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Environmental Exposure to Tremolite and Respiratory Cancer in New Caledonia: A Case-Control Study

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A case-control study on respiratory cancers was conducted in New Caledonia (South Pacific), where a high incidence of malignant pleural mesothelioma had been observed. The disease pattern suggested an environmental exposure to asbestos. The first results showed that, in some areas, tremolite asbestos derived from local outcroppings was used as whitewash (locally named "pö"). All cases diagnosed between 1993 and 1995 (including 15 pleural mesotheliomas, 228 lung cancers, and 23 laryngeal cancers) and 305 controls were included in the study. Detailed information on past or present use of the whitewash, residential history, smoking, diet, and occupation was collected. The risk of mesothelioma was strongly associated with the use of the whitewash (odds ratio (OR) = 40.9; 95% confidence interval (CI): 5.15, 325). All Melanesian cases had been exposed. Among Melanesian women, exposure to the whitewash was associated with an increased risk of lung cancer (OR = 4.89; 95% CI: 1.13, 21.2), and smokers exposed to pö had an approximately ninefold risk (OR = 9.26; 95% CI: 1.72, 49.7) compared with women who never smoked and had never used the whitewash. In contrast, no association was noted between exposure to pö and lung cancer risk among Melanesian men, probably because of lower exposure levels. Among non-Melanesians, the numbers of exposed subjects were too small to assess the effect of exposure to pö. There was no indication of elevated risks for the other cancer sites. *Am J Epidemiol* 2000;151:259–65.

asbestos; asbestos, amphibole; environmental exposure; mesothelioma; neoplasms

New Caledonia is a French territory in the South Pacific, with a population of 200,000, including 45 percent Melanesians (the indigenous people), 35 percent Europeans, and 20 percent various ethnic groups, mainly Polynesians. The most important industrial activity is nickel mining and refining. In a previous study of respiratory cancers in New Caledonia, we reported a high incidence of malignant pleural mesothelioma (1, 2), which was later confirmed (3). This excess could not be explained by occupational exposure to asbestos. Instead, the disease pattern suggested an environmental exposure to asbestos or other mineral fibers, because the incidence was approximately equal in both sexes, and the age at the time of diagnosis was young, suggesting an exposure beginning in childhood. Furthermore, the excess risk was higher among Melanesians and was limited to some rural areas in the center of the main island. These findings led us to undertake a population-based case-control study of respiratory cancers in New Caledonia. The objective was to study occupational, environmental, and lifestyle risk factors, one of the hypotheses being the presence of naturally occurring mineral fibers in the environment. Although we were primarily interested in mesotheliomas, respiratory cancers from other sites (mainly the lung and larynx) were also included, since they are known or suspected to be associated, to a lesser extent, with exposure to asbestos.

Preliminary results showed that, in the high mesothelioma incidence area, a very friable rock derived from local outcroppings has been used as a whitewash for indoor and outdoor walls of the houses. Samples of rock and whitewash, locally called "pö," were found to consist of virtually pure tremolite asbestos. Tremolite fibers were also detected in airborne samples and in biologic specimens (4, 5). Pö was extensively used by Melanesians and was also adopted to a lesser extent by the non-Melanesian population, because of its easy preparation (the rock is simply ground by hand to a powder and suspended in water). The use of this whitewash was widespread from 1930 to the end of the 1960s. Since then, other

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Abbreviations: CI, confidence interval; OR, odds ratio.

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materials (particle board, iron sheet) have replaced it, especially in villages with the highest standards of living, but the use of "pö" for whitewashing is still a common practice in some villages.

This paper presents the case-control study results, in regard to the association between tremolite exposure, mainly via the use of the whitewash, and the risk for respiratory cancer from different sites.

MATERIALS AND METHODS

Cases were identified from the Cancer Registry of New Caledonia. Eligible cases were subjects with primary cancer of the nasal cavity and sinuses, larynx, lung, and hypopharynx (*International Classification of Diseases for Oncology* topography codes 160–162, 148) or with malignant mesothelioma (morphology code 905; topography code 163 for pleural mesothelioma and 158 for peritoneal mesothelioma), diagnosed between January 1993 and December 1995. The study was limited to subjects over the age of 18 years and living in New Caledonia for at least 5 years. Among eligible cases, two lung cancer cases refused to participate. A total of 273 cases were included in the study (228 lung cancers, 23 larynx cancers, 5 hypopharynx cancers, 1 sinonasal cancer, 15 pleural mesotheliomas, and 1 peritoneal mesothelioma). Thirteen lung cancer cases were not microscopically verified but were diagnosed by clinical, radiological, and endoscopic evidence. All other cases were histologically confirmed. For mesothelioma cases, the original slides were submitted to the French Mesothelioma Panel (6) in order to confirm the diagnosis. Cases are classified by the Panel into three diagnostic categories: definite mesothelioma, possible mesothelioma (cases with a strong suspicion of mesothelioma without sufficient material to conclude with certainty), and definitely not mesothelioma. Among the 17 potential pleural mesotheliomas, two were excluded by the Panel, nine were definite mesotheliomas, and six were possible mesotheliomas. The case of peritoneal mesothelioma was classified as definite. Possible and definite mesotheliomas were included in the analysis.

Population controls were randomly selected from electoral rolls. For practical reasons, the control group was drawn at the beginning of the study and was frequency matched by sex and age (5-year age groups) to the expected distribution of the combined cases. Among the 320 controls who could be contacted, 15 refused to participate and 305 were included in the study.

In-person interviews were conducted by trained interviewers. The questionnaire included detailed information on demographic and social characteristics; ethnicity; tobacco and alcohol consumption; usual adult diet (with a quantitative food frequency questionnaire of more than 50 items); lifetime residential history (including the type of dwelling, proximity of non-coal-tarred roads); and a lifetime occupational history with a description of each job held (activity of the company, place of work, tasks performed). Specific questions were used to describe past or present use of the whitewash (frequency of preparation and application, occurrence of renovation, outcropping location) and the history of residence in whitewashed houses. The interview lasted on average 1 hour and 45 minutes for both cases and controls.

For deceased cases (39 lung cancer cases, 1 larynx cancer case, and 3 mesotheliomas) and for subjects who could not be interviewed for health reasons (19 lung cancer cases, 1 larynx cancer case, 1 hypopharynx cancer case, 1 mesothelioma case, and 2 controls), a shorter version of the questionnaire was used to interview a next-of-kin. This shorter version included the same questions on residential history and on the use of pö; simplified questions on smoking habits, alcohol consumption, and occupational history; and no information on diet. This version was also used for interviews with the subjects themselves when they could not answer the full questionnaire, mainly because of poor health (34 lung cancer cases, 8 larynx cancer cases, 4 hypopharynx cancer cases, and 5 controls).

Occupational exposures to more than 300 agents were assessed blindly from the questionnaire by an industrial hygienist. For a given product and for each job, the expert coded the probability of exposure (possible, probable, definite), the frequency of exposure (from 1 to 10), and the concentration of the product in the environment (from 1 to 10).

Several variables were constructed to summarize exposure to pö. Whitewash preparation and application could not be distinguished, since the application always involved a prior preparation of the whitewash by the same persons. Given the high number of missing values, the frequency of preparation, the periodicity of renovation, and the distance between residence and outcroppings were not further studied. A first set of analyses was performed by differentiating residence in a whitewashed house and preparation/application of the whitewash, but these variables were strongly associated and no difference emerged according to the source of exposure. The exposure variables retained for the present analysis were as follows: ever exposed, whatever the exposure source (residence or preparation); total duration of exposure; and the age at first exposure.

Data were analyzed using unconditional logistic regression. For each cancer site, adjusted odds ratios and 95 percent confidence intervals were obtained using the BMDPLR procedure (7). All odds ratios were adjusted

for age. Analyses were conducted separately for men and women. For mesotheliomas, however, given the small number of cases, men and women were grouped in the analysis, and sex-adjusted odds ratios were calculated. The effect of potential confounding factors (ethnicity, smoking, alcohol, diet, occupational exposures) was also evaluated. Ethnicity was categorized as Melanesian or non-Melanesian. For lung cancer, odds ratios were adjusted for lifetime smoking (in pack-years). Models including the number of cigarettes per day and smoking duration gave similar results. Adjustment for dietary variables (frequency of consumption) and occupational exposures (never exposed/ever exposed) did not influence the observed associations with exposure to pö and was not included in the final models. However, some occupational exposures to soil dusts (road dust, dust from the fields, mining dust, building site dust) were of interest since they might be associated with environmental exposure to tremolite. These exposures were further examined according to the cumulative level. Subjects with a possible exposure or with a low concentration (<3) were grouped in the same category (possible exposure). For the other subjects, an exposure index was computed for each job held by multiplying the concentration, the frequency, and the probability of exposure. A cumulative level of exposure was then calculated for each subject as a sum of the exposure indices, weighted by the duration of jobs.

RESULTS

Malignant mesothelioma

The risk of pleural mesothelioma was strongly associated with exposure to pö (table 1). All nine female cases and five of six male cases reported being exposed. The risk increased with the duration of exposure. Almost all cases had been exposed since birth, and no case had begun exposure after the age of 16. However, the age at first exposure and the duration of exposure were closely correlated, and they were also associated with time since first exposure. Given the small numbers of cases, it was not possible to assess an independent effect of these variables. The nonexposed case (a non-Melanesian man) had worked as an electrician and plumber, with a possible occupational exposure to asbestos. All Melanesian cases (14 cases) had been exposed to pö (vs. 53 percent of Melanesian controls, $p < 0.001$).

Because of this strong association, occupational exposures to dusts were only studied among Melanesians exposed to pö. No significant association was found. However, an elevated risk was noted for exposure to building site dust (odds ratio (OR) = 3.63; 95 percent confidence interval (CI): 0.49, 26.8) and exposure to road dust (OR = 2.62; 95 percent CI: 0.26, 26.3).

TABLE 1. Pleural mesothelioma risk associated with exposure to pö, New Caledonia, 1993–1995

Exposure to pö	No. of cases	No. of controls	Odds ratio*
Never exposed	1	223	1
Ever exposed	14	82	40.9 (5.15, 325)†
Exposure duration			
<20 years	4	38	22.2 (2.33, 211)
≥20 years	10	41	65.1 (7.69, 551)
Age at first exposure			
Birth	13	61	52.8 (6.53, 427)
≤16 years	1	11	20.0 (1.09, 368)
>16 years	0	10	0

* Odds ratio adjusted for age and sex.
† Numbers in parentheses, 95% confidence interval.

The case of peritoneal mesothelioma (not included in the above analyses) was a Melanesian man who used to prepare the whitewash and who had been living all his life in a whitewashed house. Taking this case into account slightly increased the odds ratios (OR for ever exposed = 43.5; 95 percent CI: 5.52, 342).

Lung cancer

Exposure to pö increased the risk for lung cancer among women significantly (table 2). This excess risk was primarily due to the high odds ratios observed for Melanesian women, which increased with the duration of exposure. In contrast, among men, there was no indication of an elevated lung cancer risk associated with exposure to pö for both ethnic groups. A nonsignificant increase in risk was noted for non-Melanesians exposed more than 20 years. Among non-Melanesians, however, the number of exposed subjects was small, which made the evaluation of the effect of exposure to pö difficult.

The joint effects of smoking and exposure to pö were examined among Melanesians (table 3). A positive interaction, although nonsignificant, was observed for women. The odds ratios for smoking alone and for exposure to pö alone were slightly elevated and nonsignificant. Smokers exposed to pö had an approximately ninefold risk, which was higher than that predicted by a purely multiplicative model. Among men, exposure to pö alone was associated with a nonsignificant, lowered risk of lung cancer; smoking alone was associated with a significantly increased risk, and no indication of an interaction was noted.

The lung cancer risk associated with exposure to pö was further examined according to tumor histol-

TABLE 2. Lung cancer risk associated with exposure to pö, New Caledonia, 1993–1995

Exposure to pö	Men			Women		
	No. of cases	No. of controls	Odds ratio*	No. of cases	No. of controls	Odds ratio*
All						
Never exposed	142	170	1	30	53	1
Ever exposed	35	66	0.89 (0.51, 1.54)†	21	16	2.51 (1.01, 6.22)
Exposure duration						
<20 years	9	28	0.41 (0.17, 0.99)	4	10	0.64 (0.16, 2.59)
≥20 years	26	38	1.43 (0.73, 2.82)	17	6	6.81 (2.00, 23.1)
Age at first exposure						
Birth	26	49	0.93 (0.50, 1.76)	17	12	2.51 (0.93, 6.79)
≤16 years	3	9	0.72 (0.17, 3.06)	1	2	2.03 (0.16, 25.9)
>16 years	6	8	0.85 (0.25, 2.88)	3	2	2.93 (0.34, 25.5)
Melanesians						
Never exposed	46	38	1	13	20	1
Ever exposed	27	45	0.87 (0.41, 1.85)	17	7	4.89 (1.13, 21.2)
Exposure duration						
<20 years	7	13	0.61 (0.19, 1.95)	2	1	1.46 (0.08, 27.3)
≥20 years	20	32	1.01 (0.43, 2.38)	15	6	5.93 (1.23, 28.7)
Age at first exposure						
Birth	21	36	0.88 (0.39, 2.00)	14	6	4.28 (0.92, 20.0)
≤16 years	2	5	0.70 (0.11, 4.49)	1	0	8.87 (0.55, 144)
>16 years	4	4	0.92 (0.18, 4.84)	2	1	
Non-Melanesians						
Never exposed	96	132	1	17	33	1
Ever exposed	8	21	0.51 (0.19, 1.38)	4	9	1.10 (0.25, 4.87)
Exposure duration						
<20 years	2	15	0.14 (0.03, 0.68)	2	9	0.36 (0.05, 2.50)
≥20 years	6	6	2.46 (0.57, 10.6)	2	0	∞
Age at first exposure						
Birth	5	13	0.48 (0.13, 1.73)	3	6	1.33 (0.24, 7.21)
≤16 years	1	4	0.72 (0.07, 7.38)	0	2	0.67 (0.04, 10.5)
>16 years	2	4	0.46 (0.07, 3.15)	1	1	

* Odds ratio adjusted for age (≤55, 56–65, >65 years) and smoking in pack-years: four categories for men (<20, 20–39, 40–59, ≥60) and three categories for women (never smoker, <20, ≥20).
† Numbers in parentheses, 95% confidence interval.

ogy (table 4). The effect of exposure to pö was limited to women, and the risk estimates were always lower for men than for women, for any histologic type. Among women, the excess risk associated with exposure to pö was significant for squamous cell carcinomas only, but again with the small numbers involved it is not possible to rule out a similar association for the other histologic types that also showed increases in risk.

Occupational exposures to soil dusts involving possible exposure to tremolite were examined among men (table 5). Except for an increased risk of lung cancer associated with a low level of exposure to building site dust, no significant association was found, and there

TABLE 3. Joint effects of smoking and exposure to pö among Melanesians, New Caledonia, 1993–1995

Smoking	Pö	Men*			Women		
		No. of cases	No. of controls	Odds ratio†	No. of cases	No. of controls	Odds ratio
No	No	3	12	1	5	10	1
No	Yes	6	30	0.75 (0.16, 3.58)‡	2	3	2.52 (0.24, 26.2)
Yes	No	43	26	6.05 (1.52, 24.0)	8	10	1.55 (0.34, 7.07)
Yes	Yes	21	15	4.95 (1.15, 21.3)	15	4	9.26 (1.72, 49.7)

* For men, smokers of less than 20 pack-years were included in the nonsmoker category.
† Odds ratios adjusted for age (≤55, 56–65, >65 years).
‡ Numbers in parentheses, 95% confidence interval.

TABLE 4. Lung cancer risk associated with exposure to pö, by histologic type, New Caledonia, 1993–1995

Histologic type	Men			Women		
	No. of exposed cases	No. of unexposed cases	Odds ratio*	No. of exposed cases	No. of unexposed cases	Odds ratio*
Large cell carcinoma	6	15	1.19 (0.39, 3.60)†	6	2	1.25 (0.14, 11.4)
Small cell carcinoma	4	17	0.96 (0.27, 3.37)	4	1	1.17 (0.10, 13.9)
Squamous cell carcinoma	12	47	0.77 (0.35, 1.69)	5	6	6.49 (1.31, 32.2)
Adenocarcinoma	11	41	0.68 (0.30, 1.54)	9	8	2.38 (0.67, 8.43)
Other or unknown	2	22	0.20 (0.04, 0.93)	6	4	4.05 (0.77, 21.4)

* Odds ratios adjusted for age (≤65, >65 years), smoking in pack-years (<20, ≥20), and ethnicity (Melanesians, non-Melanesians).
† Numbers in parentheses, 95% confidence interval.

TABLE 5. Lung cancer risk associated with occupational exposures to selected dusts among men, New Caledonia, 1993–1995

Exposure to dust from	No. of cases	No. of controls	Odds ratio*
Mines			
Never exposed	129	143	1
Possible exposure	9	22	0.50 (0.20, 1.25)†
Cumulative level‡			
Low	13	23	0.66 (0.29, 1.50)
Moderate	12	24	0.46 (0.21, 1.05)
High	14	24	0.57 (0.27, 1.25)
Building sites			
Never exposed	124	175	1
Possible exposure	8	16	0.88 (0.32, 2.41)
Cumulative level‡			
Low	17	13	2.56 (1.02, 6.45)
Moderate	17	17	1.10 (0.51, 2.41)
High	11	15	0.92 (0.37, 2.31)
Roads			
Never exposed	78	83	1
Possible exposure	13	22	0.51 (0.22, 1.17)
Cumulative level‡			
Low	24	44	0.69 (0.35, 1.37)
Moderate	34	43	0.83 (0.45, 1.56)
High	28	44	0.65 (0.35, 1.23)
Fields			
Never exposed	78	119	1
Possible exposure	97	116	1.08 (0.66, 1.75)

* Odds ratios adjusted for age (≤55, 56–65, >65 years), smoking in pack-years (<20, ≥20), and ethnicity (Melanesians, non-Melanesians).
† Numbers in parentheses, 95% confidence interval.
‡ The three categories (low, moderate, high) correspond to the tertiles of the distribution in controls.

was no dose-response trend with cumulative exposure. Dust from the fields could not be studied according to cumulative exposure, since almost all exposed subjects had only possible exposure. This exposure was associated with a moderate and nonsignificant increase in risk. Among women, an elevated risk was noted for exposure to field dust (OR = 2.23; 95 percent CI: 0.88, 5.61; 30 exposed cases), which decreased after adjustment for exposure to pö (OR = 1.88; 95 percent CI: 0.72, 4.87). No female case and only one female control had been occupationally exposed to other dusts.

Other cancer sites

None of the three female cases of laryngeal cancer had been exposed to pö. Among the 20 male cases, three reported an exposure to pö. Since all cases had smoked, the analysis was restricted to smokers and exsmokers. Exposure to pö was associated with a nonsignificantly decreased risk of laryngeal cancer (OR = 0.72; 95 percent CI: 0.22, 2.30), and the risk estimates were similar for Melanesians (OR = 0.71; 95 percent CI: 0.14, 3.63; two exposed cases) and non-Melanesians (OR = 0.60; 95 percent CI: 0.07, 5.22; one exposed case). Further adjustment for smoking (≤40 pack-years, >40 pack-years) and alcohol consumption (<3 glasses/day, ≥3 glasses/day) changed the odds ratios only marginally. Elevated risks were observed for occupational exposure to building site dust and mining dust, whereas road dust and soil dust were associated with a lowered risk for laryngeal cancer. None of the associations was statistically significant.

Because of small numbers, the association between exposure to pö and other cancer sites could not be evaluated. Among the five cases of hypopharyngeal cancer, one reported an exposure to pö (crude OR = 0.64; exact 95 percent CI: 0.01, 6.68). The case of sinonasal cancer had not been exposed.

DISCUSSION

Our results show that the use of pö increased strongly the risk for malignant mesothelioma. Excess risks of mesothelioma associated with the use of a tremolite-containing whitewash had been reported in several

areas of Turkey (8–10), Greece (11–14), and Cyprus (15). In Greece, an annual incidence of about 280 cases per million population was reported in the Metsovo area (11), and five cases in 28 months were observed in seven Macedonian villages for a population of 3,900 inhabitants (14), that is, about 500 cases per year per million. In southeast Turkey, the annual rate was about 50 cases per million population (8). In a small village of 425 inhabitants in Anatolia, four cases of pleural mesothelioma were observed in 4 years (10). In Corsica, where environmental exposure due to tremolite asbestos deposits was reported, the risk was estimated as 100 cases of mesothelioma/million/year (16). In New Caledonia, the population of the regions where pö has been used may be roughly estimated to be 40,000, giving an annual incidence for mesotheliomas of about 125 cases per million, which is in the range of the values observed in other areas where similar problems had been identified.

Only a few studies mentioned results regarding lung cancer and environmental exposure to tremolite. Yarocioglu et al. (8) reported that lung cancer incidence was higher in the area where a tremolite-based whitewash was used than in the reference area (without asbestos deposits). In Austria, no increased risk for lung cancer was found in a town with natural tremolite deposits (17). Geographic studies in the vicinity of asbestos factories or mines generally showed no (18, 19) or moderate (20) excess risk for lung cancer associated with other types of asbestos. In our study, exposure to pö increased significantly the risk for lung cancer in women, particularly among smokers. Conversely, no such association was noted in men. Variations in risk according to histologic type could not explain this sex difference concerning lung cancer risk, since the difference remained for all histologic subtypes.

The higher lung cancer risk observed in women may originate in incomplete control of confounding or in differences between the sexes in exposure assessment, or it may be a true difference in risk due to different exposures for men and women.

Potential confounding factors (smoking, alcohol, diet, occupational exposures) were examined and taken into account when necessary. However, occupational exposures were simply categorized into two levels (ever vs. never), and the dietary analysis concerned only the frequency of consumption for all food items, so residual confounding could not be ruled out. Further analyses including the level and duration of occupational exposures and nutrient intakes would be necessary. Nevertheless, it is unlikely that the results regarding exposure to pö, specially the difference in lung cancer risk between men and women, would be markedly changed.

Surrogate respondents were used for approximately 25 percent of lung cancer cases and for only two controls. It is possible that next-of-kin respondents would be less likely to remember the past use of pö by the subjects. However, reanalysis of the data with next-of-kin interviews excluded gave similar results, that is, no association between exposure to pö and lung cancer risk in men and positive association in women. Similarly, the use of the shorter version of the questionnaire may indicate a lower quality of interview, even if interviews were with the subjects themselves. Removing all subjects interviewed with the shorter version from the analyses did not modify the results either.

Information on exposure to pö was only that reported by the subjects, and no verification of the whitewash composition could be done. However, the specific questionnaire on the use of pö allowed the detection of a clear association with mesothelioma risk, which indirectly validated the questionnaire. Another indirect validation was provided by the analysis of several biologic samples (lung tissue or liquid from bronchoalveolar lavage), which showed that the lung burden of tremolite fibers was strongly associated with the reported use of pö. Tremolite fibers were detected in 17 samples of the 19 samples from subjects who reported exposure to pö versus 14 of the 43 samples from subjects who did not report such exposure. Furthermore, concentrations in tremolite fibers were about 20 times higher for the 17 subjects reporting exposure to pö than for the 14 unexposed subjects (unpublished data). The existence of a reporting bias could nevertheless not be excluded, but to explain the observed sex difference with respect to lung cancer risk, such a bias would have to be sex dependent. Differences between men and women in reporting exposure, although conceivable, seem unlikely to us.

The most plausible explanation for the sex difference observed for lung cancer risk is that the level of tremolite exposure would be higher for women than for men. This hypothesis is compatible with the very high concentrations of tremolite fibers detected in airborne samples collected in two houses during cleaning operations (4, 5). Although these levels represented more a measure of peak exposure than mean concentrations, they suggested the role of indoor pollution as a major source of exposure. We have recently conducted a survey on the daily activities of Melanesians. The main objective was to help determine the time and place of environmental airborne samples, but this survey also allowed us to collect comparative data on the activities of men and women. Preliminary results confirm that house cleaning is almost always performed by women and girls and show that women spend on

average about 2 more hours per day indoors than men do. These data, together with the airborne fiber concentrations observed in houses, support the hypothesis of a higher lifetime exposure to tremolite for women.

The use of pö for whitewashing is probably not the only source of exposure to tremolite. The natural erosion of soil containing tremolite or activities producing dust from this soil may entail airborne pollution. Only occupational exposures to dust from roads, mines, fields, and building sites could be examined, and those were not found to be associated with respiratory cancer risk. These exposures, however, lack the specificity needed for them to be used as a surrogate for tremolite exposure. It might be conceivable in further analyses to specify the location of mines or to take into account the place of residence for exposure to field dust, but it is not possible to characterize roads or building sites since all exposed subjects had worked in different areas of the territory.

An environmental survey is in progress, including a collection of airborne samples in different locations and circumstances. The results may help clarify the findings of the present study.

In conclusion, the use of the tremolite-containing whitewash increased strongly the risk for malignant mesothelioma, and it was also associated with an increased risk for lung cancer for women only. In contrast, no association was noted between exposure to pö and lung cancer risk among men, probably because of lower exposure levels. There was no indication of elevated risks for any of the other respiratory cancer sites.

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