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Association between Exposure to Asbestos and Pleural Effusion. Results from a Questionnaire Study of 31 000 Persons

Per Malmberg and Gunnar Hillerdal

National Institute of Occupational Health, S-171 84 Solna, Sweden and Institute of Pulmonary Medicine, University Hospital, S-751 85 Uppsala, Sweden

ABSTRACT

All visitors to a general health survey in 1979, 17,140 men and 14,371 women, completed a questionnaire on smoking habits, exposure to asbestos, silica and welding fumes, and diseases such as pleural effusion, pneumonia, cough, asthma and diabetes. Seven per cent of the men reported exposure to asbestos, 10% to welding fumes, and 6% to silica. Among those who reported work related dust exposure there was a higher proportion of smokers, and smokers exposed to dust smoked more tobacco per day than non exposed smokers. In the group of men 30-59 years of age, who did not indicate exposure to occupational pollutants 2.7% reported previous pleural effusions. However, among asbestos exposed men of the same ages, the prevalence was more than doubled (5.7%, $p<0.01$). This finding was highly significant in a logistic regression model where age and smoking habits were included. The data indicate that 10% or more of diagnosed cases of pleurisy could be associated with previous asbestos exposure.

INTRODUCTION

Beginning in 1963 and ending in 1985, all inhabitants in the county of Uppsala aged 15 years or more were invited to a general health survey every second or third year. During the visit blood pressure, hemoglobin, and urine tests were performed and a small size chest roentgenogram was taken. Between 50% and 70% of the population participated each time.

In 1979, all visitors were asked to complete a questionnaire regarding exposure to asbestos, silica, welding fumes, and occurrence of certain pulmonary and other symptoms and diseases. The aim was to investigate the relation between smoking habits and exposure to some common occupational pollutants occurring before 1979 and future pulmonary diseases in a prospective study.

During the study of the questionnaire responses at follow-up time, observations were made which were considered to be of general interest. Thus twice as many men who reported exposure to asbestos also reported a history of pleural effusion, compared to men who did not report asbestos exposure. Since the survey was performed in 1979, when the relation between pleural effusion and

asbestos exposure were practically unknown among practicing physicians, the data should be less influenced by recall bias than would be the case in similar studies performed at later dates.

MATERIAL AND METHODS

All visitors at the health survey were asked to complete a questionnaire. In the questionnaire a tobacco smoker was defined as a person who had smoked at least one cigarette per day for one year or more (or about 400 cigarettes, or 5 packs of tobacco (75 gram packs) or 200 cigars). An ex-smoker was defined as a smoker who had stopped smoking since at least six months. The answers were coded as "Yes", "No" or "Missing". Smokers were also asked to estimate the average tobacco consumption per day, the year they started to smoke and the year they stopped smoking, if ex-smokers. In the calculation of total tobacco consumption one cigarette was assumed to contain one gram of tobacco, a cigar two grams and a parcel of tobacco 75 grams

The participants were also asked to report if they had been exposed to asbestos dusts. Similarly they were asked to report exposure to silica dust and welding fumes. In a third section of the questionnaire they were asked to indicate if they presently suffered from or had previously suffered from diseases or conditions as listed in Table 4. No distinction was made between "No" replies and missing information in the questions regarding dust exposure or diseases.

The responses were coded twice for improved accuracy and fed into a computer (MicroVAX II) with the database program MIMER®. The statistical analysis was performed using the SAS statistical package®, using the Chi^2-method and logistic analysis of variance (cat-mod procedure).

RESULTS

Questionnaires from 17,140 men and 14,371 women contained identification numbers which could be used for calculation of age and were thus used in the investigation. Another 100 questionnaires from men and 70 from women did not contain identification numbers and were excluded. In 70 questionnaires from men and 180 from women information on the smoking habits were missing. The age distribution is shown in Fig. 1.

There were more tobacco smokers among men aged 40 or more than among women and male smokers smoked more than female smokers (Tables 1 and 2, Fig. 2); but at younger ages the opposite was found. The average age when smoking was commenced was practically constant for all age groups in men 30 years of age or older.

Table 1. Smoking habits according to sex and occupational exposures (per cent).

	Men all	Exposed to Asbestos	Welding	Silica	Women all
Never-smokers	40.4	30.2	32.2	29.4	54.5
Ex-smokers	26.2	30.2	28.9	28.4	14.8
Smokers	33.4	39.6	38.9	42.3	30.7

Table 2. Tobacco consumption in current-smokers and ex-smokers with and without exposure to one or more of the pollutants asbestos, silica and welding fumes.

Men	current-smokers		Ex-smokers		Women	
	Non-exposed	Exposed	Non-exposed	Exposed	Current smokers	Ex-smokers
g/day	13.6	14.5	14.1	15.9	12.5	10.4
(S.D.)	(8.2)	(8.2)[1]	(9.1)	(11.6)[1]	(5.9)	(6.4)

[1] $p<0.001$ for difference between non-exposed and exposed groups.

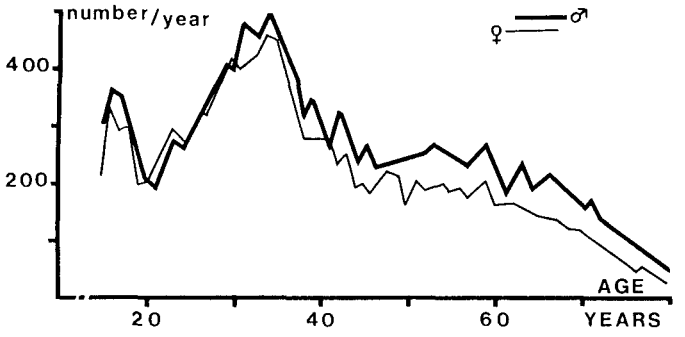


Fig. 1.

Age distribution. Three-point moving averages of each one year age group.

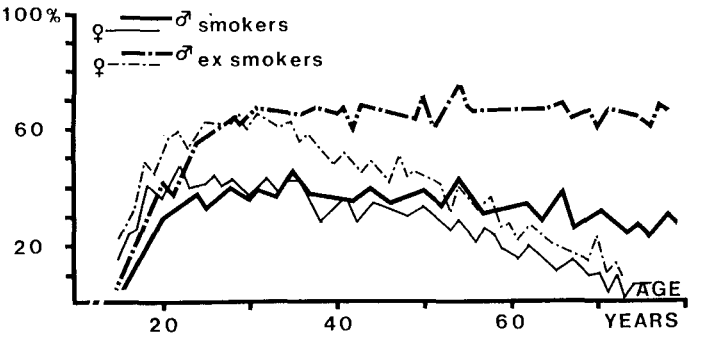


Fig. 2.

Age distribution of current smokers and ex-smokers (plus current smokers) among male and female participants. Percent of all participants in each sex and age group.
See legend to Fig. 1 for further detail.

Exposure to asbestos, welding fumes and silica are shown in Table 3. Among men who reported exposure to occupational pollutants there were more smokers, and dust exposed smokers smoked more tobacco per day (Table 2) than among age-matched referents. Exposure to occupational dusts, particularly asbestos, was reported more often among young men than among older age groups (Fig. 3). Of the men aged 30 to 59 years, 8.1% reported exposure to asbestos.

The number of persons who reported diseases or symptoms are shown in Table 4. The occurrences of diseases and symptoms (asthma, pneumonia, pleurisy, rib fractures, diabetes and chronic cough) in different age groups are illustrated in Fig. 4-7. As could be expected, the prevalence of pneumonia, pleurisy and diabetes increased with age, but asthma was more common in the younger age groups.

Table 3. Exposure to occupational agents and smoking habits (per cent)

	Men all	Current-Smokers	Ex-smokers	Never-smokers	Women all
Asbestos	6.9	8.1[a]	7.9	5.1	0.2
Welding	10.4	12.1[a]	11.5	8.3	0.2
Silica	5.7	7.2[b]	6.2	4.1	0.2

[a]$p<0.001$ for differences between smoking categories.
[b]$p<0.01$ for differences between smoking categories.

Of men aged 30 to 59 years who did not report exposure to occupational dusts 2.7% reported previous pleuritic disease. Similar prevalences of reported pleural disease were found in men who reported exposed to silica dust or welding fumes. However, among men aged 30-59 years who reported exposure to asbestos, more than twice as many (5.7%) reported previous pleural effusion (Table 5). This difference was not found in men less than 30 years of age. The association between exposure to asbestos and pleurisy was significant ($p<0.01$) in a logistic regression model which included age and smoking habits.

Table 4. Occurrence of earlier or present symptoms and diseases according to smoking habits (per cent).

	Men				Women			
	all	CS[a]	XS[b]	NS[c]	all	CS	XS	NS
Pneumonia	13.6	14.6[1]	15.8	11.4	12.1	11.9[2]	14.3	11.8
Pleural effusion	2.9	2.9[1]	4.1	2.3	2.2	1.9[ns]	2.4	2.4
Rib fracture	9.9	11.3[1]	11.1	7.9	3.2	2.5[2]	2.7	3.6
Diabetes	1.6	1.3[1]	2.4	1.3	1.3	0.7[1]	0.8	1.8
Asthma	3.6	2.9[2]	3.8	3.0	3.2	3.1[ns]	3.8	3.0
Chronic cough	2.0	3.7[1]	1.5	0.9	1.7	3.0[1]	1.5	1.1

[a]Current smoker. [b]Ex-smoker. [c]Never-smoker. [1]$p<0.001$ for differences between smoking groups. [2]$p<0.01$. [ns]Statistically non-significant.

Table 5. Prevalence of positive answers to question: "Have you or have you ever had pleuritis", according to age category and dust-exposure in men. Percent of group and group size.

Age group	No exposure or welding[a]	silica	asbestos[b]
15-29 years	0.9% (3807)	0.8% (396)	0.9% (234)
30-44 years	1.7% (4482)	1.9% (644)	4.4% (498)
45-59 years	4,1% (3072)	3.7% (376)	8.2% (268)
60+ years	5.4% (2942)	7.1% (240)	9.7% (175)
All(n=17140)	2.8% (14303)	2.8% (1656)	5.4% (1175)

[a]Excluding cases who also reported exposure to asbestos. [b]Including mixed exposure.

Fig. 3.

Age distribution of reported exposure to occupational dusts among male participants.
See legends to Fig. 1,2 for further detail.

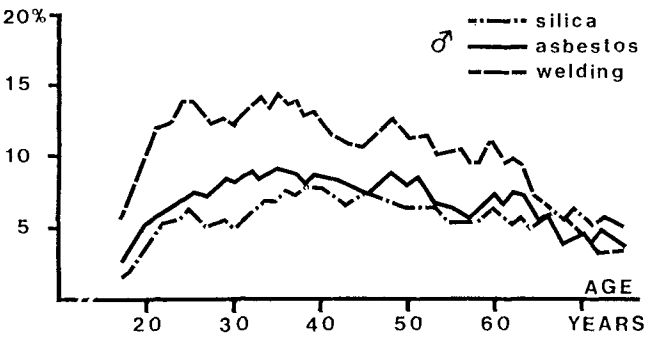


Fig. 4.

Reported frequency of earlier or present pleuritis and rib fractures among male and female participants.
See legends to Fig. 1,2 for further detail.

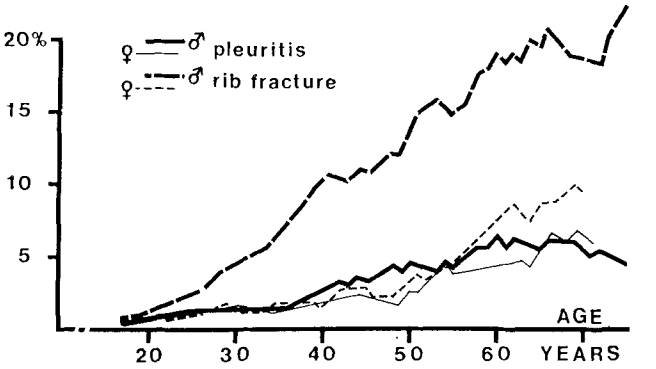


Fig. 5.

Reported frequency of earlier or present asthma and pneumonia among male and female participants.
See legends to Fig. 1,2 for further detail.

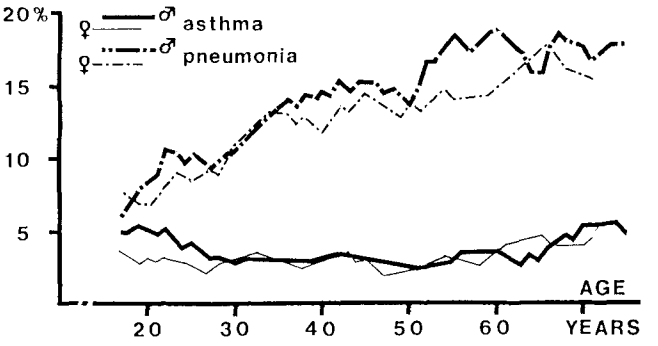


Fig. 6.

Reported frequency of earlier or present diabetes among male and female participants.
See legends to Fig. 1,2 for further detail.

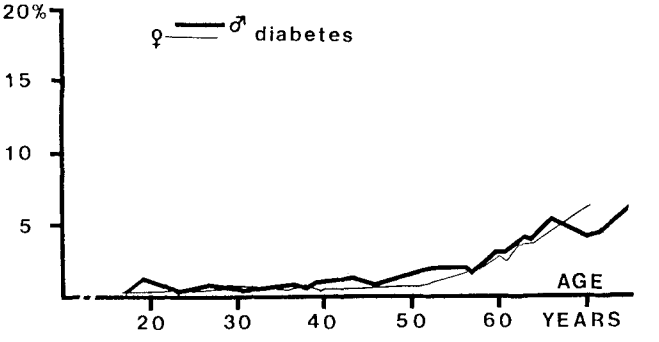
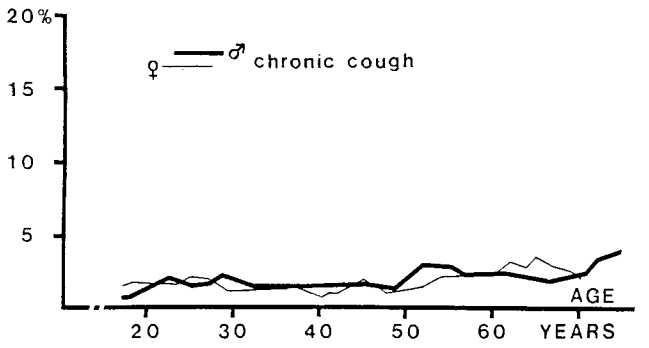


Fig. 7.

Reported frequency of earlier or present chronic cough among male and female participants. See legends to Fig. 1,2 for further detail.



DISCUSSION

The present data confirm some commonly known observations, such as the circumstance that older men smoke more than women whereas the opposite is found among young subjects.

Among those who reported exposure to silica, asbestos or welding fumes there were more smokers and dust exposed smokers smoked more than age matched controls. These findings agree with other studies (4, 8) and point to an association between occupation and lifestyle characteristics, which should be considered when interpreting data from different occupational settings.

Young subjects reported present or earlier diagnosis of asthma more often than middle aged subjects. This finding was unexpected. If the incidence of asthma is constant, an increasing proportion of subjects who have or have ever had the diagnosis would be expected with increasing age, rather than the opposite. Several explanations are possible, such as a recent change in diagnostic criteria or improved diagnostic capacity. With increasing age, episodes of childhood asthma may have been forgotten or middle aged subjects with a history of asthma may have chosen not to attend the health survey. The finding can therefore only be regarded as circumstantial evidence in the present debate regarding a possible rise in the true incidence of asthma in recent years. However, the results of the survey do not refute this notion.

Men who had indicated exposure to asbestos also reported having suffered from pleurisy more than twice as often as men who did not report asbestos exposure. This finding needs to be interpreted with consideration of the representativity of the material and of possible bias in the answers.

The health survey was in operation from 1963 to 1985, and the participation was fairly constant through the years, as was the distribution of participation among different age groups. Thus, for the age groups 35 to 65 years, the participation figures have been from 60 to 70%. Those who are invited for the first time, i.e. at age 15 to 17, have the highest participation rate (70% or more), but the second and third time - at age 18 to 25 - the interest seems to be low. Above age 70, again fewer persons will attend. The exact figures from the year 1976 have been published previously (8) and were as follows: 15-44 years of age,65 %; 45 to 64 years, 72%; above age 65, 48%; and total, 64%. According tc unpublished studies the main reasons for non-participation was either that the

subject was sick and already under medical supervision, or especially among young subjects, a feeling of good health, and thus no need for a free medical checkup.

Between 6-10% of the men indicated exposure to asbestos, silica or welding fumes and about 3% of all men indicated previous or present episode(s) of pleurisy. The observed frequency of reported pleurisy may be influenced by positive and negative selection, but selection can hardly explain the findings. Even if a higher proportion of asbestos exposed subjects who had suffered from pleurisy would attend the survey, than in the general population, such a selection bias would not be of sufficient magnitude to explain the figures obtained. Furthermore, men exposed to silica or welding fumes should have similar bias, but these groups did not have an increased prevalence of pleurisy compared to men who did not report exposure to occupational dusts.

Another possible confounding factor is recall bias. Thus if a relationship between asbestos exposure and pleurisy were known to the medical profession or to the lay public, a careful search of previous exposure to asbestos may have been performed by the subjects at the time of the diagnosis. This would increase the likelihood of remembering such exposure when the questionnaire was completed. Benign asbestos pleural effusion is now a well-recognized entity (1, 6, 7). This association between asbestos exposure and pleurisy was, however, first reported in the 1970's (5, 10, 12) and was not commonly known among the medical profession at the time of the study (1979). The association was virtually unknown in the general public at the time. Therefore recall bias is an unlikely explanation.

There are few studies regarding how many in the general population who have been occupationally exposed to asbestos. In the USA it has been estimated that 14 million living workers have had significant exposure, which would be more than 10 per cent of the adult male population (11). In Norway, in a study of 21,453 men above age 40, a mean of 18% had been occupationally exposed to asbestos. In industrialized municipalities, the figure was 9 to 26%, and in non-industrialized 7 to 8% (8). Uppsala County is not very heavily industrialized and the figures agree well with the non-industrialized municipalities in Norway. For the whole of Sweden, the percentage figures would probably be more like those of the USA.

If about 3% of men aged 30 - 60 years report having had pleurisy and twice as many among the ten percent of men who also indicate exposure to asbestos, then about 10% of all reported pleurisy could be related to asbestos exposure. Studies where subjects with pleural disease have been subjected to thoracoscopy have indicated similar proportions (2, 3, 9). The figure 10% may underestimate the true proportion of asbestos related pleurisy since this type of pleurisy is often associated with few symptoms. Furthermore, a significant number of those who reported pleurisy in the present study who had not indicated asbestos exposure, may have been exposed to asbestos unknowingly or may have forgotten this exposure at the time of the inquiry.

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Address for reprints:

Per Malmberg
National Institute of Occupational Health
S-171 84 Solna Sweden