

Cohort Mortality Study of Vermiculite Miners Exposed to Fibrous Tremolite: an Update

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A further follow-up was made of a cohort of 406 American vermiculite mine workers exposed on average to 18 fibres/ml of tremolite. Total deaths to the end of 1999 were: all causes 285 (SMR 1.27), lung cancer 44 (SMR 2.40), mesothelioma 12 (PMR 4.21%). Lung cancer SMRs increased steeply with cumulative exposure (f/ml.yr). These findings show the potential magnitude of the carcinogenic effects of tremolite fibres when contaminating commercial chrysotile, and are relevant to risks associated with tremolite fibres in the general environment.

Keywords: tremolite; cohort mortality; vermiculite; chrysotile

INTRODUCTION

Fibrous tremolite, a seldom-used amphibole asbestos fibre type, is often associated geologically with chrysotile and a variety of other minerals. In 1986, a cohort study of 165 deaths before July 1983 among 406 vermiculite miners and millers in Libby, Montana, exposed on average for 9 yr to 18 fibres of tremolite/ml, demonstrated substantial excess mortality from respiratory cancer (standard mortality ratio [SMR] 2.45) and non-malignant respiratory disease (NMRD) (SMR 2.55), including four deaths from mesothelioma (McDonald *et al.*, 1986). Very similar findings were obtained in an overlapping cohort studied independently by a group from NIOSH (Amandus *et al.*, 1988). A small cohort of vermiculite miners in South Carolina exposed to little or no fibrous tremolite showed no evidence of excess risk (McDonald *et al.*, 1988). Risk of death from respiratory cancer >20 yr from first employment increased significantly, and to a fairly similar degree, in relation to estimated cumulative exposure (f/ml.yr) in both Libby cohorts (McDonald *et al.*, 1986; Amandus *et al.*, 1988).

MATERIALS AND METHODS

With help from the National Death Index in the USA, all 241 survivors from the original cohort were traced to the end of 1999 and a further 120 deaths with certified cause were identified. Standardized mortality ratios were again calculated using US national and Montana age-specific death rates for white males for reference. A preliminary analysis (subject to correction) of respiratory cancer risk in relation to cumulative exposure has again been undertaken.

RESULTS

In Table 1, mortality by cause is summarized for the two periods, before and since July 1983; the patterns of mortality in both periods are closely similar. External causes (including accidents) are no longer in excess, but the number of mesothelioma deaths has increased from four to 12.

The SMRs for respiratory cancer and non-malignant respiratory disease are very high in both periods. Among the 19 deaths from non-respiratory tract cancer since 1983 were a further three cases of ill-defined carcinomatosis (ICD 1991), also conceivably due to mesothelioma. The results of a preliminary analysis of all deaths from respiratory cancer to date in relation to cumulative exposure are shown in Table 2. This analysis is confined to the 36 cancer deaths 20 or more years after first employment, and exposure recorded up to July 1983. The SMRs, this time again

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Table 1. Mortality in Libby cohort of vermiculite miners exposed to fibrous tremolite ($n = 406$) (reference: US white males)

	Deaths to July 1983		Deaths since July 1983 ^a	
	Observed	SMR	Observed	SMR
Respiratory cancers	23	2.45	21	2.35
All other cancers	20	1.09	19	1.29
NMRD	21	2.55	30	3.63
Circulatory diseases	65	0.87	36	1.02
External	23	1.87	3	1.03
All causes	165	1.17	120	1.43
(incl. mesothelioma)	4	(PMR = 2.4%)	8	(PMR = 6.7%)

^aTo 1 January 2000.

Table 2. Cumulative exposure to 1983 and estimated respiratory cancer SMRs to date (reference: Montana death rates)

f/ml.yr	Observed ^a	Expected	SMR
0–	13	6.15	2.11
25–	12	4.22	2.84
200–	8	1.45	5.52
500–	3	0.67	4.48
All	36	12.44	2.89

^a≥20 yr from first employment.

calculated against Montana rates, show a fairly sharp upward gradient in relation to exposures up to at least 500 f/ml.yr.

DISCUSSION

This small cohort of vermiculite miners, exposed to amphibole fibres in the tremolite series, has suffered severely from both malignant and non-malignant respiratory disease. The overall proportional mortality from mesothelioma (4.2%) is similar to that for crocidolite miners in South Africa (4.7%) and in Australia (3.9%), but 10 times higher than that observed in Quebec chrysotile miners (0.4%) (McDonald, 2000). In the Quebec mining region, the risk of mesothelioma death was some three times greater in Thetford Mines than in the town of Asbestos (McDonald *et al.*, 1997), where the proportions of tremolite in airborne fibres are believed to have been in approximately the same ratio. Within Thetford Mines the risks of both mesothelioma and lung cancer were also related to the estimated levels of tremolite in mines where the men had worked (McDonald and McDonald, 1997). This suggests the possibility that the relatively low risks of lung cancer and mesothelioma in most workers exposed to

commercial chrysotile are attributable in whole or part to contaminating tremolite. The question is not an easy one to answer, given that levels of contamination vary considerably in time and place, and that few exposure estimates available in sound epidemiological studies are sufficiently exact or specific.

CONCLUSION

The mortality experienced by this small cohort of vermiculite miners is important for three main reasons. It is the only study to have quantified the risk of exposure to fibrous tremolite in the absence of any other mineral fibre. It has shown the potential magnitude of the contribution which contaminating tremolite fibres may make to the carcinogenic effects of exposure to commercial chrysotile. It has immediate and direct relevance to current problems in northern California, arising from the release into the general environment of naturally occurring tremolite fibres, as a result of large-scale construction operations.

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