

Mortality and cancer risk among workers exposed to man-made mineral fibers in Finland

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TEPPO L, KOJONEN E. Mortality and cancer risk among workers exposed to man-made mineral fibers in Finland. *Scand J Work Environ Health* 12 (1986): suppl 1, 61–64. A cohort of 941 workers in the glass-wool producing industry in Finland was followed for deaths in 1953–1981, the mean duration of follow-up being 12.1 years. The overall mortality and mortality from individual causes of death did not differ significantly from those expected. Similarly, the cohort was followed for cancer incidence through the Finnish Cancer Registry. No excess cancer risks were observed. There were four cases of lung cancer versus 6.6 expected.

Key terms: cancer incidence, cancer mortality, industrial exposures, occupational cancer.

One of the factories included in the international epidemiologic study on the relationship between man-made mineral fiber (MMMF) exposure, mortality, and cancer incidence (2) was located in Finland. In this paper the factory is described, and data collection and results of the Finnish part of the cohort are outlined.

Factory

The factory is located in southwest Finland, in the town of Karhula. It belongs to a large multiindustrial company with plants in different parts of the country. In Karhula the company has produced glass wool and other glass products, mainly containers, and run engineering works with a steel foundry and a mechanical pulp and cardboard mill.

The production of glass wool started in 1941 and continued until 1982. Asbestos has been used for furnace (radiation) and pipe insulation, gloves, and other personal protective devices. It was used for production only in 1946–1948 on a very small scale, as purchased cloth and stitching yarn for asbestos cloth-covered mats (exposing perhaps two workers part-time). The Hager process (centrifuging) was applied in 1941–1959, and the TEL (derived from “laboratoire expérimental thermique”) rotary process in 1958–1982. No binders were used in 1941–1955, mineral lubricating oil has been used since 1954, and resin binders since 1955.

Subjects and methods

The study cohort consisted of all workers who had been employed in the MMMF plant in Karhula in

1941–1952 and were alive on 1 January 1953, and all workers who had been employed in 1953–1977. Even short-term workers were included (minimum exposure three months). Workers hired after 1977 were excluded. Different methods were applied in order to ascertain the completeness of the cohort. The main source of data was the company employment card files which were compared and supplemented by membership lists of the local trade union. The company files were abstracted for different jobs held by the workers at different times, as well as for the dates of the beginning and end of different jobs and, when relevant, of different periods for the same job. Some job changes may have been left unrecognized, however, in the card files. Occupational histories of workers existed since the 1920s. Since 1967 computerized lists existed in the company and were of great help in the collection of the material. Coding of the jobs took place at the factory by people who knew well the different phases of MMMF production and the local conditions. The job histories were abstracted until 1977.

The final cohort comprised 941 persons (616 males, 325 females). The sizes of individual groups defined in terms of MMMF exposure were as follows: production 413, secondary processes 335, maintenance 84, unspecified or mixed 84, office work 17, and mixed production and office work 8.

The cohort was followed for death through the Population Register of Finland, which also provided the causes of death, and for incident cases of cancer through the files of the Finnish Cancer Registry. Thirteen individuals (1.4 % of the total cohort) were lost from follow-up, mainly due to emigration to Sweden.

The calculation of person-years at risk started on 1 January 1953 or at the start of the first exposure to MMMF if later. The closing date of the follow-up for both mortality and incidence calculations was the date of withdrawal (lost from follow-up), date of

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Table 1. Observed and expected numbers of death and the standardized mortality ratios determined for 941 Finnish workers (males and females separately) in the man-made mineral fiber industry during a follow-up from 1953 to 1981.

Cause of death ^a	Males (N = 616)			Females (N = 325)		
	Observed	Expected	Standardized mortality ratio	Observed	Expected	Standardized mortality ratio
All malignant neoplasms (140—209)	11	14.9	74	12	10.3	116
Diseases of the circulatory system (390—458)	42	32.2	131	14	17.2	81
Diseases of the respiratory system (460—519)	7	4.6	152	3	2.2	140
Diseases of the digestive system (520—577)	3	2.2	135	1	1.3	75
Accidents, poisoning and violence (E800—E999)	21	14.2	148	4	2.6	154
Other	6	11.0	55	9	9.9	91
All causes	90	79.3	114	43	43.7	98

^a Code of the International Classification of Diseases, eighth revision, in parentheses.

death, or 31 December 1981, whichever occurred first. If the exposure to MMMF was discontinuous, the duration of exposure was defined as the sum of all individual exposure periods. The total number of person-years at risk was 11 466 (6 753 for males, 4 713 for females). Of these, 82.7 % occurred for the period 0—19 years since first exposure, 15.6 % for the period 20—29 years since first exposure, and only 1.8 % for the period ≥ 30 years since first exposure. The mean period of follow-up was 12.1 years.

The observed numbers of cause-specific deaths were compared with the expected on the basis of the sex-, age-, and calendar-period-specific numbers of person-years at risk and the corresponding cause- and period-specific mortality rates for the whole Finnish population obtained from the Central Statistical Office of Finland. Similarly, the observed numbers of incident cases of cancer were compared with the expected ones on the basis of the sex-, age-, and period-specific numbers of person-years at risk and the corresponding incidence rates for each cancer produced by the Finnish Cancer Registry for the whole Finnish population.

The results are presented as the standardized mortality ratio (SMR) and the standardized incidence ratio (SIR) defined as the ratio of the observed to the corresponding expected numbers of deaths and cancers, respectively. The statistical significance of the differences between the observed and expected numbers of cases was tested with the assumption that the observed numbers followed a Poisson distribution. The 95 % confidence intervals are also given.

The Finnish Cancer Registry was founded in 1952, and it started data collection in 1953 (1). The maintained register is population-based and covers the whole of Finland. Since 1967 every person residing in Finland has had a unique personal identification number. For those alive on 1 January 1967 the follow-up for cancer was effected through automatic record

linkage using these numbers. For those who had died earlier, the record linkage was performed manually.

Results

Mortality

There were 133 deaths in the cohort against 123.0 expected (SMR 108) (table 1). There was a slight excess mortality from cardiovascular diseases (SMR 113), respiratory diseases (SMR 148), and violent deaths (SMR 149). None of these SMR values reached statistical significance (table 1). The observed number of cancer deaths was close to that expected (SMR 91). The same was true for all individual primary sites of cancer. Four lung cancer deaths were observed, while 5.9 were expected.

No consistent trend was observable in the SMR for all causes of death or cancer deaths when the length of employment or the time since first exposure was taken into account (tables 2 and 3).

Cancer incidence

A total of 44 cases of cancer were identified from the files of the Finnish Cancer Registry. The expected number was 39.5 (table 4). The SIR for lung cancer was 61 (4 observed versus 6.6 expected). For most individual primary sites the observed number of cases did not differ significantly from that expected (table 4). Two cases of bone cancer were observed versus 0.2 expected.

There was a slight increasing trend in the SIR of all cancers taken together by increasing years since first exposure (table 3). No such trend was observable in the analysis for the length of employment (table 2). All lung cancers were diagnosed after less than 30 years since first exposure. Three of the four lung cancer cases had worked in the MMMF industry for less than 12

Table 2. Number and standardized mortality ratio (SMR) of all causes of death and cancer deaths and the number of cases of cancer and the standardized incidence ratio (SIR) for 941 Finnish workers (males and females combined) in the man-made mineral fiber industry during a follow-up from 1953 to 1981, by the length of employment.

Length of employment (years)	Mortality				Cancer incidence	
	All causes		Cancer		Number of cancer cases	SIR
	Number of deaths	SMR	Number of deaths	SMR		
<1	71	133	11	100	19	105
1-4	35	103	6	88	12	113
5-9	12	54	2	45	5	80
10-19	13	122	3	126	6	167
≥20	1	57	1	246	1	170
Unknown	1	93	—	0	1	394
Total	133	108	23	91	44	111

months during the "early" technological phase (when binders were not used).

Discussion

Only a rather small proportion of the cohort of the international MMMF study was provided by the Finnish factory. The mortality analysis did not show any statistically significant excess risks. Violent deaths were common, which is easy to explain by the fact that the use of national death rates as reference increases the SMR for violent deaths in an occupational group like manufacturers of MMMF. Social class factors are also likely to explain the slight (nonsignificant) excess mortality found for cardiovascular and respiratory diseases.

The overall result in the analyses for cancer incidence was also negative as to excess risks observed. Special emphasis in this study was directed towards lung cancer; no excess risk was found. Three of the four lung cancer cases had worked less than 12 months in the MMMF industry. There was no dose-response relationship, nor did the relative risk of lung cancer increase by increasing years of follow-up. All these results speak against an etiologic role of MMMF for lung cancer in Finland. The only significant excess cancer risk was found for bone cancer. This excess may well have been due to chance. No such risk was observed in the pooled cohort covering 13 plants (2).

One might speculate that local incidence rates should perhaps have been used as reference values instead of national rates in the calculation of the SIR values. However, the age-adjusted incidence rates of lung cancer in the province of Kymi, where Karhula is located, have been close to the national averages. Similarly, the urban/rural distribution of the study cohort at the time of first exposure (about two-thirds living in an urban environment and one-third in rural areas) roughly

Table 3. Number and standardized mortality ratio (SMR) of all causes of death and cancer deaths and the number of cases of cancer and the standardized incidence ratio (SIR) for 941 Finnish workers (males and females combined) in the man-made mineral fiber industry during a follow-up from 1953 to 1981, by years since first exposure.

Years since first exposure	Mortality				Cancer incidence	
	All causes		Cancer		Number of cancer cases	SIR
	Number of deaths	SMR	Number of deaths	SMR		
≤9	27	89	4	73	7	82
10-19	50	133	9	111	14	106
20-29	37	107	7	92	16	128
≥30	19	94	3	73	7	133
Total	133	108	23	91	44	111

Table 4. Observed (O) and expected (E) numbers of cancer cases and the standardized incidence ratios (SIR) and their 95 % confidence intervals (95 % CI) determined for 941 Finnish workers (males and females combined) in the man-made mineral fiber industry during a follow-up from 1953 to 1981, by primary site of the tumor.

Primary site	O	E	SIR	95 % CI
Oral cavity, pharynx	2	1.2	111	81-150
Stomach	5	4.1	121	39-283
Small intestine, colon	1	1.6	65	2-359
Rectum	1	1.3	80	2-447
Lung	4	6.6	61	17-156
Breast	2	4.0	50	6-180
Cervix uteri	1	1.3	79	2-438
Uterus, other	2	1.3	156	19-563
Prostate	1	1.5	66	2-368
Bladder	1	0.9	109	3-606
Bone	2	0.2	1026	124-3705
Leukemia	2	0.9	214	26-774
Lymphoma, myeloma	1	1.3	76	2-425
Other ^a	19	11.3	168	101-262
All sites	44	39.5	111	81-150

^a Pancreas 2, kidney 4, penis 1, skin (basal cell carcinoma) 8, central nervous system 3, unknown 1. For cancers of the esophagus and larynx and for melanoma of the skin, no cases were found.

corresponds to the urban/rural distribution of the total Finnish population.

This follow-up study has clearly shown that, when a cohort is small, of the order of a few thousand, the numbers of deaths and, especially, of cancer cases will, in most instances, be too small for definite conclusions in terms of showing excess risks or exclusions of such risks. For example, the numbers obtained in this study did not permit analyses by subgroups of employees or by date of employment. Joint studies aiming at the collection of large cohorts from a number of plants should thus be preferred, just as was done in the international MMMF study reported by Simonato et al in this issue (2).

References

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