900, 1906-1910, 1916-1920, 1926-1930 and 1936-1940 and the other five pages (2.6 to 2.10) giving similar data for females. Note that the range of age groups for which data are available depends on the period of birth considered.

Each page of Table 2 is divided into 2 parts. Part a, at the top of the page, gives the mortality rates by age for each country. Part b, at the bottom of the page, converts the rates within each age group to ranks (1 = highest, 2 = next highest, etc.).

Table 3 is somewhat similar to Table 2, but compares mortality rates in the 30 countries for various birth cohorts for a given age group. It is again divided into 10 pages, the first five pages (3.1 to 3.5) relating to males aged, successively, 35-39, 45-49, 55-59, 65-69, 75-79 with the other five pages (3.6 to 3.10) giving similar data for females. Note that the range of birth cohorts covered shifts from page to page, from 1911-1915 to 1961-1965 for data for age 35-39 to 1871-1875 to 1921-1925 for data for age 75-79.

As for Table 2, part a of Table 3 gives rates and part b gives ranks.

2.8 Between country comparison plots (Figures L2 and L3)

Figure 2 plots the ranks shown in part b of Table 2, but only for age groups 35-39, 45-49, 55-59, 65-69 and 75-79. Again, dependent on the period of birth, the age groups with data vary.

Where data are available for all 30 countries, the ranks plotted are exactly those given in part b of Table 2. Where data are available for less than 30 countries for a given age group, adjusted ranks are plotted where:

$$\text{Adjusted rank} = \text{Rank} * 31/(N+1)$$

N being the number of countries for which ranks are available for that age group. This adjustment ensures that the country in the middle stays in the middle, and the countries with the highest and lowest ranks stay symmetrically near the top and bottom of the figure.

The figure joins the values at successive age groups by straight lines so that one can reasonably easily see which countries are rising or falling relative to the others.

For the same sex and birth period, corresponding pages of Table 2 and Figure 2 appear on facing pages.

Figure 3 plots the ranks shown in part b of Table 3, but only for alternate birth cohorts, e.g. 1916-1920, 1926-1930 … 1956-1960 for data for age 35-39 and 1876-1880, 1886-1890, … 1916-1920 for data for age 75-79. As for Figure 2, ranks are adjusted where data are available for less than the full complement of 30 countries. Again, lines join values for the same countries and corresponding pages of Table 3 and Figure 3 appear on facing pages.

2.9 Further between country comparisons (Table L4 and Figure L4)

For 12 selected countries, lung cancer rates for age 30-84 standardized to the European Standard Population are shown for the periods 1951-1955, 1961-1965, 1971-1975, 1981-1985 and 1991-1995, separately for males and females, in Table L4. The same data are plotted in Figure L4 with a separate line showing the data for each country. As the tables and figures are each only one page, they have a suffix .1.

All 30 countries were not shown, so as to aid visual comparison. The countries were selected to include those of major interest and those showing the most extreme patterns.

3. Lung Cancer

3.1 Table L1

In men in all countries and in all periods lung cancer rates tend to rise sharply between age 30-34 and age 60-64, typically by two orders of magnitude. At around the beginning of the period studied, in 1951-1955, rates typically peaked at age 65-69 or age 70-74 (true for 17 of the 24 countries with relevant data), or even earlier (true for four of the countries), and then declined at higher ages. By around the end of the period studied, using the latest data available, this pattern of a rise then fall with age had changed. For 19 of the 30 countries, rates rose continuously up to age 80-84, the major exceptions to this being in the East European and Scandinavian countries. In all seven East European countries, the peak lung cancer rate occurred before age 80-84, while in the five Scandinavian studies, rates tended to be quite similar at ages 75-79 and 80-84, with a slightly lower rate at age 80-84 than at age 75-79 in Finland, Norway and Sweden.

Rates for age 30-84, age standardized to the European Standard Population, typically rose over the period and then fell, with peaks occurring earliest in Austria (1966-1970), UK (1971-1975), Finland, Germany, New Zealand and Sweden (1976-1980). However, rates were still rising at 1996-2000 in Hungary, Iceland, Japan, Portugal and Romania and at 1986-1990 (when data were last available) in Czechoslovakia, USSR and Yugoslavia. The highest age-standardized rate achieved for age 30-84 was 208 in Hungary in 1996-2000, other countries with peak rates above 175 being Belgium (199), Netherlands (196), UK (187), Czechoslovakia (184) and Poland (178). The lowest peak age standardized rate was 64, in Sweden, with other peak rates below 100 being in Israel (66), Portugal (74), Japan (78) and Iceland (91). The lowest rate recorded was 6.7, in Japan in 1946-1950.

Rates in women are typically substantially lower than in men, though at age 30-34 there is often little difference between the sexes, and in some countries (Australia, Canada, Denmark, Ireland, Netherlands, New Zealand, Norway, Sweden, UK, USA) rates in recent periods are quite similar in the two sexes up to age 40-44 or even age 45-49. In 24 of the 30 countries, the peak age-standardized rate for age 30-84 occurs in the latest period, minor exceptions being Israel, Portugal, Switzerland and the UK, where it occurs in 1991-1995, and Ireland where it occurs in 1986-1990. For Bulgaria, unusually, the peak was in 1961-65 with rates relatively unchanged over time. The same is true for Spain (though the peak was in 1996-2000), but in most countries there has been a very clear rise. The highest peak age-standardized rate for age 30-84 occurs in Denmark (70), with other rates of 50 or more being in Iceland (68), USA (67), Canada (60), UK (52) and Hungary (50). The lowest peaks were in Spain (10) and Portugal (11). The lowest rate recorded was 2.3 in Japan in 1946-1950.

Whereas rates in 1951-1955 typically peaked at age 65-69 or age 70-74 in men, in women they tended to peak at age 75-79 or be highest at age 80-84 (true in 18 of the 24 countries with relevant data), with only Ireland and Japan peaking at age 65-69 and Czechoslovakia, Israel, Italy and Sweden peaking at age 70-74. Based on the latest available data, 16 of the 30 countries had peak rates at age 80-84, with a further 10 peaking at age 75-79, countries with earlier peaks being Denmark and Netherlands (age 65-69) and New Zealand and Norway (age 70-74).

Claims have been made in the past by, e.g., Philip Burch,[7] that the observation of a lung cancer rate pattern that rises with age and then falls is due to there being a major genetic component to the disease, the fall occurring because the group that is particularly genetically susceptible to the disease forms a decreasing proportion of the at-risk population with increasing age due to their poorer survival. Though it is true that genetic heterogeneity should eventually lead to a downturn in disease rate with increasing age in a population that is uniformly exposed to relevant environmental factors, there are considerable problems in interpreting the lung cancer rate/age relationship as demonstrating a major genetic effect.

One problem is that, as already noted, there are numerous examples where the rate rises over the whole age range considered up to age 80-84, and it is not plausible that genetic effects would be present for some country/sex/period combinations and not for others. Another problem is that plotting lung cancer rates against age for a given time period is equivalent to comparison of data points for groups of people born at widely varying times and possibly with widely differing exposure to environmental factors. If there is a genetic or environmental factor it makes more sense to study it by plotting the relationship between lung cancer rate and age for people born at or about the same point in time.

3.2 Figure L1

The data plotted in Figure L1 are the same as those given in Table L1 but they are plotted so that rates for the same birth cohort are on the same line on the figure. Though there are exceptions where rates within a cohort decline between ages 75-79 and 80-84 (e.g. Bulgaria and Romania due perhaps to unreliable data at age 80-84 and Iceland due to small numbers of deaths) the prevailing impression is that the lines for a cohort (which are plotted on a logarithmic scale) tend to rise continuously with age, not suggestive of any large genetic effect. Instead, the impression is that the cohort lines form quite parallel curves with countries varying in how well the lines are separated.

The data for UK males (Figure L1.27) show a very clear cohort related pattern. Looking at the right hand side of the figure it is clear that rates in the cohort born in 1871-1875 are (for a given age) substantially lower than those born in 1881-1885, which themselves are substantially lower than those born in 1891-1895. Rates for the cohort born in 1901-1905 are the highest, with rates for the cohort born in 1911-1915 slightly lower, and then (looking now at the left hand side of the figure) there is a progressive fall over cohorts 1921-1925, 1931-1935 … 1961-1965. It is clear that a model in which lung cancer rate was expressed as a product of an age effect and a cohort effect would explain a substantial proportion of the variation for UK males.

Looking at the data for males for other countries, it is clear that the progressive rise over cohorts 1871-1875, 1881-1885, 1891-1895 and 1901-1905 is (where data are available) generally evident, with the exception of Romania and perhaps Bulgaria, though the separation of the lines varies by country. However, the birth cohort with the highest rates varies by country, as does the evidence of a decline in more recently born cohorts. For most countries the long term decline in risk by birth cohort seen in the UK is simply not evident. Though there are some countries for which the most recently born cohort considered (1961-1965) does have lower lung cancer rates than cohorts born earlier in the century (Australia, Belgium, Finland, Ireland, Netherlands, Sweden, UK, USA) there are some where the latest born cohorts have the highest risks (Bulgaria, France, Greece, Hungary, Japan, Portugal, Romania, Spain, Yugoslavia).

For women, though rates for the earliest born cohort plotted (1871-1875) are usually the lowest, there is generally less separation between these cohorts. Although the UK again shows a pattern of a rise then fall with increasing time of birth of the cohort, with the cohort born around 1921-1925 having the highest rates and later born cohorts having progressively lower rates, this is very much the exception rather than the rule. Some countries show a rise in lung cancer rate with increasing year of birth over virtually the whole range studied (e.g. Belgium, Canada, France, Germany, Hungary, Japan, Netherlands, New Zealand, Norway, Poland, Portugal, Sweden, Switzerland and Yugoslavia) while others have a number of recent cohorts with quite similar risk (e.g. Australia, Bulgaria, Denmark, Greece, Ireland, Israel, Italy, Romania, Spain, USA). [Note that, especially for the smaller countries, rates for the younger age groups, which provide all the data for the latest born cohorts, can be subject to relatively large variation.]

3.3 Table L2 and Figure L2

For men born in 1896-1900 (L2.1), UK has the highest rates at every age group and, for many of the countries, the rank order changes quite little. For example Austria, Poland, Czechoslovakia and Netherlands all stay in the next four positions, though with some crossover, while Portugal, Spain, Japan, Norway and Iceland are always relatively low. Countries that do appear to have changed position materially are Australia, getting relatively higher and Bulgaria and Romania, getting relatively lower.

Looking at the remaining figures for males (L2.2-L2.5), a number of patterns are evident. As period of birth becomes later, the position of UK steadily declines until for men born 1936-1940 at age 55-59 it has dropped to 14th of the 26 countries with data. The ranking of Finland has also declined with later period of birth. With later period of birth it is also evident that the position of the East European countries has worsened relative to other countries, with the ranks of Hungary, Poland, Romania, Bulgaria, Czechoslovakia and USSR always in the top few for men born in 1936-1940. Portugal and Japan have remained relatively low (with the exception of age 75-79/born 1916-1920 for Japan), as have Norway, Iceland and Sweden. It is also notable that in each figure Canada moves up as age increases.

For women born in 1896-1900 (L2.6), UK again has the highest rates at every age group, but the positions of the countries show much more change than seen for men in L2.1. However, Ireland and Hungary remain high and Portugal, Spain and Netherlands remain low.

Looking at the remaining figures for females (L2.7-L2.10), one can also see a decline in the UK's position over birth period, though it remains higher than is the case for males. It is interesting to note how, for all birth periods, the rank order of many countries varies considerably. However, Ireland and USA remain relatively high and Portugal relatively low.

3.4 Table L3 and Figure L3

The changes in position for successive birth cohorts can perhaps be seen more clearly in Figure L3 than in Figure L2. For men aged 35 to 39 and 45 to 49 one can, for example, readily see the striking decline in the position of the UK and Finland and the tendency for a rise in position for Eastern European countries (not only Soviet Block but also Greece). Hungary has particularly high rates in recent cohorts and if the trends continue, very high overall rates can be predicted in the next 20 years or so as the more recently born cohorts age.

Looking at the whole set of figures for men, one can classify the countries into various groups.

Firstly, there are those countries who have tended to show a decline in their relative position. For four countries, UK, Finland, Austria and Netherlands, rates used to be among the highest, but their decline has been quite marked. Australia, New Zealand and Switzerland have also declined relative to the other countries, but they did not start from such a high position. Belgium's position has also declined somewhat but only in recent cohorts and it still retains a high position.

Secondly, there are those countries which have tended to go up the ranking list. This applies to Hungary, Poland, Bulgaria, Romania and Greece. Romania had the lowest rates for cohorts born in 1906-10 and 1916-20 for men aged 75 to 79, but had among the highest for cohorts born in 1936-40, 1946-50 and 1956-60. Czechoslovakia has also shown some increases (and had about the highest rates in younger men when data were last available) but has always had one of the higher rates. A recent rise in position has also been seen in France, Spain and Portugal.

Thirdly, there are those countries whose positions do not show any marked change. Iceland, Japan, Norway and Sweden have always had relatively low rates, while Canada, Denmark and Germany have always been towards the middle of the ranking list.

Finally, the USA has shown a rise then decline. Rates for earlier born cohorts tended to be around the middle of those for the 30 countries, those for cohorts born in 1916-20, 1926-30 and 1936-40 were relatively high and those for cohorts born in 1946-50 and 1956-60 have gone back to being mid-table.

The data for women are less easy to classify than is the case for men. It is clear that, for a number of countries, relatively high rankings seen in earlier birth cohorts have tended to decrease. These countries include not only, as for men, the UK, Finland and Austria (though here the ranking has increased again in very recently born cohorts), but also Bulgaria (particularly for older women) and Greece. High rates in recent cohorts are seen in Iceland (whose ranking has usually been high), Hungary (whose ranking has always been quite high but has increased recently), Denmark (which has had high rates generally for cohorts born in the 1900s), Canada (which has risen sharply up the ranking list) and the USA (which rose up the rankings and has then fallen slightly in recently born cohorts. Low rates in recent cohorts have been seen in Portugal and Spain (always low) and France (though data from the latest cohort studied, 1946-1950, show relatively higher rates). Germany and Netherlands showed a decline in rankings and then an increase. Japan has tended to show a rise in the rankings and then a fall.

3.5 Table L4.1 and Figure L4.1

For lung cancer, it was felt useful to illustrate the differential trends in the different countries further by showing the change in the rate for the whole age range 30-84 (standardized to the European Standard Population) over the period 1951-1955 to 1991-1995. To aid visual comparison, data were only tabulated (Table L4.1) and plotted (Figure L4.1) for 12 selected countries.

For men, it can be seen that the countries with relatively high rates in 1951-1955 continued to show a rise until at least 1971-1975 but then showed a fall, the decline being particularly early and marked in the UK and Finland. Countries which started very low (Japan, Portugal and Norway) have all shown continuing rises, though their rates remain lower than in the other countries plotted. Continuing rises have also been seen in France, and notably Hungary. The rise in the USA flattened out between 1981-1985 and 1991-1995.

For women, on the other hand, rates have generally risen over the whole period. The rise has been particularly marked in the USA, which overtook the UK in 1981-1985, which previously had been the highest of the countries selected.

4. Summary

Lung cancer mortality rates by sex, age, period of death and birth cohort for 30 developed countries are summarized in a variety of tables and figures. From the data presented, a number of conclusions are drawn, including the following:

1. Lung cancer rates are typically substantially higher in men than in women, except in the case of recent data for younger age groups in various countries including the USA and UK.

2. For men dying early in the period studied, many countries showed a tendency for rates to rise with age up to around age 70 and then fall. Suggestions that this might indicate a major genetic component of lung cancer can be countered by the observation that rates tended to rise over the whole age range studied (30 to 84) at the end of the period studied, and more importantly by the observation of a continuing rise with age when rates for specific birth cohorts were studied.

3. The highest age-standardized rate for males aged 30-84 was 208 in Hungary in 1996-2000 while the lowest was 6.7 in Japan in 1946-1950. for women, the highest was 67 in Denmark in 1996-2000, while the lowest was 2.3 in Japan in 1946-1950.

4. In males, lung cancer rates tend to have risen progressively in nearly all countries for cohorts born in 1871-1875, 1881-1885, 1891-1895 and 1901-1905. In the UK, rates have fallen progressively for cohorts born since then, up to the latest, born in 1961-65, for which data are considered. For most countries this long-term decline is not evident. Though some countries do show a decline starting later, for many countries (including Japan, Spain, Portugal, France, Greece, Hungary and other East European countries) the latest born cohorts have the highest risks.

5. In females, lung cancer rates in the UK rose progressively for cohorts born up to around 1921-1925 and then fell in later born cohorts. This pattern was not generally seen in other countries. While in some countries the rise with increasing year of birth has flattened out in recent cohorts, in about half there is a rise in lung cancer rate over the whole range of cohorts studied.

6. In both sexes, the rank order of the countries as regards lung cancer rate has changed considerably over time (or later birth cohort).

7. In men, rates in UK, Finland, Austria and Netherlands used to be among the highest, but their decline in rank order has been relatively marked. Countries showing the most marked increases in rank order include Hungary and other East European countries, Greece, France, Spain and Portugal. Iceland, Japan, Norway and Sweden have always had relatively low rates compared to other countries.

8. In women, relatively high rankings seen in earlier birth cohorts have decreased in UK, Finland, Austria, Bulgaria and Greece. High ranks in recently born cohorts are seen in Iceland, Hungary, Denmark, Canada and the USA.

The relationship of these trends to trends in smoking habits will be considered in a further document.

5. References

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Appendix 1 – Availability of mortality data (as at June 2002)

Country	Deaths				ICD revision – year first used				
	Single years		Periods		6	7	8	9	10
	Start	End	Start	End					
Australia	1950	1999	1946-1950[a]	1996-2000[b]	1950	1958	1968	1979	1998
Austria	1955	2000	1951-1955[a]	1996-2000	1955	1958	1969	1980	-
Belgium	1954	1995	1951-1955[a]	1991-1995	1954	1958	1968	1979	-
Bulgaria	1964	1999	1961-1965[a]	1996-2000[b]	-	1964	1968	1980	-
Canada	1950	1997	1946-1950[a]	1996-2000[b]	1950	1958	1969	1979	-
Czechoslovakia[c]	1953	1990	1951-1955[a]	1986-1990	1953	1958	1968	1979	-
Denmark	1951	1998	1951-1955	1996-2000[b]	1951	1958	1969	-	1994
Finland	1952	1999	1951-1955[a]	1996-2000[b]	1952	1958	1969	1987	1996
France	1950	1998	1946-1950[a]	1996-2000[b]	1950	1958	1968	1979	-
Germany[d]	1952	1999	1951-1955[a]	1996-2000[b]	1952	1958	1968	1979	1998
Greece[e]	1961	1998	1961-1965	1996-2000[b]	-	1961	1968	1979	-
Hungary	1955	2000	1951-1955 [a]	1996-2000	1955	1958	1969	1979	1996
Iceland	1951	1997	1951-1955	1996-2000[b]	1951	1958	1971	1981	1996
Ireland	1950	1998	1946-1950[a]	1996-2000[b]	1950	1958	1968	1979	-
Israel[f]	1950	1997	1946-1950[a]	1996-2000[b]	1950	1958	1969	1979	-
Italy	1951	1998	1951-1955	1996-2000[b]	1951	1958	1968	1979	-
Japan	1950	1999	1946-1950[a]	1996-2000[b]	1950	1958	1968	1979	1995
Netherlands	1950	1999	1946-1950[a]	1996-2000[b]	1950	1958	1969	1979	1996
New Zealand	1950	1998	1946-1950[a]	1996-2000[b]	1950	1958	1968	1979	-
Norway	1951	1998	1951-1955	1996-2000[b]	1951	1958	1969	1986	1996
Poland	1959	1999[g]	1956-1960[a]	1996-2000[b]	-	1959	1969	1980	1999
Portugal	1955	2000	1951-1955[a]	1996-2000	1955	1958	1971	1980	-
Romania	1959	2000[h]	1956-1960[a]	1996-2000	-	1959	1969	1980	1999
Spain	1951	1998	1951-1955	1996-2000[b]	1951	1958	1968	1980	-
Sweden	1951	1998	1951-1955	1996-2000[b]	1951	1958	1969	1987	1997
Switzerland[i]	1951	1997	1951-1955	1996-2000[b]	1951	1958	1969	-	1995[i]
UK	1950	1999	1946-1950[a]	1996-2000[b]	1950	1958	1968	1979	-
USA	1950	1998	1946-1950[a]	1996-2000[b]	1950	1958	1968	1979	-
USSR[j]	1982	1990	1981-1985[a]	1986-1990	-	-	-	1982[j]	-
Yugoslavia[e]	1960	1990	1956-1960[a]	1986-1990	-	1960	1968	1979	-

- Not used
a First period based on less than 5 years' data – see 'Single years, Start' column
b Final period based on less than 5 years' data – see 'Single years, End' column
c Data for Czechoslovakia for 1991, for Czech Republic from 1985, and for Slovakia from 1992 are available but have not been entered
d W Germany (former Federal Republic) to 1990, unified Germany from 1991
e Earlier data are available but with insufficient detail
f Jewish population only to 1974, then total population
g 1997 and 1998 missing
h 1979 missing
i Data for Switzerland under the 10th revision are available in less detail than for other countries. See Appendix 2
j Data for USSR under the 9th revision are available in less detail than for other countries, and it is not possible to extract data for an equivalent definition of COPD. See Appendix 2

Appendix 2 - Definitions of causes of death

ICD Revision	Lung Cancer		IHD	
	Summary	Full	Summary	Full
6th and 7th	A050	162 = malignant neoplasm of bronchus and trachea, and of lung specified as primary 163 = malignant neoplasm of lung, unspecified	A081	420 = arteriosclerotic heart disease, including coronary disease 421 = chronic endocarditis, not specified as rheumatic 422 = other myocardial degeneration
8th	A051	162 = malignant neoplasm of trachea, lung and bronchus	A083	410 = AMI 411 = other acute and subacute IHD 412 = chronic IHD 413 = angina pectoris 414 = asymptomatic IHD
9th	B101	162 = malignant neoplasm of trachea, lung and bronchus	B27	410 = AMI 411 = other acute and subacute IHD 412 = old MI 413 = angina pectoris 414 = other forms of chronic IHD
10th (except Switzerland)	C33 = malignant neoplasm of trachea C34 = malignant neoplasm of bronchus and lung		I20 = angina pectoris I21 = AMI I22 = subsequent MI I23 = certain current complications following acute MI I24 = other acute IHD I25 = chronic IHD	
10th (Switzerland)	G026	Same as other countries	G051, G052	Same as other countries

AMI acute myocardial infarction
IHD ischaemic heart disease
MI myocardial infarction

Appendix 2 - Definitions of causes of death - continued/1

ICD Revision	COPD		Respiratory Diseases (non-acute)	
	Summary	Full	Summary	Full
6th and 7th	A093	501 = bronchitis unqualified	As COPD +	
		502 = CB	A094	510 = hypertrophy of tonsils and adenoids
	A097	511 = peritonsillar abscess	A095	518, 521 = empyema and absess of lung
		512 = chronic pharyngitis and nasopharyngitis	A096	519 = pleurisy
		513 = chronic sinusitis		
		514 = deflected nasal septum		
		515 = nasal polyp		
		516 = chronic laryngitis		
		517 = other diseases of URT		
		520 = spontaneous pneumothorax		
		522 = pulmonary congestion and hypostasis		
		523 = pneumoconiosis due to silica and silicates (occupational)		
		524 = other specified pneumoconiosis and pulmonary fibrosis of occupational origin		
		525 = other chronic interstitial pneumonia		
		526 = bronchiectasis		
		527 = other diseases of lung and pleural cavity **(including emphysema)**		
8th	A093	490 = bronchitis, unqualified	As COPD +	
		491 = CB	A094	500 = hypertrophy of tonsils and adenoids
		492 = emphysema	A095	510 = empyema
		493 = asthma		513 = abscess of lung
	A096	501 = peritonsillar abscess		
		502 = chronic pharyngitis and nasopharyngitis		
		503 = chronic sinusitis		
		504 = deflected nasal septum		
		505 = nasal polyp		
		506 = chronic laryngitis		
		507 = hay fever		
		508 = other diseases of URT		
		511 = pleurisy		
		512 = spontaneous pneumothorax		
		514 = pulmonary congestion and hypostasis		
		515 = pneumoconiosis due to silica and silicates		
		516 = other pneumoconiosis and related diseases		
		517 = other chronic interstitial pneumonia		
		518 = bronchiectasis		
		519 = other diseases of respiratory system (**including COPD**)		

CB chronic bronchitis
URT upper respiratory tract
COPD chronic obstructive pulmonary disease

Appendix 2 - Definitions of causes of death - continued/2

ICD Revision	COPD		Respiratory Diseases (non-acute)	
	Summary	Full	Summary	Full
9th (except USSR)	B323	490 = bronchitis, not specified as acute or chronic	As COPD +	
		491 = CB	B313	470,471 = deflected nasal septum and nasal polyps
		492 = emphysema	B314	472,473 = chronic pharyngitis, nasopharyngitis and sinusitis
		493 = asthma	B315	474 = chronic diseases of tonsils and adenoids
	B324	494 = bronchiectasis	B319	475-478 = peritonsillar abscess, chronic laryngitis, laryngotracheitis, allergic rhinitis, other diseases of URT
	B325	495 = extrinsic allergic alveolitis		
		496 = chronic airways obstruction NEC (**including COPD**)	B326	500-508 = pneumoconiosis and other lung disease due to external agents
			B327	511 = Pleurisy
			B329	510, 512-519 = empyema; pneumothorax; absess of lung and mediastinum; pulmonary congestions and hypostasis; post inflammatory pulmonary fibrosis; other alveolar and parietoalveolar pneumopathy; lung involvement in conditions classified elsewhere; other diseases of lung; other diseases of respiratory system
9th (USSR)	not possible		S329, B323	Same as other countries
10th (except Switzerland)	J40 = bronchitis, not specified as acute or chronic J41 = simple and mucopurulent CB J42 = unspecified CB J43 = emphysema J44 = other COPD J45 = asthma J46 = status asthmaticus J47 = bronchiectasis J67 = hypersensitivity pneumonitis due to organic dust (farmer's lung etc)		As COPD + J30-J39 = vasomotor and allergic rhinitis; chronic rhinitis, nasopharyngitis and pharyngitis; chronic sinusitis; nasal polyp; other disorders of nose and nasal sinuses; chronic disease of tonsils and adenoids; peritonsillar abscess; chronic laryngitis and laryngotracheitis; diseases of vocal chords and larynx NEC; other diseases of URT J60-J66 = pneumoconiosis (coalworker's; due to asbestos and other mineral fibres; due to dust containing silica; due to other inorganic dust; unspecified; associated with tuberculosis) J68-J70 = RC due to inhalation of chemicals, gases etc; pneumonitis due to solids and liquids; RC due to other external agents J80-J82 = adult respiratory distress syndrome; pulmonary oedema; pulmonary eosinophilis NEC J84-J86 = other interstitial pulmonary diseases; abscess of lung and mediastinum; pyothorax J90-J94 = other disease of pleura J95-J96 = postprocedural RD NEC; respiratory failure NEC J98-J99 = other RD; RD in DCE	
10th (Switzerland)	G063	J40-J46, i.e. same as other countries except excludes J47 = bronchiectasis and J67 = hypersensitivity pneumonitis due to organic dust (farmer's lung etc)	G063, G064	Same as other countries except includes J22 = unspecified acute lower respiratory infection and excludes J99 = RD in DCE

CB chronic bronchitis
COPD chronic obstructive pulmonary disease
DCE diseases classified elsewhere
NEC not elsewhere classified
RC respiratory conditions
RD respiratory disorders
URT upper respiratory tract