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Occupation, smoking, and lung cancer

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The report by Damber and Larsson on occupation and lung cancer in northern Sweden attracted our interest as suggesting an aetiological fraction for occupational exposures in the order of 9–18%.[1] Others have reported quite different figures, however, from 5%[2] to even 50%.[3] Such quantitative estimates tend to be particularistic, as merely relating to specific populations in time and place whereas the qualitative identification of risk factors provides for generalisation. In view of the divergent estimates that have been presented for occupational exposures and smoking with regard to lung cancer we think that many quantitative evaluations of these factors are needed from various countries and different areas to complete the picture. We report here a similar evaluation from an area in south eastern Sweden, which is more industrialised although with less mining than in northern Sweden.

Subjects and methods

A total of 62 cases (ICD 162–163) were collected during 1980–2 through the lung clinic of the University Hospital of Linköping and were compared with 198 hospital referents drawn from the same clinic and from the medical clinic of the hospital. The referents had visited one of the clinics the same day as the case was registered at the lung clinic. The initial aim was four referents per case, matched for age and sex but referents with a known cancer were excluded. The difference in mean age between cases and referents was 0·5 years and there was the same sex distribution with four times as many men as women. All subjects were given a self administered questionnaire which, if information was lacking, was supplemented by a telephone interview. Occupation was considered in detail with regard to the nature of the work task and its approximate duration. Furthermore, a smoking history was collected both with regard to the quantity and the duration of smoking.

In the first phase of the analysis the occupations considered in the questionnaire were classified by three occupational health physicians as to the known or suspected risk of lung cancer, formulating the following occupational categories (OC).

OC–3—Work tasks with probable exposure to asbestos or mine work.

OC–2—Pesticide spraying, welding of different types, locomotor driving, or forest work with motorsaw or with herbicides.

OC–1—Metal work, furniture making, or other wood and forest related work.

OC–0—All other work.

Similarly, smoking categories (SC) were based on "cigarette years"—that is, the daily quantity times the duration in years as follows

SC–0—Non-smoker, cigarette-years = 0.

SC–1—Mild smoker, cigarette-years < 80.

SC–2—Moderate smoker, cigarette-years > 80 and < 100.

SC–3—Heavy smoker, cigarette-years > 100 (the highest was 192; very heavy smoking was unusual).

Statistical methods

Rate ratios (RR), attributable cases (AC), and aetiological fractions (AF) were calculated by using the methods described by Miettinen,[4–6] Walter,[7] and Pastorino *et al.*[3] The analyses of the data also involved the principles of Mantel and Haenszel.[8]

Results

The table presents the rate ratios, the number of AC and other parameters in the various smoking and occupational categories, respectively.

As expected the rate ratio increased progressively with increase in smoking, with a greatest rate ratio of 5·1 (90% confidence interval 2·6–9·8) in category SC–3. As to occupations, OC–1 and OC–2 had a rate ratio of less than or close to unity, whereas it was 3·3 (90% CI 1·0–7·6) in OC–3. A fairly high rate ratio was observed for the combination of SC–3 and OC–3, 16·7 (90% CI 3·2–85·5).

The table also shows the number of AC in various categories where the rate ratio exceeds unity. By means

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Distribution of cases and referents by smoking and occupational category

Smoking category	*Case-referent*	*Occupational category* 0	1	2	3	*Total*	*RR (a)*	*AC (a)*	*AF (%)*
0	C	7	4	7	1	19			
	R	39	18	37	3	97			
	RR(c)	(1·0)	(1·2)	(1·1)	(1·9)		1·0	0·0	
1	C	3	2	6	2	13			
	R	14	13	25	2	54			
	RR(c)	(1·2)	(0·9)	(1·3)	(5·6)		1·2	2·2	17
2	C	4	1	5	1	11			
	R	9	2	16	1	28			
	RR(c)	(2·5)	(2·8)	(1·7)	(5·6)		2·0	5·8	54
3	C	6	1	9	3	19			
	R	4	5	9	1	19			
	RR(c)	(8·4)	(1·1)	(5·6)	(16·7)		5·1	15·3	81
1+2+3	C	13	4	20	6	43			
	R	27	20	50	4	101			
	RR(c)	(2·7)	(1·1)	(2·2)	(8·4)		2·2	23·2	54
Total	C	20	8	27	7	62			
	R	66	38	87	7	198			
	RR(b)	(1·0)	(0·7)	(1·0)	(3·3)				
	AC(b)	0·0	—	0·6	4·9				
	AF(%)		—	2	70				

AC = Attributable cases with reference to: (a) non-smokers adjusted for occupational exposure and (b) occupationally unexposed adjusted for smoking.
RR = Risk ratio with reference to: (c) occupationally unexposed non-smokers.
AF = Aetiological fraction.

of AC, the aetiological fractions (AF) were calculated. The aetiological fractions for the different smoking categories were 17%, 54%, and 81%, respectively. In total the AF for smoking was 54%.

The AF due to occupational exposures might be considered in relation to the total material as well as with regard to certain subpopulations. Hence, by means of the AC in OC–3, a sort of maximum AF of 4·9 AC/62 total cases = 7·9% was obtained, whereas the corresponding AF within OC–3 is 4·9 AC/7 total cases = 70%. On the other hand, the proportion of total cases preventable by eliminating smoking (without modifying occupational exposures) is 23·2 AC/62 total cases = 37·4%. Contrasting the subjects in all various levels of smoking and potential risk occupations with occupationally unexposed non-smokers (seven cases and 39 referents in the reference category) the overall proportion of cases as theoretically preventable by eliminating both occupational exposure and smoking is 42·7% (90% CI 7–78%) of the total number of cases.

Discussion

There may be several aetiological possibilities that have not been taken care of in this study—for example, unidentified occupational risk factors in OC–0. The possible effect of radon gas in dwellings[9,10] was studied quite carefully, however, by applying the Miettinen confounder score technique to account for confounding from other risk factors but no effect was seen, perhaps because of insufficient gradients of exposure in the study population. Any important confounding effect of social class difference (cf Pastorino *et al*[3]) is less likely to operate in this study because cases and referents were taken from the same lung and medical clinics and because social class differences are less prominent in Sweden. The possible exposure to environmental tobacco smoke was not taken into account in the analysis.

In OC-3 (work tasks with possible exposure to asbestos and mine work) there were only seven cases and seven referents and all were men; hazardous jobs are not held by women. Six individuals were exposed to asbestos and one to mine work in both the case and referent groups. This particular OC-group shows a more or less multiplicative effect of the occupational exposures and smoking that confirms earlier views,[3,11,12] although not all observations have been consistent.[13]

The proportion of lung cancer referable to occupation was 8% which is close to that found by Damber and Larsson[1] and in the lower end of the range of 5–50% presented in other studies (cf Kjuus *et al*[14]). Our study, however, included men and women, whereas the other studies dealt with men only. Since women smoked less than men and have had less hazardous jobs a lower proportion of lung cancer due to occupation (and smoking) would be expected in women.

Since only 43% of the cases could be explained on the above presumptions, additional but unknown aetiological factors seem to operate. The unexplained fraction in the Pastorino study[3] was 10%; Kjuus *et al* reported 6%[14] and Schoenberg *et al* 8%.[15] These studies, however, included only men. So, a minor fraction of male cases and a major fraction of female cases have to be referred to causes other than suspected or known occupational exposures and smoking.

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