Journal of Epidemiology and Community Health, 1978, **32**, 86-96

Factors related to respiratory and cardiovascular symptoms in the United Kingdom

G. DEAN
From the Medico-Social Research Board, Dublin

P. N. LEE
From the Tobacco Research Council, London

G. F. TODD
From the London School of Hygiene and Tropical Medicine

A. J. WICKEN AND D. N. SPARKS
From Research Surveys of Great Britain

SUMMARY Factors related to eight respiratory and cardiovascular symptoms have been studied in a sample of 12 736 men and women aged 37 to 67 living in England, Scotland and Wales. The prevalence of each of these symptoms was independently associated with increasing age, with lower social class, with living in Wales, and with exposure at work to fumes or to dust, especially in mines or quarries. Prevalence of some symptoms was also increased in those who were divorced, separated or widowed, who took less exercise or who were seriously over or under weight. Respiratory symptoms increased with the number of cigarettes smoked, with level of inhalation, and with the smoking of plain rather than filter cigarettes, though the last two associations were significant only for some symptoms. Smokers who had given up for five years or more had levels of symptoms similar to those who had never smoked, while pipe and cigar smokers had markedly fewer symptoms than cigarette smokers. The relationship between smoking and cardiovascular symptoms was not as clear as the relationship between smoking and respiratory symptoms.

Objectives

This study was carried out with two objectives. Firstly, we wished to determine whether the prevalence of certain readily ascertainable cardio-respiratory symptoms is associated less with smoking filter cigarettes than it is with smoking plain cigarettes. Secondly, we wished to obtain nationally representative estimates of the prevalence rates of these symptoms in such a way that they could subsequently be re-estimated if desired. This paper is mainly concerned with the prevalence rates, and with determining which of the factors studied were significantly related to the symptoms investigated.

Study methods

POPULATION STUDIED AND METHOD OF SAMPLING

The study was based on a nationally representative sample survey of 6277 men and 6459 women aged 37 to 67 interviewed at home in England, Scotland and Wales in 1972. The method of sample selection has been described in detail by Sparks and Lee (1976).

RESPIRATORY AND CARDIOVASCULAR SYMPTOMS

Information on chest, heart and arterial symptoms was obtained from questions based on the Medical Research Council Respiratory Symptoms Questionnaire (1966) and on the London School of Hygiene Questionnaire on Cardiovascular Symptoms (Rose and Blackburn, 1968). As the questions had to be presented by medically unqualified interviewers, the original questionnaire was slightly simplified under the supervision of the medical director of the project, Dr G. Dean. Precise definitions of the wording are given in the Appendix on page 96.

The answers to the questionnaire were used to assess general health; the presence of cough, phlegm, breathlessness, wheezing and the 'bronchitis

syndrome' (prolonged cough, prolonged phlegm and shortness of breath); the effect of the weather on the chest as well as the presence of angina; 'possible claudication'; and 'possible infarction': that is, a past history of severe chest pain.

SMOKING AND OTHER FACTORS

The number and type of manufactured cigarettes currently smoked, the proportion of filters, and the current consumption of cigars, pipe tobacco and hand-rolled cigarettes were recorded. Respondents were asked about inhalation. Questions on past smoking habits were also asked for each of the five-year periods from 1923-7 to 1958-62, and for each two-year period from 1963-4 to 1971-2.

Other questions related to age; sex; marital status; social class; place of residence and housing density (in childhood, 10 years ago, and in 1972); occupation; type of industry employed in and for how long; exposure to dust, gas or fumes; amount of exercise taken; alcohol consumption; height; weight; whether the respondent was trying to lose weight; and the type of household and the number of persons in it. The measurements of height and weight were used to calculate an obesity index (weight in pounds divided by height in inches squared $\times$ 100).

Objectives of the statistical analysis

For this paper, we decided that, for each combination of factor and symptom considered, we would restrict our attention to answering two questions.

The first was 'How do average symptom prevalences compare between two people of the same age and sex, but differing in the factor of interest?' The second question was 'What is the average difference in symptom prevalence between two people who are identical in all other factors shown to affect prevalence significantly, but who differ in the factor of interest?'

Clearly, calculation of such differences (subsequently referred to as 'adjusted differences') averaged over the whole population may not give a full picture of the relationship between the factor and the symptom, since the true average may be higher in some subsets of the population and lower in others. However, such interactions are generally of lesser importance than the main effects we studied. Supplementary tabulations are available on request.*

*From P. N. Lee, Tobacco Research Council, Glen House, Stag Place, London SW1E 5AG

Statistical methods

Full details of the statistical methods used have been described elsewhere (Sparks and Lee, 1976). Summarised, these were as follows:—

REDUCTION OF NUMBER OF VARIABLES

Extensive cross-tabulations were carried out of the symptoms against the smoking, personal and environmental factors and a reduced set of symptoms and factors selected for further study.

MODEL COMPARISON

Using data on morning cough, various mathematical models were tested, (including the logistic) relating symptom prevalence to factor level. It was concluded that there was little to choose between the models in regard to adequacy of fit of the data. Therefore the additive multiple regression model was chosen for further work because it was the simplest.

MULTIPLE REGRESSION ANALYSIS

For each symptom studied a number of multiple regressions including different combinations of factors were calculated. As a result, a final list of factors was chosen, all of which appeared to have a statistically significant association with at least one of the symptoms. The multiple regression coefficients and standard errors from these final equations were used to determine the magnitude and significance of the associations with the factors *included* in the list. This final list consisted of age, social class, smoking group, inhalation, current residence, current housing density, marital status, obesity index, industry employed in, years worked in dusty job, years worked in fumes, and occupational status. The levels of each factor used in the analysis can be found in Tables 2 to 7.

GOODNESS-OF-FIT TESTING

For each factor *excluded* from the final equations, including those excluded at the first stage of the analysis, the observed symptom prevalence at each level of the factor was compared with that predicted from the final equations. A close correspondence between these observed and expected numbers with symptoms, as judged by the χ^2 test, indicated that the factor was correctly excluded, inasmuch as it had no independent association with the symptom after all the other factors included in the final equations had been taken into account.

Results

Table 1 lists eight respiratory and cardiovascular symptoms which were investigated in detail. For each symptom it gives the number and percentage of men and women affected. Analysis was also made of chronic cough, regular wheezing and other phlegm score groupings, but conclusions for these symptoms were qualitatively so similar to those for morning cough, wheezing and phlegm score 3 or 4 that the results are not presented here.

Table 1 *Overall prevalence for each sex of the eight symptoms studied*

Symptom	Men		Women	
	No. with symptom	*% with symptom*	*No. with symptom*	*% with symptom*
'Bronchitis syndrome'	407	6·5	278	4·3
Morning cough	1862	29·7	1259	19·5
Shortness of breath	1170	18·6	1503	23·3
Wheezing	2000	31·9	1546	23·9
Phlegm score 3 or 4	1265	20·2	847	13·1
Angina	409	6·5	395	6·1
'Possible claudication'	288	4·6	355	5·5
'Possible infarction'	662	10·5	476	7·4
No symptoms	2805	44·7	3356	52·0
Total sample	6277		6459	

Tables 2 to 7 give results for all the factors included in the final regression equations. Each Table gives the observed prevalence of each symptom, age-standardised to the overall age distribution of the study population of each sex, to illustrate the *apparent* degree of relationship between the factors and the symptoms. It also shows the *adjusted* difference in prevalence between the factors (based on the regression coefficients of the final equations) together with the significance of this difference. The final column of each table gives the age-standardised percentage of the population with none of the eight symptoms, to illustrate to some extent the degree of overlap between the symptoms studied.

The results of the goodness-of-fit tests showed that with the one exception of 'amount of exercise taken', none of the excluded factors had any significant independent association with symptom prevalence. The results for exercise are summarised in Table 8.

It should be borne in mind that a significant association does not imply a causative relationship between the factor and the symptom. Each association must therefore be considered on its merits.

Conclusions

AGE (Table 2)

For all the symptoms considered, there was a highly significant increase in prevalence with increasing age. The analysis showed that the association with age approximated to a linear relationship, although the rates of increase varied markedly between the symptoms. The rate of increase with age when adjusted for other factors was normally 80% to 90% of the simple unadjusted rate, which suggests that these other factors explain little of the increase in prevalence associated with age.

SOCIAL CLASS (Table 3)

For all symptoms, and for both sexes, observed prevalence increases with lower social class, often quite markedly. Much of this difference can be explained by factors other than age, since on average the adjusted differences are only about 41% (men) or

Table 2 *Symptom prevalence by conventional age groups*

Sex	Age group (years)	No.	'Bronchitis syndrome'	Morning cough	Shortness of breath	Wheezing	Phlegm score 3 or 4	Angina	'Possible claudication'	'Possible infarction'	No symptoms
			Observed prevalences								
Males	37–39	714	2·1	24·8	6·3	26·8	13·9	2·0	1·7	5·3	55·6
	40–44	894	1·3	23·9	6·7	24·5	14·4	2·9	2·6	7·5	54·7
	45–49	973	5·3	28·9	14·2	29·2	18·3	3·7	3·5	8·5	47·1
	50–54	1029	5·6	31·2	15·4	31·7	19·0	5·2	3·5	9 3	45·0
	55–59	936	8·4	30·7	22·6	32·4	22·9	8·5	5·1	14·5	42·1
	60–64	900	11·6	33·7	32·0	38·8	25·0	11·7	7·8	14·6	36·2
	65–67	831	10·5	33·6	32·4	39·5	27·1	11·3	7·8	13·4	33·5
Females	37–39	699	2·0	15·3	14·9	18·6	11·3	2·7	2·3	5·4	60·2
	40–44	906	2·3	15·8	15·3	20·4	10·2	3·9	3·3	5·6	59·1
	45–49	1043	4·0	21·5	18·6	24·1	13·6	5·3	3·7	6·0	54·4
	50–54	1068	5·1	19·6	23·6	24·1	13·7	6·7	6·4	7·2	52·2
	55–59	1014	5·5	21·5	24·4	26·3	13·7	6·1	5·6	7·0	51·5
	60–64	1031	5·0	20·2	32·0	27·3	13·4	8·4	8·6	9·5	44·5
	65–67	698	5·6	21·5	34·8	25·1	15·9	9·3	8·0	11·2	42·1
			**Estimated 'adjusted' differences in prevalence for every 10 years of age*								
	Males		2·3	3·5	8·7	4·3	4·0	3·4	2·0	2·9	—
	Females		1·3	4·2	6·2	3·7	2·7	2·0	2·1	1·9	—

*Approximately every 10 years: in regression analysis six age groups are used (37–41; 42–46; 47–51; 52–56; 57–61; 62–67). These are coded as 1 through 6. 'Adjusted difference' is based on increase in prevalence per 2 age units. All 'adjusted differences' are statistically significant ($P < 0.001$).

Table 3 *Symptom prevalence by social class*

Sex	*Social class group*	*No. in group*	*'Bronchitis syndrome'*	*Morning cough*	*Shortness of breath*	*Wheezing*	*Phlegm score 3 or 4*	*Angina*	*'Possible claudication'*	*'Possible infarction'*	*No symptoms*
			Age-standardised prevalences								
Males	A or B	680	1·0	19·1	9·3	19·6	11·2	3·0	2·3	8·4	59·4
	C1	1313	3·4	21·8	14·2	25·1	14·2	5·8	2·7	8·4	53·2
	C2	2230	5·9	31·4	16·1	32·5	20·5	5·6	5·3	9·8	43·3
	D or E	2054	10·0	35·8	26·9	39·2	26·0	8·7	5·9	13·0	35·5
Females	A or B	686	1·6	12·7	12·4	13·7	8·3	2·8	2·5	7·1	65·7
	C1	1426	1·9	13·8	17·1	18·8	9·8	4·9	4·6	6·8	59·0
	C2	2205	3·9	20·7	24·1	25·3	13·9	6·6	5·6	7·1	50·1
	D or E	2142	6·8	23·9	29·4	29·0	15·7	7·2	6·8	8·5	45·2
			Estimated 'adjusted' difference in prevalence from that of groups A or B								
Males	C1		1·2	—0·5	3·2†	3·1	1·4	2·3‡	0·1	—0·4	
	C2		1·5	4·2†	2·2	5·6*	4·0‡	1·2	1·5	0·2	
	D or E		3·5†	4·6‡	8·3**	9·3**	6·7**	2·7‡	1·2	0·6	
Females	C1		—0·2	—0·6	2·5	2·3	0·6	1·8	1·3	—0·6	
	C2		1·4	4·7*	7·9**	6·6**	3·5‡	3·1*	2·1‡	—0·5	
	D or E		3·5**	6·4**	11·0**	7·4**	4·3*	3·4*	2·8*	0·4	

†P <0·1 ‡P <0·05 *P <0·01 *P <0·001

Table 4 *Symptom prevalence of current smokers of manufactured cigarettes only*

Smoking group (a) (mean consumption)	*No. in group*	*'Bronchitis syndrome'*	*Morning cough*	*Shortness of breath*	*Wheezing*	*Phlegm score 3 or 4*	*Angina*	*'Possible claudication'*	*'Possible infarction'*	*No symptoms*
		Age-standardised prevalences								
Males										
Never smoker	1116	3·5	12·5	11·7	18·8	11·4	3·7	3·1	7·5	65·6
Filter 1– 7 (4·5)	85	5·1	19·6	17·1	21·5	14·4	4·8	4·8	12·4	50·5
8–12 (10·1)	246	8·6	32·8	21·5	33·5	20·8	7·7	4·7	12·5	41·3
13–17 (15·0)	220	9·4	36·3	23·4	37·3	25·4	4·4	7·0	12·5	36·8
18–22 (19·9)	502	8·5	44·0	21·4	38·8	26·9	7·0	6·2	11·1	32·9
23–27 (24·9)	101	1·0	50·6	11·7	37·1	34·2	4·4	1·8	12·8	25·9
28–32 (30·0)	137	8·7	56·8	23·5	53·2	34·5	5·7	7·2	12·5	17·3
33+ (43·2)	123	13·8	52·1	30·0	48·4	28·4	2·6	12·0	16·3	19·3
Plain 1– 7 (4·4)	87	8·2	22·6	25·8	37·7	17·5	10·3	4·5	13·8	43·9
8–12 (10·3)	123	13·0	40·3	21·8	38·1	27·1	10·2	7·0	14·7	38·8
13–17 (14·9)	95	11·6	56·0	21·5	42·4	34·4	7·9	4·8	10·5	24·4
18–22 (19·9)	213	8·6	49·8	20·6	43·6	27·3	5·1	7·4	11·6	29·3
23–27 (24·8)	35	7·3	48·6	28·7	46·1	20·3	5·0	8·2	5·0	30·8
28–32 (30·0)	71	11·2	65·5	26·1	41·6	34·5	5·4	2·8	5·2	23·6
33+ (42·1)	66	9·0	64·5	32·6	43·4	35·7	10·7	8·1	14·0	18·5
Females										
Never smoker	3207	2·5	9·8	21·0	15·5	7·5	6·0	4·8	6·5	62·2
Filter 1– 7 (4·1)	337	3·8	16·9	25·6	22·7	13·8	5·0	7·2	8·7	49·8
8–12 (9·9)	530	4·2	25·8	23·7	32·5	16·6	5·1	6·1	9·3	41·4
13–17 (14·9)	350	5·1	29·6	20·3	36·0	16·6	5·3	5·9	7·2	43·8
18–22 (19·9)	557	10·6	45·1	29·6	42·1	25·8	5·4	5·9	8·2	31·1
23+ (31·5)	226	12·0	56·6	26·4	42·1	34·3	9·5	5·2	11·3	22·1
Plain 1– 7 (3·8)	167	2·7	16·0	20·4	23·3	12·7	3·0	4·9	7·3	52·5
8–12 (10·1)	88	6·9	29·1	31·5	34·0	19·3	5·6	3·0	9·8	48·4
13–17 (15·0)	59	8·4	47·8	30·9	43·5	26·9	7·0	3·6	3·1	28·3
18–22 (20·0)	97	10·2	56·6	40·8	43·5	29·6	6·0	8·6	10·5	18·9
23+ (31·6)	41	17·2	64·9	33·1	46·5	32·5	4·0	17·9	7·9	20·7
		Estimated 'adjusted' differences in prevalence								
Males										
Filter 18–22 v Never smoker		2·6*	28·4**	5·0**	12·7**	10·7**	—0·9	2·9**	2·6‡	
For every 5 cigarettes smoked (b)		0·2	5·9**	0·9†	2·6**	2·2**	—0·3	0·3	0·1	
Plain v filter		1·3	5·8*	0·1	0·6	0·2	0·7	—0·1	—1·8	
Females										
Filter 13–17 v Never smoker		4·4**	24·3**	3·1‡	16·1**	12·5**	—1·7‡	0·5	1·1	
For every 5 cigarettes smoked (b)		2·1**	9·8**	1·3‡	5·0**	4·5**	0·6	0·2	0·2	
Plain v filter		1·2	4·8‡	4·2*	1·6	1·2	0·1	—0·2	—0·5	

†P <0·1 ‡P <0·05 *P <0·01 **P <0·001

(a) Never smoker = one who is not and never has been a regular smoker of manufactured cigarettes, hand-rolled cigarettes, pipes or cigars. Filter smoker = a current smoker of manufactured cigarettes only who now smokes more than half filters. Plain smoker = one who smokes half or more plain cigarettes.

Numbers given are the total nos. of manufactured cigarettes per day. Numbers in brackets represent the mean consumption in that category.

(b) Approximately for every 5 cigarettes smoked: in regression analysis, consumption groups are coded as 1 through 7 (or 5 for females). 'Adjusted' difference is based on increase in prevalence for each group.

Table 5 *Symptom prevalence of other smoking groups*

Sex	Smoking group (a) (mean consumption)	No. in group	'Bronchitis syndrome'	Morning cough	Shortness of breath	Wheezing	Phlegm score 3 or 4	Angina	'Possible claudication'	'Possible infarction'	No symptoms
			Age-standardised prevalences								
Males	Never smoker	1116	3·5	12·5	11·7	18·8	11·4	3·7	3·1	7·5	65·6
	Hand-rolled only (2·5)	424	7·7	38·8	22·5	36·8	24·6	7·3	5·6	10·4	36·0
	Pipe only (2·5)	364	3·2	15·1	13 1	27·9	12·3	4·7	2·1	8·1	54·2
	Cigar only (21·2)	120	3·4	20·2	11·6	22·7	12·0	3·4	2·6	6·7	54·9
	Mixed others only (0·9, 1·2, 8·6)	208	5·4	24·8	17·1	33·0	19·0	3·8	4·0	9·2	46·0
	Manufactured cigarettes and others (17·7, 0·3, 0·5, 1·4)	735	7·5	43·3	18·9	40·5	26·8	6·5	3·1	13 1	32·1
	Ex-smoker only manufactured cigarettes gave up ⩽4 years ago	233	8·9	18·8	27·6	24·9	15·8	14·7	7·2	14·7	49·1
	Other ex-smokers gave up ⩽4 years ago	147	7·2	16·7	22·1	30·9	17 3	13·7	8·4	11·1	47·0
Females	Never smoker	3207	2·5	9·8	21·0	15·5	7·5	6·0	4·8	6·5	62·2
	Other current smokers (10·2, 0·8, 0·1, 2·2)	101	12·7	41·5	32·3	44·0	23·8	5·9	4·4	7·9	25·8
	Ex-smokers; gave up ⩽4 years ago	228	1·3	6·8	18·4	16·9	10·2	7·5	2·8	5·5	65·0
			Estimated 'adjusted' difference in prevalence from that of 'never' smokers								
Males	Hand-rolled only		2·6‡	24·7**	6·4*	12·0**	10·1**	1·3	2·6†	0·3	
	Pipe only		−1·0	5·8‡	−0·6	7·6*	0·9	−0·3	−1·1	0·6	
	Cigar only		1·4	8·6‡	−0·4	3·7	1·3	−1·3	0·7	−0·4	
	Mixed others only		2·3	14·8**	3·8	12·3**	8·0*	−1·4	1·7	0·5	
	Manufactured cigarettes and others		2·2‡	29·2**	1·9	14·3**	11·6**	−0·7	0·1	3·3‡	
	Ex-smoker only manufactured cigarettes; gave up ⩽4 years ago		3·5‡	4·9	9·4**	−2·6	0·8	7·3**	4·0*	4·0‡	
	Other smokers; gave up ⩽4 years ago		3·3	5·2	6·9‡	7·7*	5·0	7·6**	6·2**	1·8	
Females	Other current smokers		9·5**	31·8**	11·6*	25·0**	15 6**	−0·5	−0 7	−0·4	
	Ex-smokers; gave up ⩽4 years ago		−1·0	−3·1	−2·7	−1·3	1·8	0·3	−1·6	−0·2	

†P<0·1 ‡P<0·05 *P<0·01 **P<0·001

(a) For definition of a 'never' smoker, see Table 4. A 'hand-rolled' only or 'pipe only' or 'cigar only' smoker currently smokes hand-rolled cigarettes or pipes or cigars respectively but no other smoking material. 'Others' = hand-rolled cigarettes, pipe, or cigars but not manufactured cigarettes. 'Man cigs and others' = manufactured cigarettes now and others either now or in the past.

For females, 'Other current smokers' = current smokers who are not smokers of manufactured cigarettes only.
Single numbers in brackets refer to mean consumptions (hand-rolled cigarettes and pipe in ozs./week, cigars in no./week). Triple numbers in brackets refer consecutively to mean consumptions of hand-rolled cigarettes, pipe, and cigars. Quadruple numbers in brackets refer to manufactured cigarettes, hand-rolled, pipe, and cigars.

Table 6 *Symptom prevalence by inhalation of all current and ex-smokers of manufactured cigarettes*

Sex	Inhalation group	No. in group	'Bronchitis syndrome'	Morning cough	Shortness of breath	Wheezing	Phlegm score 3 or 4	Angina	'Possible claudication'	'Possible infarction'	No symptoms
			Age-standardised prevalences								
Males	Hold in mouth	756	6·0	26·8	16·6	30·0	19·3	4·6	4·8	9·8	45·9
	Take to back of throat	460	5·7	31·0	18·4	30·8	22·2	6·9	3·3	9·3	43·8
	Take partly into chest	771	6·7	32·8	18·9	36·5	22·2	9·1	4·7	11·1	39·9
	Take right into chest	2607	8·5	37·1	22·8	38·6	24·3	7·6	5·3	12·7	35·7
Females	Hold in mouth	1075	5·0	22·7	24·3	26·4	14·8	5·3	6·2	7·4	48·2
	Take to back of throat	587	4·2	27·2	22·4	30·8	17·6	5·8	5·9	7·3	45·5
	Take partly into chest	587	4·9	29·9	21·9	34·0	18·2	8·0	6·0	8·8	41·2
	Take right into chest	981	9·1	35·2	30·4	38·1	23·6	6·1	6·2	10·3	35·5
			Estimated adjusted difference in prevalence from that of 'hold in mouth' group								
Males	Take to back of throat		−0·9	−2·3	1·2	2·5	1·5	2·3‡	−2·3‡	−0·4	
	Take partly into chest		0·2	−0·7	2·0	7·8**	2·0	4·3**	−0·7	1·2	
	Take right into chest		1·0	2·0	4·1**	8·6**	2·6‡	2·2*	−0·5	2·6**	
Females	Take to back of throat		−1·5	−1·4	−1·7	2·9	1·0	1·7	0·4	0·1	
	Take partly into chest		−1·6	0·9	−2·2	4·5‡	−0·0	2·3*	1·0	1·0	
	Take right into chest		1·9*	3·2‡	5·5*	7·3**	3·7*	0·9	0·6	2·3‡	

†P<0·1 ‡P<0·05 *P<0·01 **P<0·001

Table 7 *Symptom prevalence by some personal and environmental characteristics*

Sex	*Characteristic*	*No. in group*	*'Bronchitis syndrome'*	*Morning cough*	*Shortness of breath*	*Wheezing*	*Phlegm score 3 or 4*	*Angina*	*'Possible claudication'*	*'Possible infarction'*	*No symptoms*
			Age-standardised prevalences								
	(i) Residence										
Males	Southern (a)	3051	4·2	24·9	15·2	28·3	16·6	5·2	3·8	10·1	49·4
	Northern (b)	2594	7·8	33·0	20·8	33·2	22·6	7·0	5·1	10·2	41·7
	Wales	332	15·5	43·4	30·7	52·3	31·5	14·1	7·3	17·1	28·2
Females	Southern	3114	3·6	17·9	19·8	20·2	11·2	5·3	4·4	7·0	55·9
	Northern	2999	4·8	20·2	25·7	26·3	14·7	6·5	6·5	7·2	49·9
	Wales	346	6·6	27·5	33·0	36·4	16·7	9·8	6·9	12·3	34·4
			Estimated 'adjusted' difference from that in Southern group								
Males	Northern		1·3‡	3·6‡	1·9†	0·1	2·7	0·8	0·3	−1·7‡	
	Wales		6·3**	11·2**	7·7**	15·8**	8·2**	5·9**	1·0	3·2†	
Females	Northern		0·5	−0·0	3·7**	3·3*	1·9‡	0·7	1·7*	−0·2	
	Wales		2·0	6·3*	10·2**	12·6**	3·5†	3·9*	1·8	4·5*	
			Age-standardised prevalences								
	(ii) Marital status										
Males	Married or single	5968	6·1	28·9	18·3	31·4	19·9	6·5	4·4	10·6	45·4
	Divorced, separated or widowed	309	14·0	45·2	25·5	41·6	25·3	6·0	6·7	9·7	30·9
Females	Married or single	5389	3·7	18·7	22·0	22·7	12·6	5·9	5·1	7·3	53·4
	Divorced, separated or widowed	1070	8·5	24·8	31·3	29·6	17·3	6·2	7·3	9·0	42·6
			Estimated 'adjusted' difference from that in married or single group								
Males	Divorced, separated or widowed		5·3**	9·1**	3·5	6·6‡	2·2	−0·8	2·4‡	−3·4†	
Females	Divorced, separated or widowed		2·8**	2·4†	6·0**	4·9**	1·9	0·7	2·0‡	0·7	
			Age-standardised prevalences								
	(iii) Obesity Index (c)										
Males	<3·0	625	11·7	44·7	25·5	35·5	27·6	7·5	5·8	15·3	34·9
	3·0–3·3	1786	6·3	28·4	17·0	29·2	19·0	5·6	4·7	10·1	47·3
	3·4–3·7	2165	5·0	26·7	16·5	29·7	18·5	7·1	3·3	10·4	47·9
	3·8 or more	1678	6·4	29·3	20·5	36·1	20·8	6·5	5·6	9·8	41·0
Females	<3·0	1016	5·9	22·0	21·9	22·1	16·3	5·5	4·7	7·6	52·7
	3·0–3·3	1951	3·1	18·4	18·2	20·6	11·9	4·9	4·8	7·4	56·4
	3·4–3·7	1749	2·9	19·7	20·0	22·1	11·3	6·8	5·2	6·3	55·1
	3·8 or more	1688	6·0	20·9	33·1	30·6	14·2	7·1	6·9	8·2	43·5
			Estimated 'adjusted' difference in prevalence								
Males	per unit of Obesity Index		−1·0	−2·8	2·4	5·3	−0·5	0·6	0·1	0·5	
	per unit of (Obesity Index–3·5)²		1·2*	−0·1	1·8*	1·6‡	0·7	−0·0	0·7†	−0·9	
Females	per unit of Obesity Index		1·5	1·8	9·8‡	7·6†	0·8	1·2	1·5	0·5	
	per unit of (Obesity Index–3·5)²		0·6*	0·6	3·4**	2·0**	0·6	0·5	0·6‡	−0·1	

†P <0·1 ‡P <0·05 *P<0·01 **P <0·001

(a) 'Southern' embraces Greater London, the south-east, the south-west, East Anglia, and the east Midlands; (b) 'Northern' includes Scotland, the north, the north-west, Yorkshire and Humberside, and the west Midlands; (c) Obesity Index is equal to 100 × weight in lbs divided by height in inches squared.

Table 8 *Symptom prevalence by amount of exercise*

Sex	Exercise group	No. in group	'Bronchitis syndrome'	Morning cough	Shortness of breath	Wheezing	Phlegm score 3 or 4	Angina	'Possible claudication'	'Possible infarction'	No symptoms
			Age-standardised prevalences								
Males	Heavy	811	4·2	29·7	11·3	31·3	18·3	3·8	3·0	8·5	46·3
	Moderate	2928	3·7	26·1	12·9	27·6	17·2	5·1	3·8	8·0	49·5
	Slight	2033	9·0	30·9	23·7	34·7	22·5	8·3	5·3	12·1	41·8
	None	505	13·9	43·1	39·4	43·4	29·3	10·4	7·7	19·2	28·6
Females	Heavy	450	4·7	21·9	17·5	21·0	13·9	4·7	3·6	5·3	58·6
	Moderate	3016	3·0	16·5	18·2	21·4	12·0	4·8	4·3	6·0	56·6
	Slight	2387	4·8	21·1	25·9	25·1	13·2	7·0	6·7	7·8	49·4
	None	606	8·8	25·8	39·2	32·8	18·3	8·9	6·6	11·8	36·9
			Difference between observed prevalences and those expected from final regression analysis								
Males	Heavy		−1·8	+0·5	−6·1	−0·1	−2·4	−1·8	−1·2	−1·2	
	Moderate		−1·6	−1·9	−3·6	−2·4	−1·6	−0·8	−0·3	−1·5	
	Slight		+2·1	+1·1	+4·2	+2·5	+2·1	+1·5	+0·6	+1·3	
	None		+3·8	+7·3	+13·5	+5·4	+4·7	+1·7	+1·5	+5·4	
Females	Heavy		−0·3	+1·0	−5·0	−3·0	−0·4	−0·5	−1·3	−1·2	
	Moderate		−0·9	−1·8	−3·6	−1·1	−0·5	−1·0	−0·8	−1·2	
	Slight		+0·3	+1·6	+2·1	+0·7	−0·2	+0·8	+1·2	+0·4	
	None		+3·6	+2·0	+13·4	+4·9	+3·3	+2·4	+0·4	+5·0	
			Significance of exercise based on χ^2 (3 DF)								
Male			**	**	**	**	**	**	†	**	
Female			**	*	**	*	N.S.	*	*	**	

†P <0·1 ‡P <0·05 *P <0·01 **P <0·001

58% (women) of the magnitude of the age-standardised differences. However, even after adjustment, the effect of social class is statistically significant for most symptoms.

SMOKING (Tables 4, 5 and 6)

The classification of smokers in Tables 4 and 5 is based principally on current smoking habits, although a great deal of information on past smoking habits was also recorded. There were three main reasons for this. Firstly, symptom prevalence of those who had given up smoking for more than four years hardly differed from that of those who had never smoked. Secondly, past smoking habits were strongly correlated with present ones, and any effects of past smoking, after adjusting for those of current smoking, would have had to be large to have been seen as significant, and this seemed unlikely. Thirdly, past smoking habits are likely to be less reliably recorded than current habits because of difficulties of recall.

From Tables 4 and 5 it can be seen that the smoking of cigarettes in any form (plain, filter or hand-rolled), whether by themselves or in conjunction with other types of tobacco, is strongly associated with prevalence of the three respiratory symptoms: morning cough, wheezing and phlegm. This association remains even after taking other factors into account, and it increases with the number of cigarettes smoked. Cigarettes are also associated to a lesser degree with shortness of breath and the 'bronchitis syndrome'. The association with cardiovascular symptoms is less clear. 'Possible claudication' is significantly associated for men ($P<0·001$), but there is no dose-response and the association for women is not significant. 'Possible infarction' is only just significantly associated for men ($P<0·05$), but not for women, and there is no dose-response. Angina shows a negative trend.

Filter cigarettes were slightly less associated with the prevalence of all five respiratory symptoms than plain cigarettes. This difference was statistically significant only for morning cough in both sexes and for shortness of breath in women. For cardiovascular symptoms the differences were very small and non-significant.

Pipe and cigar smoking was far less associated with symptom prevalence than cigarette smoking. Significant associations were noted only for morning cough and wheezing.

For those who had given up smoking five years or more ago, prevalences were similar to those of non-smokers. This was also true of women who had given up smoking more recently. For males, however, the prevalence of many symptoms, particularly shortness of breath, angina, and claudication, was higher in recent ex-smokers than in non-smokers.

Prevalence of most symptoms increased with increasing depth of self-reported inhalation, but the magnitude of this increase differed for the different symptoms. The increase in prevalence of shortness of breath and wheezing in both sexes was quite large and highly significant, and for men only the increased prevalence of angina and of possible infarction were also significant.

ENVIRONMENTAL CHARACTERISTICS (Table 7)
Respondents were classified as currently living in one of 11 regions. We combined these regions into three areas: Southern (with the lowest observed prevalence on all factors); Northern (intermediate); and Wales (highest). In each of these areas prevalence varied little by region. After adjustment for other factors, most of the difference between Northern and Southern disappeared although some small but significant differences remained. The difference between Wales and Southern, although it was partly explained by other factors, remained large and highly significant for all factors except 'possible claudication'. The goodness-of-fit analyses confirmed that, after taking into account current residence (and all the other factors), neither residence 10 years ago nor residence in childhood helped to explain variations in symptom prevalence.

Housing density, whether measured 'now', 10 years ago or in childhood, had no material association with the prevalence of any symptom. Nor did the type of household or the number of persons in it.

PERSONAL CHARACTERISTICS (Tables 7 and 8)
Those who were divorced, separated, or widowed had a significantly higher ($P<0.05$) prevalence of 'bronchitis syndrome', wheezing, and 'possible claudication' (both sexes), morning cough (men only), and shortness of breath (women only) compared with those who were married or single. Comparisons for other symptoms, although not statistically significant, usually pointed in the same direction.

The relationship between symptoms and the obesity index was not simple, in that prevalences were often above average for high and low values of the index and otherwise below average. An attempt to quantify this U-shaped association was made by including a quadratic term in obesity index in the regression equation. This proved significant for 'bronchitis syndrome', shortness of breath, wheezing, and 'possible claudication'. In interpreting these results, it should be borne in mind that the index was based on self-reported height and weight, and to that extent it may be somewhat inaccurate.

High-symptom prevalence was associated with a low amount of exercise in a number of cases. The inverse association with shortness of breath was particularly definite, no doubt because those with symptoms were unable to take much exercise.

Neither the frequency of alcohol consumption nor the sort of alcohol consumed had any significant relationship with symptom prevalence. Nor had height.

OCCUPATIONAL CHARACTERISTICS (Table 9)
Male respondents were classified as employed in one of 14 main types of industry. Prevalences were similar in each category except for the group employed in mines or quarries, who had an appreciably higher prevalence of every symptom. Although a considerable proportion of this difference could be explained by other factors, the adjusted excess was still highly significant for five symptoms, and positive for the other three.

A positive relationship was also found for every symptom for men employed in dusty or fume-laden workplaces, and this was often statistically highly significant.

Table 9 *Symptom prevalence in men by some occupational characteristics*

Characteristic group	*No. in group*	*'Bronchitis syndrome'*	*Morning cough*	*Shortness of breath*	*Wheezing*	*Phlegm score 3 or 4*	*Angina*	*'Possible claudication'*	*'Possible infarction'*	*No symptoms*
		Age-standardised prevalences								
Other industries	5838	5·6	28·5	17·7	30·6	18·9	6·0	4·1	10·1	45·9
Mines and quarries	394	19·0	47·5	31·1	51·5	37·7	14·5	11·3	17·2	25·3
		Estimated 'adjusted' difference from that in 'other industries' group								
Mines and quarries		5·6**	8·1**	1·2	3·6	8·2**	4·4*	4·9**	1·8	
Years worked in dusty job		*Age-standardised prevalences*								
None	3824	3·9	25·3	14·9	25·3	15·2	5·1	3·9	8·8	51·0
1–10	935	8·0	32·5	23·0	38·3	24·4	8·8	4·6	12·4	46·7
11 or more	1287	12·1	39·1	25·0	45·6	30·0	8·7	6·6	13·9	32·4
For every 10 years in dusty job		*Estimated 'adjusted' difference in prevalence for years worked in dusty job*								
		1·6**	1·3†	2·2**	3·9**	2·7**	0·5†	0·3	0·6†	
Years worked in fumes		*Age-standardised prevalences*								
None	5361	5·8	28·1	17·8	30·0	19·0	6·3	4·3	9·8	46·4
1–10	375	7·3	37·6	21·3	41·5	25·8	6·1	5·5	13·3	35·4
11 or more	465	13·3	41·1	24·5	44·2	29·4	9·3	6·9	15·9	32·4
		Estimated 'adjusted' difference in prevalence for years worked in fumes								
For every 10 years in fumes		1·2*	2·8**	0·3	2·1†	1·6†	0·2	0·5	1·4†	

†P <0·1 ‡P <0·05 *P <0·01 **P <0·001

Discussion

Direct comparison of our results with those of other research workers is difficult. One reason for this is that the alterations we made to the Medical Research Council and London School of Hygiene Symptom Questionnaires (see Appendix on page 96) may well have produced a different pattern of response even if all other circumstances had been identical. We realised that this might be so when we altered the questions. But in view of the type of interview to be sought, we felt it important to make sure that the conditions asked about would be readily disclosed by the respondents, and that the questions were as simple and clear as possible. The main effect of these changes was probably minimal, but the somewhat more substantial changes we made to the question about claudication probably mean that what we call 'possible claudication' is not directly comparable to the 'intermittent claudication' symptom used by other workers. The true value of the results presented here cannot be fully judged at present but we are considering making good this deficiency by following up the mortality of the study population.

Furthermore, many of the major studies published refer to particular sub-groups, such as civil servants (Reid *et al.*, 1974), or migrants (Young, 1974), or populations from other countries, such as Norway (Haenszel and Hougen, 1972); and when reporting their results different workers tend to adjust for different sets of co-factors in presenting their analyses.

In spite of these problems, where similar relationships have been studied, our findings agree quite well with those of other workers. Smoking cigarettes has been found on many previous occasions to be strongly associated with respiratory symptoms (for example, Lambert and Reid, 1970; Haenszel and Hougen, 1972) but much more weakly related to cardiovascular symptoms. Our finding that smoking has a positive association with 'possible infarction' but not with angina has been reproduced by Young (1974) and Zeiner-Henriksen (1971), although Reid *et al.* (1966) did find a positive association with angina. Young (1974) also found, as we did, that increasing exercise was associated with decreasing prevalence of both cardiovascular and respiratory symptoms, and that short and heavy or tall and light people, and also stone workers (similar to our workers in mines and quarries) had high prevalence of respiratory symptoms.

Our study has also produced information on a number of relationships where little or no evidence was previously available. In particular, the amount of attention we paid to classifying the population by smoking habits has allowed us to conclude that the prevalence of respiratory symptoms tends to be similar in smokers of hand-rolled cigarettes to that in smokers of manufactured cigarettes only. It is, however, smaller in smokers of pipes and cigars. Except for morning cough and wheezing, their prevalence rates are similar to those for non-smokers. Our study also shows that smokers of filter cigarettes tend to have a somewhat lower prevalence of respiratory symptoms than smokers of plain cigarettes (although this is only clearly significant for morning cough); and that smokers who have given up the habit for more than four years tend to have levels similar to those of non-smokers. This is not true for the cardiovascular symptoms, where, as Zeiner-Henriksen (1971) has found, ex-smokers have higher levels than continuing smokers.

Our finding of a clear relationship between self-reported inhalation levels and some symptoms (shortness of breath, wheezing, angina, and 'possible infarction') but no relationship for the other symptoms are interesting, especially in the light of recent results on the relationship of inhaling to mortality from disease associated with smoking. Doll and Peto (1976) found no overall relationship between self-reported inhaling and mortality from cancer of the lung (although they did find a slight relationship for light and moderate smokers); cancer of the oesophagus; or cancer of other respiratory sites. By quoting Wald *et al.* (1978) who found that after adjusting for amount smoked the HbCO levels of smokers who said that they inhaled deeply were similar to those of smokers who said that they inhaled slightly or not at all, Doll and Peto implicitly suggested that their results might to some extent be explained by the general inaccuracy of self-reported inhaling data. In the same paper, however, Doll and Peto reported a notably higher mortality among inhalers than among non-inhalers from chronic bronchitis, emphysema, and pulmonary heart disease; from ischaemic heart disease in men under 65; and from some 'other conditions closely associated with smoking'—thus indicating that self-reported inhalation was measuring something of relevance. Reid *et al.* (1976) also discovered a significant effect of inhaling on coronary heart disease. They found that the death rate for non-inhaling cigarette smokers was no higher than for non-smokers.

The higher prevalences of respiratory symptoms in the lower social classes, in those exposed to dust or fumes, and in those who are divorced, separated, or widowed, are all consistent with previous knowledge. However, the findings of an exceptionally high

prevalence of all the symptoms in those living in Wales were a little surprising in view of the fact that the excess mortality rate for Wales for chronic bronchitis and coronary heart disease, compared with that in England, is only relatively small. On the other hand, the Hospital In-Patient Enquiry (Department of Health and Social Security and Office of Population Censuses and Surveys, 1972) showed that discharge rates per 10 000 population for bronchitis and emphysema for hospitals in Wales were the highest for any region (19·6) compared with the average for England (11·4). Although discharge rates do not measure prevalence precisely, the figures support the finding in this study of a high prevalence of symptoms of bronchitis in Wales.

Symptoms undoubtedly give some information on subsequent mortality (Rose *et al.*, 1977) and some indication of the current disease state of the respondent. Nevertheless, a large part of what is being measured is probably a non-specific short-term effect. For example, Dean (1965) showed that immigrants to South Africa from the United Kingdom lose the high British risk of dying from chronic bronchitis, and in this study the respiratory symptom prevalence of ex-smokers who had given up for more than four years tended to be similar to that of non-smokers. Furthermore, the relationship of symptom prevalence to age is, for many symptoms, flatter than the shape of the relationship of mortality to age, and the relationship between smoking and mortality from coronary heart disease, especially among the young (Doll and Peto, 1976) is very much more marked than that between smoking and cardiovascular symptom prevalence. These findings suggest that further essential processes, presumably capable of being modified by external factors, must be involved before those with symptoms die.

Although those with symptoms are more likely subsequently to die than those without (for example, Krueger *et al.*, 1970), it should not therefore be inferred that symptoms are a necessary or sufficient step on the pathway to subsequent mortality. The study of symptoms can never be an adequate substitute for the study of mortality itself.

We thank members of the statistical sub-committee of the Tobacco Research Council for much helpful advice on the design and analysis of the study, and Mrs Barbara A. Forey for considerable help in carrying out the analyses described.

Reprints from G. Dean, Medico-Social Research Board of Ireland, Dublin 2.

References

Dean, G. (1965). The causes of death among South African-born and immigrants to South Africa compared with England and Wales. *South African Medical Journal*, special supplement.

Department of Health and Social Security and Office of Population Censuses and Surveys (1972). *Report on Hospital In-Patient Enquiry for the Year 1972.* Part I, Tables. HMSO: London.

Doll, R., and Peto, R. (1976). Mortality in relation to smoking. 20 years' observations on male British doctors. *British Medical Journal*, **2**, 1525-1536.

Haenszel, W., and Hougen, A, (1972). Prevalence of respiratory symptoms in Norway. *Journal of Chronic Diseases*, **25**, 519-544.

Krueger, D. E., Rogot, E., Blackwelder, W. C., and Reid, D. D. (1970). The predictive value of a postal questionnaire on cardiorespiratory symptoms. *Journal of Chronic Diseases*, **23**, 411-421.

Lambert, P. M., and Reid, D. D. (1970). Smoking, air pollution and bronchitis in Britain. *Lancet*, **1**, 853-857.

Medical Research Council (1966). Questionnaire on respiratory symptoms and intructions for its use. Medical Research Council: London.

Reid, D. D., Cornfield, J., Markush, R. E., Siegel, D., Pedersen, E., and Haenszel, W. (1966). Studies of disease among migrants and native populations in Great Britain, Norway and the United States. National Cancer Institute, Bethesda, USA. Monograph No. 19, 321-346.

Reid, D. D., Hamilton, P. J. S., Keen, H., Brett, G. Z., Jarrett, R. J., and Rose, G. (1974). Cardiorespiratory disease and diabetes among middle-aged male civil servants. *Lancet*, **1**, 469-473.

Reid, D. D., Hamilton, P. J. S., McCartney, P., Rose, G., Jarrett, R. J., and Keen, H. (1976). Smoking and other risk factors for coronary heart disease in British civil servants. *Lancet*, **2**, 979-984.

Rose, G. A., and Blackburn, H. (1968). *Cardiovascular Survey Methods.* WHO: Geneva.

Rose, G. A., Hamilton, P. J. S., Keen, H., Reid, D. D., McCartney, P., and Jarrett, R. J. (1977). Myocardial ischaemia, risk factors and death from coronary heart disease. *Lancet*, **1**, 105-109.

Sparks, D., and Lee, P. N. (1976). Regression techniques in survey analysis. Paper read to Royal Statistical Society, London.

Wald, N., Idle, M., and Baily, A. (1978). Carboxyhaemoglobin levels and inhaling habits in cigarette smokers. *Thorax*, **33**, 201-206.

Young, J. L. (1974). Cardiorespiratory symptom prevalence among Norwegian migrants to the United States and siblings still alive in Norway with an adjustment for sibship size. Institute of Statistics Mimeo Series No 922. University of North Carolina.

Zeiner-Henriksen, T. (1971). Cardiovascular disease symptoms in Norway; a study of prevalence and a mortality follow-up. *Journal of Chronic Diseases*, **24**, 553-567.

Appendix

DEFINITIONS OF SYMPTOMS

Questions on symptoms were based on the Medical Research Council Respiratory Symptoms Questionnaire (MRCQ) (1966) and on the London School of Hygiene Questionnaire (LSHQ) on Cardiovascular Symptoms (Rose and Blackburn, 1968), but some modifications were made and additional questions were asked.

Morning cough was based on 'Do you ever have a cough when you wake up in the morning?' (There is no equivalent in the MRCQ).

Shortness of breath was based on 'Do you ever get short of breath walking with other people at an ordinary pace on the level?' (The MRCQ says '. . . people of your own age on level ground?').

Wheezing was based on 'Does your chest ever sound wheezing or whistling?' (The MRCQ is the same).

Phlegm score was based on three questions:—

1. 'In the winter, do you usually bring up any phlegm from your chest first thing in the morning?' (The MRCQ inserts 'on getting up' after 'morning' and puts 'in the winter' at the end of the question).

2. 'Do you usually bring up any phlegm from your chest either during the day or at night, in the winter?' (The MRCQ omits 'either').

3. 'Do you bring up any phlegm like this on most days for three months or more, each year?' (The MRCQ has '. . . days or nights for as much as three months each year?'). Phlegm score 3 is based on Yes to question 1 and Yes to either question 2 or question 3. Phlegm score 4 is based on Yes to all three questions.

Bronchitis syndrome required having shortness of breath, prolonged phlegm (question 3 above), and prolonged cough. Assessment of this was based on 'Do you cough at these times on most days, for three months or more during the whole year?' This was the third of a series of questions on cough similar to those on phlegm, only with 'cough' replacing the words 'bring up any phlegm from your chest'.

Angina was based on positive answers to the following questions:—

1. 'Have you ever had any pain or discomfort in the middle of your chest?' (The LSHQ says 'in your chest').

2. 'Do you get it when you walk uphill or hurry? (The LSHQ says 'Do you get this pain or discomfort when you walk uphill or hurry?')

The angina assessment also depended on the following answers to two further questions;—

3. 'When you get any pain or discomfort in your chest, what do you do? Do you stop, slow down, or continue at the same pace?' *Answer:* 'Stop or slow down'. (The LSHQ omits from the question the words 'what do you do?').

4. 'How soon does it go away? Does it go away in 10 minutes, or less, or more than 10 minutes?' *Answer:* 'Ten minutes or less'. (The LSHQ simply asks 'How soon? Ten minutes . . .').

'Possible infarction' was based on 'Have you ever had a severe pain across the front of your chest lasting half an hour or more?' (The LSHQ says 'lasting for').

'Possible claudication' was based on a positive answer to 'Do you regularly get a distinct pain in one leg only, on walking, but not standing still?' (The LSHQ asks a number of separate questions). The claudication assessment was also based on the following answers to questions:

1. 'What do you do if you get it when you are walking? Do you stop, slow down, or continue at the same pace'? *Answer:* 'Stop walking,' or 'Slow down'

2. 'What happens to it if you stand still? Does it usually continue more than 10 minutes, or disappear in 10 minutes or less?' (This is similar to the LSHQ). *Answer:* 'Disappears in 10 minutes or less.'