INFLUENCE OF SMOKING ON MORTALITY FROM VARIOUS DISEASES IN SCOTLAND AND IN ENGLAND AND WALES*

AN ANALYSIS BY COHORTS

BY

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During an investigation into the relative frequency of bronchitis mortality in England and Wales and in Scotland over the years 1940 to 1960 (to be published) it was found, when standardized death rates were compared, that there was an average excess in England and Wales over Scotland of 28.5% in males and 23.6% in females. In attempting to discover an explanation for this difference, one of the factors to be examined was the influence of smoking. As no figures for the relative consumption of tobacco or cigarettes in the two countries are available, an indirect approach to the problem was adopted.

Cigarette smoking in the United Kingdom virtually began, among males, at the beginning of the century (Fig. 1), and increased steadily, with further sharp increases at the time of the two world wars. Among women the habit, always less extensive than in the males, began later and rose more slowly, but also showed a marked increase in the second world war. Consequently if a disease, such

FIG. 1.—Annual cigarette consumption for males and females in United Kingdom. Adapted from Todd (1959).

as bronchitis or carcinoma of the lung, were closely associated with cigarette smoking, a rise in mortality would be expected to manifest itself in men earlier than in women. In other words, the ratio of the male death rate to the female death rate would rise as time went on, although an increase in female smoking habits might result in a later lowering of this ratio. In Scotland the rise would be less if the influence of smoking were less. To test this hypothesis we examined the diseases thought to have some connexion with smoking. Of these, bronchitis and carcinoma of the lung are the most obvious.

A changing factor in the environment which affected males more than females would be most readily detected by comparing the relative mortality of males and females in successive generations or "cohorts." In this study a "cohort" is defined as that part of the total population born in each 10-year period, beginning in 1846–55. The experience of each subsequent cohort was studied, the last being that born between 1906 and 1915, whose mortality experience is still incomplete.

*Based on a paper given by Eileen Crofton to the Scottish Association of Physicians, Edinburgh, October, 1961.

For each cohort the ratios between the male and female death rates were calculated for each 10-year age-group within the cohort, beginning with the mortality when the cohort was aged 15 to 24, and ending when it was 65 to 74 years.

In addition to bronchitis and carcinoma of the lung, respiratory tuberculosis and pneumonia were included as major respiratory diseases which might be influenced by cigarette smoking. Smoking may also be concerned in the aetiology of ischaemic heart disease and peptic ulcer, so mortality from these diseases was also examined (Royal College of Physicians of London, 1962). Finally, cerebrovascular disease, in which there is no indication in the literature that cigarette-smoking has any effect, was included as a control.

Each line in Figs. 2–15 represents the experience of one cohort, and shows the change in the male/female ratio of death rates at different ages of death. The male/female ratios are shown separately for England and Wales and for Scotland.

Details are given in the appendix of the nomenclature accepted under each category of disease.

Results

Bronchitis (Figs. 2, 3).—These figures show the rise in the male/female ratio first occurring in the 1876–85 cohort, and increasing in subsequent cohorts. This rise is more pronounced in England and Wales in the 1876–85 and the 1886–95 cohorts than it is in Scotland. These are the

FIG. 2.—Bronchitis, England and Wales.

cohorts first exposed to cigarette smoking to any appreciable degree, and the difference between the two countries could be due to a later spread of the habit to Scotland. There is little difference between the two countries in the later cohorts.

Carcinoma of the Lung (Figs. 4, 5).—No figures for carcinoma of the lung are available for the earlier cohorts (see appendix). In England and Wales, but not in Scotland, a large increase is seen in the cohort born 1876–85. This corresponds to the first cohort likely to be affected by the

rise in cigarette-smoking. Subsequent cohorts show further rises in the male/female ratio in both countries, but the rise in England and Wales is greater than in Scotland, suggesting an earlier smoking effect.

Respiratory Tuberculosis (Figs. 6, 7).—This shows an interesting similarity to the preceding figures, and suggests one possible explanation for the persistently higher death rates in elderly males.

Pneumonia (Figs. 8, 9).—The picture here is confusing. In both countries a peak is seen in the male/female ratio at the 45-54 and 34-44 age-groups, in the 1876-85 and 1886-95 cohorts respectively. As already mentioned, these are probably the first important smoking cohorts, and the peak male/female ratios (and indeed the peak mortalities)

occurred before the introduction of sulphonamides. The decrease in the male/female ratios at older ages in these cohorts, and the absence of these peaks in the middle-aged in subsequent cohorts, could be due to the beneficial effect of therapy neutralizing the adverse effect of tobacco. But this is somewhat speculative.

Ischaemic Heart Disease (Figs. 10, 11).—In both countries there is a tendency for the peak male/female ratio to shift to earlier ages in succeeding cohorts, this occurring earlier and the shift being more marked in England and Wales than in Scotland. This is consistent with smoking influencing mortality in the middle-aged, though not in older men. This fact is attributed by several workers to an elevation of serum cholesterol and increase of β/α lipoprotein ratio caused by cigarette smoking which is seen in young and

FIG. 3.—Bronchitis, Scotland.

FIG. 4.—Carcinoma of lung, England and Wales.

FIG. 5.—Carcinoma of lung, Scotland.

FIG. 6.—Respiratory tuberculosis, England and Wales.

FIG. 7.—Respiratory tuberculosis, Scotland.

FIG. 8.—Pneumonia, England and Wales.

middle-aged men, though not in the elderly (Gofman *et al.*, 1955; Karvonen *et al.*, 1959; Dawber *et al.*, 1959; Bronte-Stewart, 1961; Acheson and Jessop, 1961).

Peptic Ulcer (Figs. 12, 13).—The 1876–85 cohort shows the first peak in the male/female ratio at the age of 55–64 in England and Wales. Subsequent cohorts in both countries show a shift to the left, the greatest excess of male deaths

occurring at successively earlier ages. This is most marked in Scotland. The reason for the difference is uncertain.

Cerebrovascular Accidents (Figs. 14, 15).—This disease group accounts for a large proportion of the total death rate (12.6% in 1960 in England and Wales, 14% in Scotland) and yet no rise in male/female ratio can be detected. This suggests that the mortality from this disease is unrelated to smoking.

Conclusion

The rise in the male/female ratio of death rates in certain diseases probably connected with cigarette smoking occurred earlier, and to a greater extent, in England and Wales than in Scotland. This is clear-cut in the case of bronchitis, carcinoma of the lung, and respiratory tuberculosis. It is probable in ischaemic heart disease and possible in peptic ulcer, the influence on both these diseases being confined to middle age. In pneumonia the position is uncertain, the picture being confused by the introduction of chemotherapy. No effect was seen in cerebrovascular accidents, a group introduced as a control because it was thought to be unassociated with smoking. These findings lend support to the suggestion that when cigarette smoking began it spread more rapidly in England and Wales than it did in Scotland. It may therefore be one of the factors accounting for the preponderance of bronchitis in England and Wales. The recent rise in the male bronchitis death

FIG. 9.—Pneumonia, Scotland.

FIG. 10.—Ischaemic heart disease, England and Wales.

FIG. 11.—Ischaemic heart disease, Scotland. Note: The 25-34 point on the 1886-95 cohort and the 35-44 points on the 1856-85 cohorts are based on very small numbers.

FIG. 12.—Peptic ulcer, England and Wales.

FIG. 13.—Peptic ulcer, Scotland.

FIG. 14.—Cerebrovascular accidents, England and Wales.

FIG. 15.—Cerebrovascular accidents, Scotland.

rate in Scotland, particularly in the younger age-groups (45-64) (Fig. 16), may therefore be partly due to a late smoking effect. The present rates for carcinoma of the lung in Scotland, which are as high as or even higher than, those in England and Wales, may be due to smoking exerting a more rapidly lethal effect in this disease.

FIG. 16.—Bronchitis, males. Age-groups 45-64.

Summary

Male/female ratios of death rates at various ages have been analysed in 10-year cohorts. The method has been used to compare the mortality in Scotland and in England and Wales from various diseases possibly connected with smoking. The results suggest that smoking has been exerting an effect longer in England and Wales than in Scotland. The recent rise in bronchitis mortality in younger age-groups in Scotland may be attributable to a smoking effect now beginning to exert an influence on the death rate in middle-aged men.

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APPENDIX

The basic data were obtained from the *Annual Reports of the Registrar-General for Scotland*, the *Statistical Reviews for England and Wales*, and the *Census Reports for Scotland and England and Wales*.

The diseases included under the various headings in the investigation were as follows:

Bronchitis.—1870-1910, "bronchitis." 1920, *International Statistical Classification of Diseases* (I.C.) 89 and 90. 1930, I.C. 99. 1940, I.C. 106. 1950 and 1960, I.C. 500-502.

Carcinoma of the Lung.—No figures available before 1910. 1910, "carcinoma of the lung" in England and Wales; "carcinoma of larynx, lung, and pleura" in Scotland. 1920 and 1930, "carcinoma of larynx, lung, and pleura." 1940, I.C. 47. 1950 and 1960, I.C. 160-165.

Respiratory Tuberculosis.—1870-1910, "pulmonary tuberculosis." 1920, I.C. 28 and 29. 1930, I.C. 31. 1940, I.C. 13. 1950 and 1960, I.C. 001-008.

Pneumonia.—1870-1910, "lobar pneumonia," "bronchopneumonia," "epidemic pneumonia," and "pneumonia not defined." 1920, I.C. 91 and 92. 1930, I.C. 100 and 101. 1940, I.C. 107-109. 1950 and 1960, I.C. 490-493.

Ischaemic Heart Disease.—1870 and 1880, no figures available for Scotland. 1870-1880, England and Wales: "angina pectoris." 1890-1910, "angina pectoris." 1920, I.C. 80. 1930, I.C. 89. 1940, I.C. 94. 1950 and 1960, I.C. 420.

Peptic Ulcer.—1870-1900, figures not available. 1910, "gastric ulcer." 1920, I.C. 102. 1930, I.C. 111. 1940, I.C. 117. 1950 and 1960, I.C. 540, 541 (and 542 in England and Wales).

Cerebrovascular Accidents.—1870 and 1880, "apoplexy." 1890 and 1900, "apoplexy, hemiplegia, brain paralysis." 1910, "cerebral haemorrhage, cerebral embolism"; "apoplexy and hemiplegia." 1920, I.C. 64 and 82a. 1930, I.C. 74. 1940, I.C. 83. 1950 and 1960, I.C. 331 and 332.

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RELIGHTING OF CIGARETTES AND LUNG CANCER

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The evidence for incriminating the smoking of cigarettes as a major factor in the aetiology of lung cancer is now overwhelming (Royal College of Physicians of London, 1962). There are, however, two facts which have not been satisfactorily explained: one is the finding that the disease is commoner in urban than in rural areas (Stocks, 1947); the other is the fact that the incidence, as deduced from deaths assigned to cancer of the lung, is much higher in Great Britain than in certain other countries—for example, United States of America—in which the cigarette consumption is apparently similar (Doll, Hill, Gray, and Parr, 1958). Further comparison between Great Britain and the U.S.A. in terms of the relative cigarette consumption and the eventual crude death rate 20 years later from cancer of the lung has shown that in Great Britain the latter is high, whereas in the U.S.A. it is low (Doll, 1958).

Hammond (1958) investigated on a comprehensive scale in the U.S.A. one aspect of smoking habits based on a study of over 4,000 cigarette ends, and found the average length to be 30.9 mm., whereas in a study of nearly 800 cigarette ends in Great Britain (Doll *et al.*, 1959) the average length was 18.7 mm.

We had gained the impression that patients in hospital suffering from lung cancer seemed particularly prone to the habit of putting out their cigarette half-way through and relighting the stumps. In the Manchester district this is known as "dimping" or "decking." It was planned to try to discover if a prolonged habit of the relighting of cigarettes was related to an increased hazard of contracting bronchial cancer, for if this were found to be the case it might constitute a factor influencing the international differences in incidence, on the assumption that in countries