PAPERS AND ORIGINALS

Mortality among doctors in different occupations

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Summary

A total of 20 540 male doctors who replied to a questionnaire on their smoking habits that was sent to them on 1 November 1951, and who were aged 35 years and over, were classified according to their occupation as listed in the Medical Directory for 1952 and followed up until 1 November 1971. Examination of the mortality rates in 11 occupational groups showed gross heterogeneity for smoking-related diseases but not for all other diseases grouped together. On average, general practitioners smoked 37% more cigarettes than did hospital physicians and surgeons and the overall death rates among general practitioners were about 23% higher than among physicians and surgeons of similar ages. This excess death rate was chiefly accounted for by a 38% excess mortality from smoking-related diseases such as lung cancer, chronic bronchitis, and ischaemic and pulmonary heart disease. The few other statistically significant associations between occupation and disease were thought to be due either to chance or to the effect of the disease on the choice of specialty.

Introduction

The practice of medicine has been associated at different times with various hazards, including an enhanced risk of infection and (in Babylon) the risk of amputation of the hands "if the doctor shall open an abscess with a bronze knife and shall kill the patient."[1] Now, however, according to the Registrar General,[2] male doctors aged under 65 have a slightly lower mortality than the national average, though it is still higher than that of all men in the same socioeconomic category (standardised mortality ratios, 89 for doctors* and 76 for all men in socioeconomic class I).

With the increase in specialisation the work of different doctors has become more varied, and the same mortality does not necessarily apply to all occupational groups. Indeed, there is already substantial evidence that some groups may experience different hazards, either because of the nature of their work or because of the personal characteristics that led them to adopt it. Radiologists and radiotherapists have an increased risk of leukaemia and other cancers,[4 5] psychiatrists of suicide,[6 7] laboratory workers of tuberculosis,[8 9] and general practitioners of coronary thrombosis.[10] Furthermore, anaesthetists may have an increased risk of cancer,[11-13] and carcinogenic agents may be formed in the atmosphere from anaesthetic gases.[14] We therefore decided to analyse the experience of a large number of doctors in different specialties whose mortality as a whole had been observed for 20 years during another investigation.[3 15]

Subjects and methods

The population consisted of 34 440 male doctors of all ages who replied to a questionnaire on their smoking habits that was sent to them on 1 November 1951. We consider here those who were then aged 35 and over (and who might, therefore, be expected to have established themselves in a specialty) and whose names were recorded in the *Medical Directory* for 1952. They were classified in one of 16 occupational groups according to the description in the 1952 directory of the post that they then held. In the absence of a specific description they were assumed to be working in general practice. General practitioners were classified as being in partnership if this was implied in the 1952 directory and otherwise as single-handed. (In 1976, to check the validity of this method we wrote to 100 doctors whom in 1952 we had classified as single-handed general practitioners. Eight had died, six letters were returned "not known," and 80 doctors (93% of those who could have received our letter) replied. Of these, 45 (56%) said that they had been single-handed general practitioners in 1952, and 25 (31%) that they had been general practitioners in partnership; 10 (13%) were better classified in other categories.) Hospital doctors were classified as physicians (including paediatricians, venereologists,

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*This is higher than the figure (76) obtained previously,[3] which related to a selected population of respondents who were likely to have had an unusually low mortality (see first paragraph of Results) and were observed over a different period (1 November 1951 to 31 October 1971, as against 1959-63).

and other medical specialists), surgeons (including obstetricians and gynaecologists, ophthalmologists, and otorhinolaryngologists), anaesthetists, psychiatrists, radiologists, and laboratory workers (pathologists and biochemists); others were classified as working in public health or the armed Forces, as scientists (whom we pooled with laboratory workers), as working abroad, or as retired, and a few could be classed only as working in miscellaneous or unknown occupations. In addition to this categorisation any doctor who did some anaesthetic work without being a full-time anaesthetist was classified as an "anaesthetic user." The numbers of doctors placed in each of these categories are shown in table I. In this classification employment as an anaesthetic user was given precedence over any other employment, so that general practitioners, for example, who were also anaesthetic users were counted only in this latter category.

TABLE I—*Numbers of male doctors aged 35 or more in 1951 by specialty (as listed in 1952 Medical Directory)*

	No
Anaesthetics	547
Part-time anaesthetic users	704
Doctors with no explicit mention of anaesthetic use:	
General practice, single-handed	6848
General practice, in partnership	3857
Hospital practice, medical*	2181
Hospital practice, surgical†	2386
Hospital practice, psychiatry	527
Hospital practice, radiology	347
Scientific research, pathology, or biochemistry	853
Armed Forces	992
Public health and administration	1298
Total	20540
Groups of doctors not considered in later analyses:	
Work abroad	271
Listed as retired	2246
Other	607
Unknown	660
Total	3784
Grand total	24324

*Including physicians, paediatricians, neurologists, and venereologists.
†Including surgeons, obstetricians and gynaecologists, ophthalmologists, and otorhinolaryngologists.

Doctors who were retired or working abroad or in miscellaneous or unknown occupations were thought unlikely to contribute useful information to this study and were excluded. The remainder (20 540) were followed up until 1 November 1971, when 6977 were found to have died and 13 502 to be alive. The remaining 61 (0·3%), who could not be traced, were assumed to be alive.

For each occupational category the number of man-years under observation in each five-year age group was counted and the number of deaths that would have been expected had occupation been irrelevant to mortality calculated by multiplying the number of man-years at risk by the age-specific mortality rates for the population as a whole. Deaths were classified by various causes or groups of causes according to the World Health Organisation's *Seventh Revision of the International Lists of Diseases and Causes of Death* with minor modifications, and expected numbers calculated for each cause in each occupational category. (For more-detailed accounts of the method and classification of the causes of death see ref [3].) In later years further questionnaires on smoking habits were sent to all survivors, but this paper uses data only from the 1951 and 1966 questionnaires.

TABLE II—*Mortality of doctors by specialty and selected causes expressed as observed numbers of deaths and observed numbers as percentages of numbers expected if age-specific death rates were same for all specialties (internal SMR)*

Specialty in 1952 *Medical Directory*	All causes of death		Ischaemic heart disease and myocardial degeneration		Chronic bronchitis, emphysema, or pulmonary heart disease		Cancer of lung, mouth, or oesophagus		Other cancers	
	No observed	% of expected	No observed	% of expected	No observed	% of expected	No observed	% of expected	No observed	% of expected
General practice, single-handed	2589	109***	1066	114***	90	126**	163	108	300	102
Hospital psychiatry	153	109	60	106	6	162	14	146	19	109
Radiology	102	105	34	88	1	37	8	126	15	124
General practice, in partnership	1238	102	506	105	41	116	86	109	153	101
Armed Forces	526	101	182	94	16	91	35	132	54	84
Public health	468	97	164	86*	12	81	30	97	61	101
Part-time anaesthetic users	254	93	111	105	4	48	7	43*	29	86
Anaesthetics	161	92	59	86	4	79	6	57	23	107
Science or laboratory	220	89	87	89	6	85	11	69	28	90
Hospital, medical specialty	587	88***	231	88*	7	37**	38	90	78	94
Hospital, surgical specialty	679	86***	235	76***	21	91	39	80	107	110
Total	6977	100	2735	100	208	100	437	100	867	100
χ^2 with 10 degrees of freedom	52·87 (P<0·001)		49·22 (P<0·001)		19·46 (P<0·05)		17·93 (P=0·06)		4·79 (NS)	

For one group against other 10 groups: *P<0·05; **P<0·01; ***P<0·001.
NS = Not significant.

TABLE III—*Cigarette consumption in 1951 and 1966 and deaths between 1951 and 1971. For each specialty mean cigarette consumption and number of deaths are expressed as percentages of values expected from age distribution of doctors in that specialty. Specialties are listed in decreasing order of cigarette consumption (smoking ratio—see text)*

Specialty	% of mean expected cigarette consumption		Deaths			
	1951	1966	Main smoking-related diseases†		All other diseases	
			No observed	% of expected	No observed	% of expected
General practice, single-handed	111	118	1383	115***	1206	104
General practice, in partnership	109	114	660	106	578	97
Armed Forces	103	108	247	100	279	102
Part-time anaesthetic users	97	109	129	95	125	91
Anaesthetics	101	96	74	84	87	100
Psychiatry	102	84	81	111	72	107
Surgical specialty	87	90	310	78***	369	95
Radiology	97	76	44	89	58	123
Public health	86	76	210	85*	258	109
Medical specialty	85	69	285	84**	302	92
Science or laboratory	71	63	109	86	111	92
Total	100	100	3532	100	3445	100
χ^2 with 10 degrees of freedom			67·31 (P<0·001)		12·27 (NS)	

†Ischaemic heart disease, myocardial degeneration, and all conditions listed previously[3] as being closely associated with smoking—namely, cancer of lung, mouth, or oesophagus; chronic bronchitis, emphysema, or pulmonary heart disease; and also hernia, aortic aneurysm (non-syphilitic), and respiratory tuberculosis.
For one group against other 10 groups: *P<0·05; **P<0·01; ***P<0·001.
NS = Not significant.

Results

Standardised mortality ratios (SMRs)—that is, the observed numbers of deaths expressed as percentages of the numbers expected—are given in table II for each of the 11 relevant occupational categories for all causes of death and, separately, for four principal groups of causes. Table II also shows the total number of deaths observed in each occupational category and the total number attributed to each cause. For most occupational categories the numbers of deaths attributed to any one cause were small and significant differences would not have been expected unless the risk of death differed greatly from the average. The results are presented as mortality ratios rather than as mortality rates because the rates were artificially low. Firstly, the population observed was a self-selected group of respondents. Only 66% of those who were sent the initial questionnaire (in 1951) replied, and there is evidence that men who were likely to die within three years and, to a less extent, heavy smokers and men otherwise at high risk tended not to reply.[15] Secondly, men were followed up from 1 November 1951 but were included in the study only if their names appeared in the 1952 *Medical Directory*. Men who died in the first few months of the study may, therefore, have been excluded. For both these reasons the recorded mortality must be less than the true mortality among doctors. Neither factor, however, should have biased the comparison of mortalities in different occupations.

Table II shows that the total mortality was significantly higher than average among single-handed general practitioners and significantly lower than average among consultant physicians and consultant surgeons. None of the other differences approached significance. The excess mortality among single-handed general practitioners was largely due to diseases that are associated with cigarette smoking (ischaemic heart disease and myocardial degeneration; cancer of the lung, mouth, and oesophagus; and chronic bronchitis, emphysema, and pulmonary heart disease), and a deficiency of these diseases was a main reason for the low mortality among physicians and surgeons. That differences in smoking habits may be the principal reason for the difference between occupations is suggested by table III, which shows for each occupation the age-standardised cigarette consumption and the standardised mortality rates for all the main diseases associated with smoking and all other diseases combined. For smoking-related disease there was gross heterogeneity between occupations ($\chi^2_{10}=67{\cdot}31$; $P<0{\cdot}0001$).

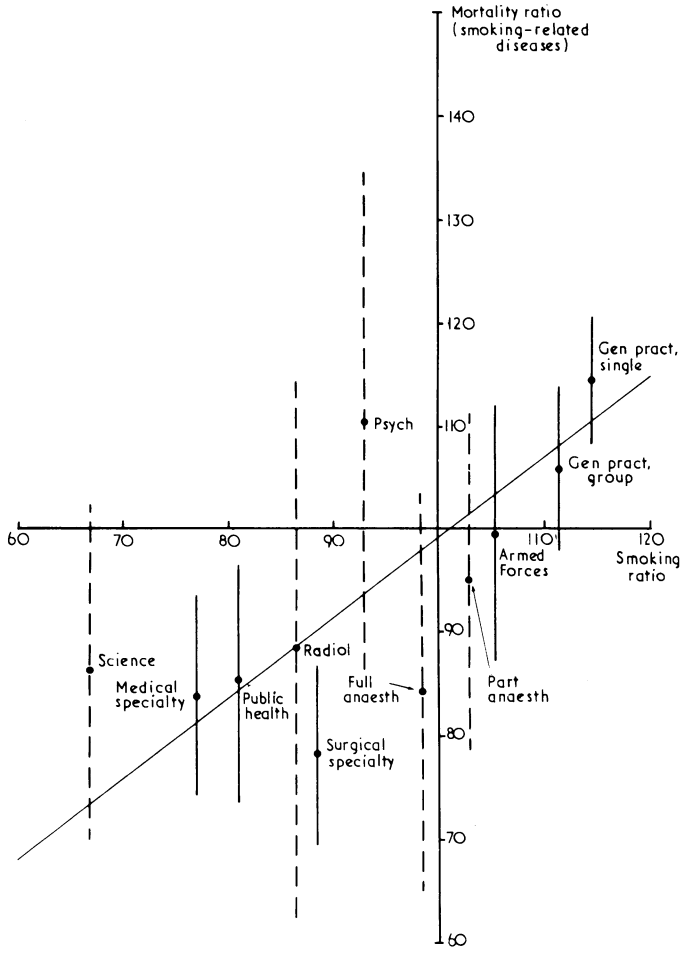

FIG 1—SMR (with 95% confidence interval) for mortality from main smoking-related diseases against smoking ratio for each of 11 specialties, together with regression line of SMR on smoking ratio. Longer confidence intervals corresponding to groups with fewer deaths are given by broken lines only to emphasise visually that they are unreliable and that attention should be directed chiefly to shorter, solid lines, which describe more reliable SMRs.

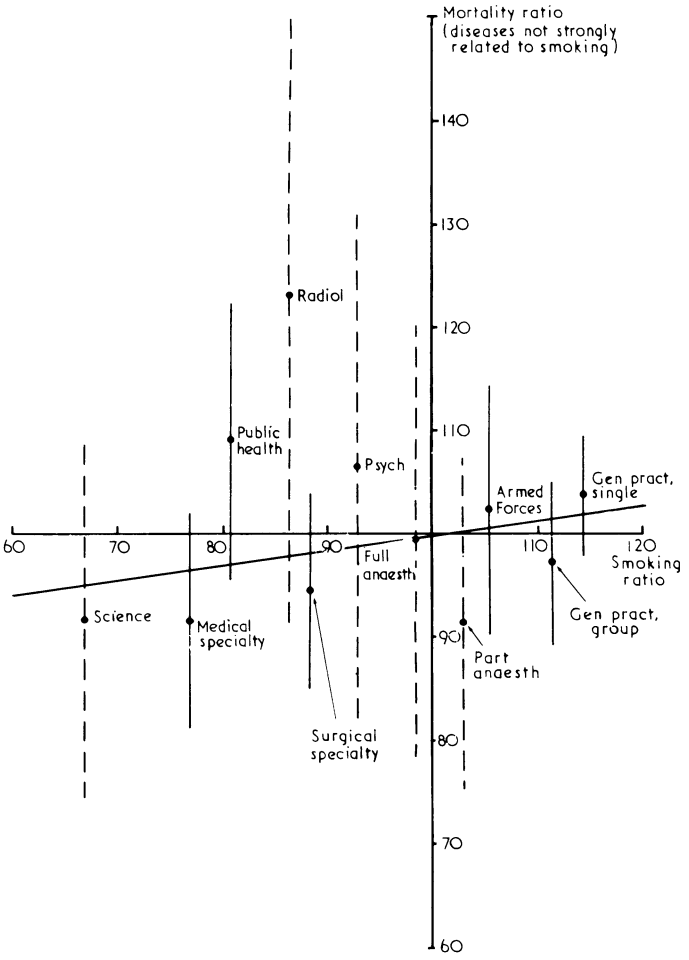

FIG 2—SMRs and regression line for "all other" diseases. Compare with fig 1.

It is not clear how the cigarette consumption of a group of doctors over an extended period can best be characterised by a single number, especially since men of different ages tend to have different smoking habits and many of them changed their habits during the study, usually by giving up or smoking less. We have chosen to use as our single descriptive number a quantity that is analogous in some respects to the SMR. Taking all doctors together, and examining only their replies in 1951, we computed the mean 1951 cigarette consumption in each five-year age group from 35-9 to 85 and over. Knowing the numbers of, for example, radiologists in each age group, we could then predict what the mean 1951 cigarette consumption among radiologists would have been had the average consumption by radiologists in a particular age group been the same as the average for all doctors in that age group and could express the actual mean consumption among radiologists as a percentage of this predicted mean. This method yields the percentages given in the first column of table III: similar calculations based on the survivors who answered the 1966 questionnaire on smoking yields the percentages given in the second column of table III. To obtain a single number describing the 20-year mean smoking habits in each specialty we arbitrarily defined the "smoking ratio" for each specialty as the average of these 1951 and 1966 percentages.

Fig 1 shows the mortality ratio for the main smoking-related diseases, as defined in table III, against the smoking ratio. For each

TABLE IV—*Specific causes of death significantly (P<0·05) more or less common among doctors in one particular specialty than among doctors in other specialties*

Specialty	Cause of death	Deaths		χ^2 test§
		No observed	No expected	
General practice, single-handed ..	More ischaemic heart disease†	1066	932·2	28·9***
	More chronic bronchitis‡	90	71·3	7·0**
	More bladder cancer	28	19·2	5·4
	More alcoholism and cirrhosis of liver	28	20·3	3·9
General practice, in partnership ..	More Parkinsonism	16	6·8	13·6***
	More nephritis	14	8·3	4·0
Public health	Fewer aortic aneurysms	1	7·1	4·7
Hospital, medical specialty	Less chronic bronchitis‡	7	19·1	7·8**
	Less ischaemic heart disease†	231	263·4	4·3
Hospital, surgical specialty	Less ischaemic heart disease†	235	307·5	19·0***
Anaesthetics	More cancer of pancreas	5	1·7	4·7
Radiology	More non-thrombotic cerebrovascular disease	13	6·7	5·2
Armed Forces	More oesophageal cancer	8	3·5	4·9
Part-time anaesthetic users	Less lung cancer	5	12·9	4·4

**P<0·01; ***P<0·001; all others nominally P<0·05.
†And myocardial degeneration.
‡And emphysema and pulmonary heart disease.
§χ^2 on one degree of freedom with continuity correction.

specialty the 95% confidence interval for the SMR is indicated. The weighted line of regression of the SMR on the smoking ratio, which is plotted, has a slope of 0·78±SE 0·11, which, as might be expected, is highly significantly different from zero (P<0·0001). Fig 2 shows the SMRs in each specialty for other diseases. The slope of the regression line is 0·14±0·11, which is not significantly different from zero.

It has already been noted that there is no significant heterogeneity between the SMRs in different specialties from the diseases described in fig 2, and in fact all the 95% confidence intervals in fig 2 overlap the 100% line. Although in fig 1 there is gross heterogeneity about the 100% line for SMRs ($\chi^2_{10}=67$), the heterogeneity about the regression line is barely significant ($\chi^2_9=17$; P<0·05), and it is clear that by far the greater part of the heterogeneity has been accounted for by differences in cigarette smoking, especially between general practitioners and other doctors. The only other notable contribution to the heterogeneity is the exceptionally low mortality among surgeons.

Examination of 40 separate causes or groups of causes of death showed significant heterogeneity between occupations only for ischaemic heart disease and myocardial degeneration ($\chi^2_{10}=49·22$; P<0·0001) and for chronic bronchitis, emphysema, and pulmonary heart disease ($\chi^2_{10}=19·46$; P<0·05). Individual differences that were significant for one occupation compared with all other occupations are listed in table IV.

Discussion

The excess of ischaemic heart disease and chronic bronchitis in single-handed general practitioners and the deficiency of ischaemic heart disease in hospital physicians and surgeons, and of chronic bronchitis in hospital physicians, may be attributed respectively to their above and below average consumption of cigarettes (table III). The excess of Parkinsonism in general practitioners in partnership was partly compensated for by a deficiency of deaths among single-handed general practitioners (nine against 13·8 expected) and may well be the result of changes in occupation caused by the disease. The small excess of cancers of the pancreas in anaesthetists was not accompanied by an excess of deaths from other tumours (table II) or by an excess of pancreatic cancers in part-time anaesthetists (one observed against 2·7 expected). Like many if not all of the other small differences, the excess of pancreatic cancers in anaesthetists may be an artefact of chance thrown up in the course of examining more than 400 associations. That this is the most likely explanation is supported by the results of the most recent American studies,[16 17] which failed to confirm the existence of any special hazard of cancer among anaesthetists.

When, as in this study, a large number of associations between disease and occupation are examined, many spuriously significant associations will emerge and some genuine associations, which would have been observed had the study been even larger than it was, may fail to reach statistical significance. It may, therefore, be of interest to note some of the observations that were statistically not significant, as they may help to interpret other findings. These include the occurrence of four deaths by suicide among psychiatrists with 2·8 expected, three deaths from pulmonary tuberculosis among pathologists with about 0·8 expected—10·8 is 46% of the expected mortality among research and laboratory workers, 46% of whom were pathologists—and 23 deaths from cancer among radiologists and radiotherapists with 18·4 expected.

This last excess is small, and could perhaps be attributable solely to chance, for although an earlier study[18] showed that doctors who had joined the British Institute of Radiology before 1921 had a 50% excess mortality from cancer, the same study showed in 1958 that those who had joined the British Institute of Radiology or similar professional bodies after 1921 had no such excess (22 cancer deaths observed against at least 23 expected).

This work was carried out with financial help from the Medical Research Council, which sought information on the mortality of anaesthetists. Miss Barbara Hafner, Mrs Norton, and Mrs Thompson classified the doctors by occupation and prepared the data for computer analysis; Mrs Sutherland followed up the random sample of single-handed general practitioners; and Mr Richard Gray helped with many of the analyses.

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