Trends in Mortality among British Doctors in Relation to Their Smoking Habits

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On 31 October 1951, Doll and Hill sent a questionnaire to all members of the medical profession in the United Kingdom enquiring about their smoking habits. On the basis of their replies 40,637 doctors (34,445 men and 6,192 women) could then be classified in a few broad groups according to their age, the amount of tobacco they smoked, their method of smoking, and whether smoking had been continued or abandoned. Further questionaries were sent to the male survivors at the end of 1957 and again at the beginning of 1966, and to the female survivors in 1961. Information about the date and cause of death of the men and women who died was obtained with the assistance of the Registrars General in the United Kingdom, the General Medical Council, and the British Medical Association. When necessary, information was also sought from the records of the fighting Services and from other sources at home and abroad. A few deaths came to light only as a result of the response to the second and third questionaries. Doctors who did not reply to the third questionary and who were not known to have died or to have been struck off the medical register were followed up individually. All but 21 of the 34,445 men (0.06 per cent) were eventually shown to be alive on 1 November 1965 or to have died before that date, so that the mortality rates calculated from the data can be only very slightly in error.

Detailed accounts of the study have been given in previous publications (Doll and Hill, 1954, 1956, 1964). In these reports it was noted that the doctors who chose to answer the initial questions cannot have been altogether representative of the total. The seriously ill would have been unable to respond, so that the mortality of those who did would have been, at least for a time, abnormally low. In fact, using a 1 in 10 random sample of those who were initially written to as a basis, Doll and Hill (1964) calculated that the standardised death rate of those who did reply was only 63 per cent of the death rate for all doctors in the second year of the inquiry and 85 per cent in the third year. In the fourth to tenth years the proportion varied about an average of 93 per cent and there was no evidence of any regular change.
with the further passage of time. Evidently the effect of selection did not wear off entirely, but after the third year it had become slight.

**TRENDS IN MORTALITY**

In this report, we present the trends in mortality from different diseases and groups of diseases observed in male doctors during the first fifteen years of the study, and we compare them with the trends recorded for the whole population of England and Wales. We have limited the comparison to ages 35 to 84 years as (i) none of the doctors under observation was less than 35 years old at the end of the period of study, and (ii) age-specific death rates for the general population are not published for men more than 84 years old. Altogether, 6,321 deaths occurred among 34,203 men in this age group. The total mortality observed in each of the fifteen years is shown in Table 1.

**Table 1. Observed mortality in doctors, by year of observation**

| Year of observation | Calendar year (1 November to 31 October) | Death rate per 1,000 men |
|---------------------|------------------------------------------|-------------------------|
| 1                   | 1951-52                                  | 14.3                    |
| 2                   | 1952-53                                  | 15.2                    |
| 3                   | 1953-54                                  | 17.4                    |
| 4                   | 1954-55                                  | 17.9                    |
| 5                   | 1955-56                                  | 17.0                    |
| 6                   | 1956-57                                  | 17.3                    |
| 7                   | 1957-58                                  | 19.9                    |
| 8                   | 1958-59                                  | 17.2                    |
| 9                   | 1959-60                                  | 17.4                    |
| 10                  | 1960-61                                  | 17.6                    |
| 11                  | 1961-62                                  | 16.3                    |
| 12                  | 1962-63                                  | 18.5                    |
| 13                  | 1963-64                                  | 17.7                    |
| 14                  | 1964-65                                  | 16.6                    |
| 15                  | 1965-66                                  | 16.4                    |

In this and subsequent tables the death rates have been standardised for age, using the population of England and Wales as recorded in 5-year age groups at the 1961 census as the standard. For the purpose of comparison with the national data we have omitted the experience of the first and second years, since the mortality rates in these years are obviously biased by the selection of relatively fit men at the start of the enquiry. We have also omitted the fifteenth year as the last intensive follow-up was conducted in 1966 and we cannot be as certain that all deaths that occurred in that year have been recorded as for other years. The data for the remaining twelve years have
been grouped in three four-year periods to reduce the effect of random variation of small numbers which, while not important in relation to all deaths, could be important for deaths due to individual diseases. By grouping the observations in this way, it will be noted that we have included one year of observation in the first period for which Doll and Hill (1964) had evidence that the initial self-selection of respondents might still be affecting the trend in mortality. By so doing we may have slightly underestimated the mortality in the first four-year period and, consequently, underestimated the extent to which mortality subsequently fell, and overestimated the extent to which it rose.

**Table 2.** Ages 35 to 84 years. Death rate in doctors and in population of England and Wales, by cause and date of observation: standardised for age

| Cause of death                                      | Standardised death rate per 1,000 men per year in | Doctors | England and Wales |
|----------------------------------------------------|--------------------------------------------------|---------|------------------|
|                                                    | 1953     | 1957     | 1961     | 1954     | 1958     | 1962     |
| Lung cancer                                        | 1.10     | 0.85     | 0.83     | 1.49     | 1.71     | 1.88     |
| Other cancers of upper respiratory and digestive tracts | 0.28     | 0.30     | 0.17     | 0.32     | 0.28     | 0.27     |
| Chronic bronchitis and emphysema                   | 0.44     | 0.49     | 0.54     | 1.60     | 1.70     | 1.84     |
| Arteriosclerotic heart disease                     | 5.19     | 5.64     | 5.59     | 4.25     | 4.91     | 5.64     |
| Peptic ulcer                                       | 0.09     | 0.16     | 0.08     | 0.36     | 0.28     | 0.23     |
| Cirrhosis of liver and alcoholism                  | 0.14     | 0.17     | 0.17     | 0.06     | 0.06     | 0.06     |
| Pulmonary tuberculosis                             | 0.16     | 0.17     | 0.03     | 0.35     | 0.23     | 0.16     |
| Related causes                                     | 7.40     | 7.77     | 7.42     | 8.43     | 9.17     | 10.08    |
| Other cancer                                       | 2.25     | 2.06     | 2.07     | 2.75     | 2.73     | 2.67     |
| Other respiratory disease                          | 0.49     | 0.62     | 0.65     | 1.36     | 1.46     | 1.42     |
| Cerebrovascular disease                            | 2.06     | 2.41     | 2.03     | 2.69     | 2.57     | 2.48     |
| Other cardiovascular disease                       | 3.01     | 2.93     | 3.03     | 4.13     | 3.46     | 2.93     |
| Violence                                           | 0.74     | 0.86     | 0.79     | 0.81     | 0.79     | 0.77     |
| Other causes                                       | 1.45     | 1.36     | 1.30     | 1.89     | 1.56     | 1.42     |
| Unrelated causes                                   | 10.00    | 10.24    | 9.88     | 13.62    | 12.57    | 11.69    |
| All causes                                         | 17.40    | 18.01    | 17.30    | 22.05    | 21.74    | 21.77    |

We have compared these rates with the rates for England and Wales, as the great majority of the doctors were resident in these countries. The inclusion of data for Scotland, Northern Ireland, and the Republic of Ireland would have improved the comparison, but would have made little difference to the results. Had we done this, the comparison would still not have been perfect as some of the doctors were nationals of other Commonwealth countries and returned home during the period of observation, while others emigrated.
Rates for the doctors observed over periods beginning on 1 November and ending on 31 October have been compared with national rates observed two months later (that is, from 1 January to 31 December).

Mortality rates observed in the three four-year periods are shown separately in Table 2 for 13 causes of death or groups of causes and for all causes. The causes of death have been shown in two classes according to whether the conditions causing death were or were not thought to be related to smoking. For this purpose, we used the classification suggested by the results of the first ten years’ observations (Doll and Hill, 1964). We, therefore, classified as ‘related causes’: cancer of the lung (ICD number 162–163), other cancers of the upper respiratory and digestive tracts (ICD numbers 140–148, 150, 160–161), chronic bronchitis and emphysema (ICD numbers 502, 527), arteriosclerotic heart disease with certain exclusions (ICD number 420), peptic ulcer (ICD numbers 540–542), cirrhosis of the liver and alcoholism (ICD numbers 322, 581), and pulmonary tuberculosis (ICD numbers 001–008). Since we had obtained detailed evidence of the causes of death for all patients who were certified as dying of cancer of the lung, we limited this category to deaths in which lung cancer was the most probable diagnosis. Fourteen out of 280 deaths were consequently attributed to other causes; 3 in the first period, 6 in the second, and 5 in the third. Deaths attributed to arteriosclerotic heart disease with mention of chronic bronchitis or cor pulmonale were excluded, as these would be associated with smoking for other reasons*, and deaths attributed to coronary disease with mention of hypertension were classified with deaths due to hypertension, as the earlier data had shown that these deaths were unrelated to smoking (Doll and Hill, 1964). The mortality attributable to lung cancer and arteriosclerotic disease in doctors is, therefore, not strictly comparable with the corresponding rates in the population of England and Wales as a whole. There is, however, no reason to suppose that these modifications have affected the relative mortality rates in different periods.

The results show that the mortality of doctors from all diseases that were ‘related to smoking’ increased from the first to the second period and then fell to its initial level, while the corresponding mortality rate of all men in England and Wales increased steadily throughout. Of the individual diseases, the most striking difference is observed for lung cancer, the mortality of which fell by 25 per cent in doctors and increased by 26 per cent in the general population. The trend in mortality from diseases that were unrelated to

* This exclusion was made for the purpose of examining coronary disease uncomplicated by other factors, but these deaths should have been included among ‘related diseases’. The number (45), however, is too small to have materially affected the result.
smoking paralleled the trend in the mortality from related diseases in doctors, but decreased progressively in the general population.

The trends in mortality at ages 35 to 84 years are influenced to a large extent by the relatively high mortality recorded at the oldest ages. In these age groups diagnosis is least certain and the effect of changes in smoking habits is least likely to be able to make itself felt. We have, therefore, examined separately the trends in mortality at ages 35 to 64 years and these are shown in Table 3. The results show that at these ages the mortality from 'related diseases'

Table 3. Ages 35 to 64 years. Death rate in doctors and in population of England and Wales, by cause and date of observation: standardised for age

| Cause of death                                | Standardised death rate per 1,000 men per year in |
|----------------------------------------------|--------------------------------------------------|
|                                             | Doctors                                          | England and Wales                                |
|                                             | 1953 1957 1961                                   | 1954 1958 1962                                   |
| Lung cancer                                  | 0.60 0.56 0.37                                  | 1.13 1.19 1.20                                  |
| Other cancers of upper respiratory and digestive tracts | 0.14 0.20 0.13                                  | 0.14 0.13 0.12                                  |
| Chronic bronchitis and emphysema            | 0.18 0.12 0.14                                  | 0.74 0.73 0.71                                  |
| Arteriosclerotic heart disease              | 2.94 2.73 2.77                                  | 2.19 2.52 2.90                                  |
| Peptic ulcer                                 | 0.04 0.05 0.05                                  | 0.19 0.13 0.10                                  |
| Cirrhosis of liver and alcoholism           | 0.16 0.14 0.13                                  | 0.05 0.05 0.05                                  |
| Pulmonary tuberculosis                       | 0.16 0.11 0.03                                  | 0.29 0.17 0.10                                  |
| Related causes                               | 4.22 3.90 3.61                                  | 4.72 4.91 5.19                                  |
| Other cancer                                 | 1.16 1.03 0.86                                  | 1.39 1.36 1.33                                  |
| Other respiratory disease                    | 0.18 0.22 0.16                                  | 0.55 0.52 0.42                                  |
| Cerebrovascular disease                      | 0.56 0.96 0.50                                  | 0.80 0.75 0.70                                  |
| Other cardiovascular disease                 | 1.11 1.01 1.07                                  | 1.05 0.92 0.82                                  |
| Violence                                     | 0.53 0.84 0.68                                  | 0.60 0.61 0.60                                  |
| Other causes                                 | 0.77 0.59 0.58                                  | 0.82 0.65 0.60                                  |
| Unrelated causes                             | 4.30 4.64 3.86                                  | 5.21 4.80 4.47                                  |
| All causes                                   | 8.52 8.54 7.47                                  | 9.93 9.71 9.66                                  |

fell progressively in doctors and increased progressively in the country as a whole. Again the contrast was most marked for cancer of the lung (−38 per cent and +7 per cent). For diseases that were unrelated to smoking the trend in mortality in doctors was irregular, while in the country as a whole the mortality steadily decreased. For all causes taken together the mortality in doctors decreased by 12 per cent, while in the country as a whole it decreased by 3 per cent.
### Table 4. Smoking habits of doctors replying to the three questionaries

| Year | Age Group | Number of respondents | Non-Smokers | Ex-Smokers | Pipe or Cigar Smokers | Mixed Smokers | Cigarette Smokers | Cigarette (amount/day) |
|------|-----------|-----------------------|-------------|------------|----------------------|---------------|-------------------|----------------------|
|      |           |                       |             | 1-14       | 15-24                | 25+           |                   |                      |
| 1951 | 35 to 84  years | 24,149                | 12-0        | 19-5       | 13-2                 | 13-9          | 41-3              | 22-6                 |
| 1957 | 35 to 84  years | 27,572                | 14-4        | 28-4       | 13-6                 | 10-7          | 32-9              | 18-9                 |
| 1966 | 35 to 84  years | 25,833                | 19-2        | 32-0       | 18-8                 | 8-6           | 21-3              | 12-9                 |
|      |           |                       |             | 19-5       | 13-6                 | 10-7          | 32-9              | 18-9                 |
|      |           |                       |             | 21-2       | 19-2                 | 8-1           | 22-0              | 12-4                 |
| 1951 | 35 to 64  years | 20,074                | 12-6        | 18-1       | 11-5                 | 13-6          | 44-1              | 21-5                 |
| 1957 | 35 to 64  years | 23,024                | 15-7        | 26-5       | 12-7                 | 10-2          | 35-0              | 18-3                 |
| 1966 | 35 to 64  years | 20,253                | 21-2        | 29-5       | 19-2                 | 8-1           | 22-0              | 12-4                 |
|      |           |                       |             | 19-5       | 13-6                 | 10-7          | 32-9              | 18-9                 |
|      |           |                       |             | 21-2       | 19-2                 | 8-1           | 22-0              | 12-4                 |

### Table 5. Estimated consumption of cigarettes by the adult male population of the United Kingdom 1951 to 1966

| Year | Consumption of cigarettes per adult male |
|------|------------------------------------------|
|      | Per year | Per day |
|      | Manufactured | Total* | Manufactured | Total* |
| 1951 | 3610     | 4006    | 9-9          | 11-0   |
| 1957 | 3790     | 4208    | 10-4         | 11-5   |
| 1966 | 3640     | 4174    | 10-0         | 11-4   |

*The report of the Tobacco Research Council (1969) gives data only for the total consumption of hand-rolled cigarettes by both sexes. We have assumed that they were all smoked by men.
SMOKING HABITS
The smoking habits of doctors were, in all probability, never identical with those of the general population and the habits of those who responded to the initial questionnaire were certainly different from those who did not (Doll and Hill, 1964). The habits of those who replied to the three questionaries are summarised in Table 4, standardised for age within the broad age groups of 35 to 84 years and 35 to 64 years respectively. Over the period of observation, the proportion of doctors of comparable ages who were ex-smokers increased progressively at ages 35 to 84 years from 20 per cent to 32 per cent, while the proportion who smoked only cigarettes fell from 41 per cent to 21 per cent. At ages 35 to 64 years the corresponding proportions were 18, 29, 44 and 22 per cent.

Estimates of the smoking habits of all men in Britain of the same ages are not available to enable an exact comparison to be made between the smoking habits of doctors and other men. The results of surveys undertaken between 1956 and 1968 have been published by the Tobacco Research Council (1969) and some of the most relevant results were cited in the College’s report on smoking (Royal College of Physicians, 1971). Some data relating to the years 1948–50 were obtained by Research Services Limited and have been reported by Todd and Laws (1959). Estimates of the average number of cigarettes smoked by an adult male in the United Kingdom in the same years in which information was obtained for the British doctors have been extracted from the report of the Tobacco Research Council (1969) and are shown in Table 5. From these data it seems unlikely that any major change in smoking habits can have taken place that was at all comparable with the change in the habits of the doctors that were under observation. It should be noted, however, that the sale of cigarettes with filter tips increased greatly and the proportion of all manufactured cigarettes that were tipped (and consequently contained less tobacco) increased from 1 per cent in 1951 to 61 per cent in 1966. We have no data for the use of filter-tipped cigarettes by doctors, but it is unlikely that they can have avoided being affected by so gross a change.

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