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Previous asbestos exposure and smoking habits in the county of Telemark, Norway — A cross-sectional population study

by Bjørn Hilt, MD,[1] Sverre Langård, MD, MSc,[1] Per G Lund-Larsen, MD,[2] Jan T Lien, MD[3]

HILT B, LANGÅRD S, LUND-LARSEN PG, LIEN JT. Previous asbestos exposure and smoking habits in the county of Telemark, Norway — A cross-sectional population study. *Scand J Work Environ Health* 12 (1986) 561–566. In order to study the number of persons previously exposed to asbestos in the general population, an investigation with a self-administered questionnaire and a screening with 10 × 10-cm chest radiographs was conducted among 28 216 men aged 40 years and over in nine municipalities in the county of Telemark, Norway. Among the 21 453 subjects who answered the questionnaire in the primary screening, 3 888 (18.1 %) reported previous occupational exposure to asbestos. Of the exposed subjects 2 368 (61.4 %) were less than 60 years of age, and 2 611 (69.9 %) had been exposed for the first time after 1950. In regard to the degree of exposure, 77.7 % considered their previous exposure to be light. Past and present smoking habits were recorded for all the subjects, and a high-risk group of 1 734 subjects with past exposure to asbestos and present smoking was identified. Approximately 270 incident cases of lung cancer can be expected among the 21 453 study subjects during the next 10 years, and it is estimated that about 110 of these cases will occur in the high-risk group with combined asbestos-cigarette exposure.

Key terms: identification of high-risk groups, occupational exposure to asbestos in the general population.

The incidence of various diseases caused by previous asbestos exposure, in particular asbestos-related cancers, will presumably continue to increase during the next 10–20 years. The number of previously exposed persons who are still at increased risk of acquiring asbestos-related diseases is unknown. As it is of interest for preventive purposes to know the extent of this future health problem, different attempts have been made to estimate the number of previously exposed workers.

Nicholson et al (17) have estimated that 14 million living workers in the United States (US) have had asbestos exposure exceeding 2–3 fiber-years/ml, and they expect approximately 200–250 thousand cancer deaths among these workers before the year 2010. On the basis of the number of asbestos-exposed workers required to recruit the current incidence of mesothelioma in the United States, Walker et al (19) have estimated that 74 000 lung cancer and mesothelioma deaths will occur among asbestos-exposed subjects from 1980 through 2009.

From a review of epidemiologic studies Lemen et al (14) have estimated that four million workers in the United States have been heavily exposed to asbestos, and they expect that 1.6 million of these will die from asbestos-related cancers during the coming years, 20–25 % from lung cancer, 7–10 % from pleural or peritoneal mesothelioma, and 8–9 % from asbestos-related gastrointestinal cancers.

In the county of Uppsala in Sweden, Hillerdal (4) estimated that 7.4 to 37.9 % of the population in six municipalities had been employed in "asbestos occupations" in 1950. In a later communication it was reported that about 6 % of the men over the age of 40 years in the same county "admitted exposure to asbestos" (5). However, no further details were given as to how this figure was established.

Even though the aforementioned studies are based on rough estimates, and the suggested figures vary considerably, they indicate that previous asbestos dust exposure will give rise to a significant health problem in the United States, and other countries, for many years to come.

The first cases of asbestosis reported in Scandinavia were diagnosed in 1939 in three industrial workers from the county of Telemark in Norway (20). Telemark is located in southeast Norway, and some of the 18 municipalities within the county have had heavy industry since the turn of the century.

During the last few years several cases of asbestos-related diseases have been observed among the county population (6, 7, 9, 11, 13). Therefore, it seemed of interest to study the extent of previous occupational asbestos exposure among all inhabitants in the county.

The present paper reports the results of a cross-sectional questionnaire survey of previous occupational asbestos exposure and smoking habits in the general male population. An attempt was made to estimate

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the number of asbestos-related lung cancers that can be expected in the county population in the coming years, and the possibilities for identifying specific risk groups for preventive efforts are discussed.

Subjects and methods

In accordance with legislation introduced in Norway in 1947, the National Health Screening Service has carried out screening for tuberculosis throughout the country since that year. The screening includes a 7 × 7-cm frontal-view radiograph of the lungs at two- to five-year intervals. As selective tuberculosis screening was planned for the county of Telemark in 1982 – 1983, it was decided to include a screening for previous occupational exposure to asbestos and for the prevalence of asbestos-related diseases in the county population.

Due to long latency periods, asbestos-related diseases are rare below the age of 40 years, and in the general population they are also rare among women (4). For practical and economic reasons the screening had to be restricted to about 30 000 subjects and to a smaller geographic area than the whole county. Therefore, the study group was restricted to men aged 40 years and older who were alive on 1 January 1982 and who were resident in one of seven industrialized or two rural municipalities within the county. The industrialized communities had a variety of industries such as electrochemical, ferroalloy, and electrical equipment industries, iron foundries, paper mills, and shipyards. A total of 63 711 males and 65 479 females was living in these municipalities at the start of the study. The two last-mentioned municipalities, which served as "reference communities," are rural areas with only a little industry. They had 3 102 male and 3 069 female inhabitants. In the whole county population there were 33 420 men above the age of 39 years.

All men who were eligible received a questionnaire with inquiries about any previous occupational exposure to asbestos dust. The questionnaire had a short introduction presenting the aim of the study. Otherwise, no instructions or information was given about probabilities of asbestos exposure in different trades or occupations. The wording of the questions was: (i) "Have you ever been exposed to asbestos dust in your work?", (ii) "In what kind of industry or which occupation did the exposure take place?", (iii) "When were you first exposed to asbestos and how long did the exposure last?", and (iv) "Would you consider the degree of your previous exposure as light, moderate or heavy?"

There were also detailed questions on past and present smoking habits. Those who had smoked regularly for one year or more were classified as smokers. Smokers who had stopped smoking more than one year prior to the investigation were regarded as exsmokers.

Along with the self-administered questionnaire, all study subjects received information on the time and place for a radiographic examination. The questionnaires were collected and checked for completeness by the staff in the X-ray unit during that examination.

Table 1. Responses of the 21 453 men to the questionnaire on previous occupational exposure to asbestos.

Municipality	Alternatives				Crude rate "yes" (%)	Age adjusted rate "yes" (%)
	"Yes"	"No"	"Don't know"	Other		
Industrial						
Porsgrunn	1 220	2 911	652	18	25.4	25.3
Skien	1 106	4 867	898	19	16.1	15.9
Notodden	450	1 666	287	9	18.6	18.8
Bamble	335	1 022	284	1	20.4	19.4
Kragerø	158	1 422	181	3	9.0	9.1
Nome	169	1 014	186	5	12.3	12.9
Tinn	363	845	184	3	26.0	26.7
Reference						
Seljord	43	465	88	5	7.2	7.6
Kviteseid	44	468	60	2	7.7	8.2
All	3 888	14 680	2 820	65	18.1	.

Table 2. Age distribution in relation to responses to the questionnaire on previous asbestos exposure.

Age group	Number of subjects	"Yes"		"No"		"Don't know"		Others (N)
		Number	Percent	Number	Percent	Number	Percent	
40 – 49	4 938	1 160	23.5	2 982	60.4	789	16.0	7
50 – 59	5 864	1 226	20.9	3 806	64.9	824	14.1	8
60 – 69	6 159	1 048	17.0	4 317	70.1	774	12.6	20
≥ 70	4 492	454	10.1	3 575	79.6	433	9.6	30

Results

In the seven industrialized communities a total of 26 715 men received the questionnaire, and 75.9 (range 72.5 – 83.2) % completed it. In the two rural communities 1 501 received the questionnaire, and 77.3 and 79.3 % completed it. A total of 21 453 (76.0 %) of those who were eligible answered the questionnaire.

Table 1 presents the answers to the question on previous occupational exposure to asbestos.

Table 2 shows the age distribution of the men in relation to the answers to the question on previous asbestos exposure.

Four subjects stated that they had been exposed to asbestos in the first decade of the century, and 24 had been exposed for the first time between 1910 and 1919. In table 3 the decade of first exposure is presented for the 3 735 subjects who had answered that particular question. All in all, 2 611 (69.9 %) men had been exposed for the first time after 1950, and 1 201 (32.2 %) after 1960.

Most (77.7 %) of those who reported previous asbestos exposure considered their exposure to be light, whereas 16.1 % considered it to be moderate, and 4.5 % heavy.

In regard to the workplaces or occupations in which previous asbestos exposures had taken place, three electrochemical plants in three municipalities appeared to be the main sources of exposure. However, as is shown in table 4, asbestos exposure had been rather common in many other workplaces and occupations. Since 273 of the 3 888 exposed subjects had not reported their place of exposure and 526 reported two different workplaces, the table contains 4 141 reported exposure situations. There were also 97 subjects who reported yet a third place of exposure. Among these 97 were 6 in the electrochemical industries, 6 in shipyards, 16 as engineers aboard ships, and 66 in other industries or occupations.

Smoking habits were recorded for 21 319 subjects, and the distribution of smoking habits in relation to the answers regarding previous asbestos exposure is presented in table 5. The highest proportion of current smokers (48.7 %) was found among those who had answered "yes" and were between 50 and 59 years of age. Figure 1 presents smoking habits in relation to age for the whole study group. Among the 3 879 who had answered "yes" about previous asbestos exposure and who had answered the questions about smoking habits, there were 1 734 current smokers, 1 396 exsmokers, and 749 never smokers.

As a consequence of the primary radiographic screening, 1 372 men were subjected to a secondary screening (8). Among them 375 had answered "yes," 813 "no," and 169 "don't know" about asbestos exposure on the questionnaire. At the secondary screening the 1 372 men were interviewed in detail by one of the authors (BH) in order to verify whether they

Table 3. Decade of first exposure for 3 735 of the men who answered "yes" to the question on previous asbestos exposure.

First exposure	Number with first exposure	Percent of exposed subjects
Before 1930	106	2.8
1930 – 1939	278	7.4
1940 – 1949	740	19.8
1950 – 1959	1410	37.8
1960 – 1969	871	23.3
1970 – 1979	314	8.4
1980 & later	16	0.4

Table 4. Types of industries and occupations in which the 3 888 men in Telemark had been occupationally exposed to asbestos.

Industry/occupation	Exposure places reported
Electrochemical and chemical industries	1 589
Building and construction industries	468
Shipyards	298
Seaman (machine room)	290
Ferroalloy industries	276
Automobile repair work	191
Electrical equipment industries	182
Cement industries (not asbestos cement)	128
Wood-processing industries	95
Iron foundries	61
Metal works (including welding)	45
Refractory material industries	33
Wood-working industries	23
Mechanics	21
Insulators	20
Railroad repair work in shops	17
Other occupations/exposure sources	404

Table 5. Smoking habits and asbestos exposure of the 21 319 subjects who answered the questions on both exposure factors.

Questionnaire response on asbestos exposure	Number	Current smokers				Ex-smokers[a] (%)	Never smokers[a] (%)
		1 – 19 cigarettes/d (%)	≥20 cigarettes/d (%)	Amount unknown (%)	All smokers[a] (%)		
"Yes"	3 879	31.9	9.0	3.7	44.6 (42.8)	36.0 (36.7)	19.4 (20.5)
"No"	14 631	29.5	5.6	5.8	40.9 (41.4)	28.6 (28.6)	30.5 (30.0)
"Don't know"	2 809	32.6	8.9	4.0	45.5 (44.6)	33.1 (33.1)	21.4 (22.3)
All	21 319	30.3	6.7	5.2	42.2	30.6	27.2

[a] Age-adjusted rates are given in parentheses.

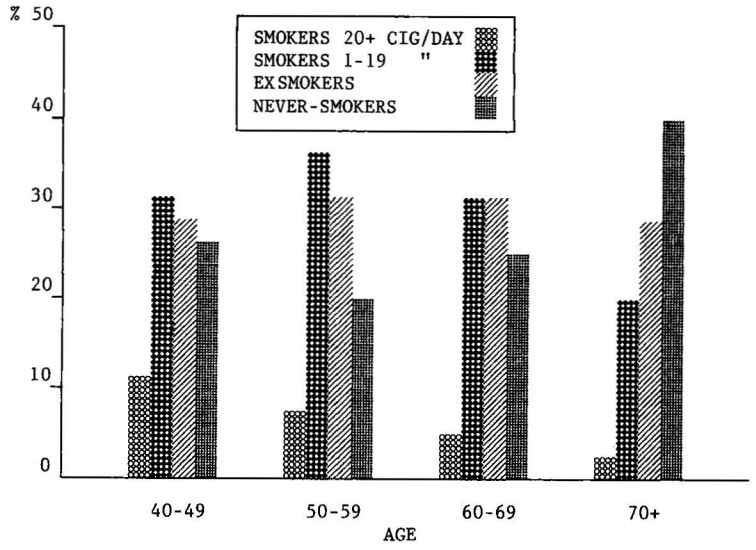

Figure 1. Smoking habits in relation to age (in years) among the 21 319 men who gave information on smoking in the questionnaire. (cig = cigarettes)

Table 6. Relationship between answers given on asbestos exposure in the questionnaire during the primary screening and during the interview at the reexamination.

Asbestos exposure according to interview	Questionnaire response		
	"Yes" (N = 375)	"No" (N = 813)	"Don't know" (N = 169)
"Yes"	365	453	116
"No"	10	360	53

had been occupationally exposed to asbestos. Table 6 gives the combined results of the questionnaire and the interview concerning asbestos exposure. If the answers given in the interview reflect the true picture of exposure, the primary screening had a sensitivity regarding this questionnaire information of 44.6 % and a specificity of 97.3 %.

Discussion

The present study presents evidence that a high proportion of the male population in Telemark has been occupationally exposed to asbestos during previous years.

The results show a great difference in the rate of exposed subjects between the industrial communities and the two rural communities which served as reference.

The results from the present study cannot be applied generally to other populations without reservations. On the other hand, it is likely that asbestos exposure has been as common in other Norwegian communities with a similar industrial structure. In a study of occupational determinants for lung cancer in Telemark and the neighboring county Vestfold, Kjuus et al (12) found that previous asbestos exposure was present to about the same extent among lung cancer patients from the two counties. As Hillerdal et al (5) did not describe the method they used to record a 6 % proportion of exposed men over 40 years of age in the county of Uppsala, Sweden, it is not possible to discuss the differences in the rate of exposed subjects between Telemark and Uppsala further.

In a population study like the present one, a participation of 76 % can be regarded as acceptable (15). There is no reason to assume that those who did not answer the questionnaire should be healthier (10, 18) or have been less exposed to asbestos than those who did answer. Therefore, the number of persons who answered the questionnaire was used as the basis for the calculation of the proportion of exposed persons.

If 10 – 12 million of the assumed 14 million currently living US workers with previous asbestos exposure were above the age of 39 years in 1980 (17), they would represent approximately 26 – 32 % of the US male population above that age. This figure is somewhat higher than the proportion of exposed subjects (18.1 %) observed on the basis of a questionnaire in the present study. However, as the questionnaire information on asbestos exposure in the present study showed a rather low sensitivity, it can be concluded that the observed number of exposed subjects should be regarded as a minimum estimate. Even when a probable selection of the interviewed subjects through findings of the primary screening is considered, it can be estimated that the real number of exposed subjects in the study population is probably between 6 000 (28 %) and 8 000 (37 %).

On the assumption that 20 – 30 % of Norwegian men above the age of 39 years and living in urban areas and 5 – 10 % of men of the same age in rural areas have been exposed to asbestos, the present number of Norwegian men in this age group with previous exposure would be between 92 000 and 148 000. Together with the observed high proportion of exposed subjects in the lower age groups from the present study popu-

lation, their comparatively "late exposures," and the fact that the import of raw asbestos to Norway peaked about 1970 (16), these figures indicate that previous asbestos exposure may be considered as a major determinant for different diseases within the general population in Norway for at least 15 – 25 more years.

The most serious health problem in coming years due to previous asbestos exposure will presumably be the increased mortality from lung cancer. For 21 319 of the 21 453 subjects who were included in the present study, the occupational exposure to asbestos and smoking habits up to 1982 are now known. On the basis of the age- and sex-specific incidence rates for lung cancer in Telemark in 1979 – 1983, as given by the Norwegian Cancer Registry (1), it can be estimated that about 270 lung cancers will occur in the study cohort during the next decade. Due to a probably lower degree of asbestos exposure, the risk of lung cancer may not increase so much among asbestos-exposed subjects in the present study as in the cohort of insulation workers studied by Hammond et al (3). Even so, when their well-known relative rates for lung cancer in relation to asbestos exposure and smoking habits are applied to the present study population, the approximate distribution of the 270 lung cancer cases would be as shown in figure 2. About 110 of the 270 expected cases would occur in the identified high-risk group of 1 734 current smokers with previous asbestos exposure. On the other hand, only six cases would be expected to occur among the 5 057 subjects who were neither exposed to asbestos nor to tobacco smoke.

As suggested, the 3 888 subjects who reported exposure on the questionnaire should be regarded as a minimum estimate. If the real number of exposed subjects were 50 or 100 % higher and smoking habits were unchanged, the number of new lung cancers among the 1 734 identified risk subjects would be 92 and 78, respectively. In that case the number of lung cancers among all the asbestos-exposed smokers would be 137 or 155, respectively. The 1 734 identified subjects still constitute a major high-risk group and, as such, represent an appropriate target group for risk factor intervention.

Among insulation workers who had stopped smoking before 1967 and who were observed from 1967 through 1976, Hammond et al (3) found the risk of dying of lung cancer to be reduced to one-third. Therefore, one important objective for intervention within risk groups with known exposure to asbestos and tobacco smoke is to convince each person at risk to stop smoking. If this goal were achieved for 50 % of the 1 734 high-risk subjects identified in the present study, and provided that the asbestos exposure has been of the same duration and intensity as in the study of Hammond et al, the incidence of lung cancer among the 3 888 subjects with a history of asbestos exposure would presumably be reduced by 26 % during a 10-year period. In this regard it is also important to observe that the proportions of both previous asbestos exposure and current smoking in the present study population are higher among the younger age groups.

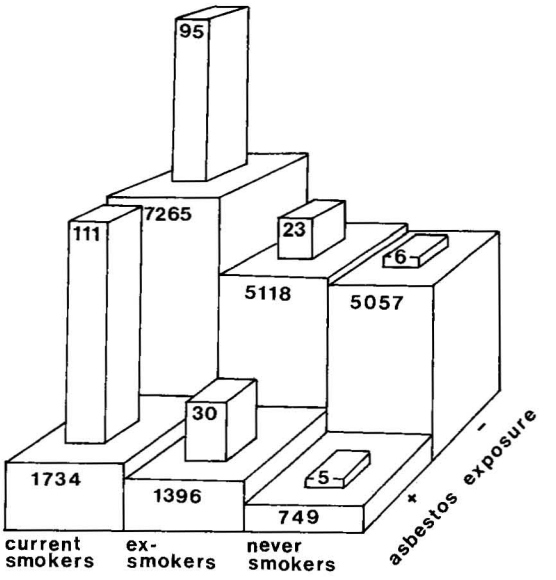

Figure 2. Study subjects (N = 21 319) grouped according to questionnaire information about asbestos exposure and smoking habits (boxes), and the number of lung cancers expected to occur in each group during the next decade (columns).

In the Early Lung Cancer Detection Program conducted by the US National Cancer Institute, there have been some promising results regarding survival rates for patients who had their lung cancers resected at an early stage (2). One goal for further research would therefore be to evaluate the possibilities for lung cancer screening to achieve secondary lung cancer prevention among such high-risk groups as identified in the present study.

The present study is one of few studies designed to identify subjects in the general population with previous occupational exposure to asbestos. As it has been pointed out, the method applied may be used for identifying different risk groups among the general population, and these risk groups again can serve as appropriate targets for intervention where such intervention a priori may be expected to give the most promising results.

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