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Original Article

Cancer Incidence in Asbestos-Exposed Workers: An Update on Four Finnish Cohorts

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ABSTRACT

Background: We assessed the cancer risks of four different Finnish asbestos-exposed cohorts. We also explored if the cohorts with varying profiles of asbestos exposure exhibited varying relative risks of cancer.
Methods: The incident cancer cases for the asbestos-exposed worker cohorts were updated to the end of 2012 using the files of the Finnish Cancer Registry. The previously formed cohorts consisted of asbestos mine workers, asbestosis patients, asbestos sprayers, and workers who had taken part in a screening study based on asbestos exposure at work.
Results: The standardized incidence ratio (SIR) for mesothelioma varied from about threefold to > 100-fold in the different cohorts. In the screening cohort the SIR for mesothelioma was highest in 2003–2007, In other cohorts it was more constant in 5-year period inspection. The SIR for lung cancer was about twofold to tenfold in all except the screening cohort. Asbestos sprayers were at the highest risk of mesothelioma and lung cancer.
Conclusion: The SIR for mesothelioma is high in all of the cohorts that represent different kinds of asbestos exposure. The smaller SIR for mesothelioma in the screening cohort with lowest level of asbestos exposure might suggest dose-responsiveness between asbestos exposure and mesothelioma. It does seem that the highest risk of lung cancer in these cohorts except in the youngest of the cohorts, the screening cohort, is over. The highest SIR for lung cancer of the asbestosis patient and sprayers cohort is explained by their heavy asbestos exposure.

1. Introduction

Asbestos is the name given to a group of naturally occurring fibrous minerals. The two main groups of these minerals are serpentine, which includes chrysotile; and amphiboles, which includes crocidolite, anthophyllite, and amosite. The adverse health effects of asbestos have been known since the first half of the 20th century. When handled, asbestos fibers may emanate into the air and be easily inhaled. After inhalation, fibers end up in the smallest bronchial tubes and the alveoli. They can also be transferred via the lymphatic veins to different parts of the body. Asbestos exposure may cause, for example, pleural plaques, pleural effusion, pulmonary fibrosis (asbestosis), lung cancer, and mesothelioma of the pleura or peritoneum. The Helsinki Criteria for the diagnosis and attribution of asbestos were updated in 2014. Laryngeal and ovarian cancers were considered asbestos-caused diseases [1,2]; the International Agency for Research of Cancer (IARC) found sufficient evidence of asbestos causation of these cancers in humans [3,4].

The latency period of asbestos diseases is from 10 years to 40 years or even longer. All types of asbestos fibers are known to cause health hazards, crocidolite being the most potent. After the widespread use of asbestos in the 20th century, hundreds of thousands of workers in industrialized countries have contracted an asbestos-related disease. According to the World Health Organization (WHO) estimates, > 107,000 people die each year from asbestos-related lung cancer, mesothelioma, and asbestosis resulting from occupational exposures [5].

In Finland, unlike in other countries, anthophyllite asbestos has been widely used because of its domestic production in the Paakkila and Maljasalmi mines in 1918–1975. Approximately 40% of all asbestos used in Finland was anthophyllite. Finland also imported asbestos in the forms of chrysotile, amosite, and crocidolite. Asbestos

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was widely used in construction materials, especially during the 1960s and 1970s. Although all uses of asbestos were banned by 1994 in Finland, it is estimated that half of the asbestos that was previously used in construction is still in place. Due to earlier asbestos exposure, new asbestos-related diseases are still diagnosed in Finland. The numbers of work-related asbestos-induced lung cancer and mesothelioma cases show an almost flat trend, with ~50 new cases of lung cancer and 50 new cases of mesothelioma emerging each year in Finland [6]. It is estimated that the incidence of mesothelioma and lung cancer will begin to diminish by the end of the 2010s. The number of registered asbestosis cases has already fallen by ~50% from the highest values of the mid-1990s.

In this study we assessed the cancer risks of four different Finnish asbestos-exposed cohorts. Our main aim was to determine whether the cessation of the use of asbestos some 20 years ago has affected the risks of asbestos-related cancers. We also explored whether the cohorts with somewhat varying profiles of asbestos exposure exhibited varying relative risks of cancer and whether an excess of cancers of the larynx or ovaries could be identified in these cohorts.

2. Materials and methods

Table 1 shows the number of workers in the different cohorts and subcohorts, followup period, person-years, and the proportion of men and tobacco smokers among the workers.

"Asbestos mine workers" is the oldest cohort, and comprises workers of the former Paakkila and Maljasalmi anthophyllite asbestos mines in Finland. The Paakkila mine began operating in 1918; Maljasalmi in 1943. A total of 734 workers were followed up: they had been employed in these mines for at least 3 months between January 1953 and July 1967. Altogether 28% of the workers were exposed for over 5 years. Workers of the mine and the refinery were considered to have heavy asbestos exposure while the rest of the personnel had moderate asbestos exposure. [7]. The Maljasalmi mine was closed in 1953, and the Paakkila mine in 1975. It is possible that these workers were also exposed to asbestos afterwards in, for example, the construction industry.

The "asbestosis patient" cohort was formed in 1977–1985, and consisted of patients who visited the Finnish Institute of Occupational Health for a periodic health examination due to previously diagnosed asbestosis. They had worked as insulation (53 workers), asbestos mine (24 cases) or asbestos cement factory (24 cases) workers, sprayers (14 cases), or in other asbestos-exposing work (13 cases). Their mean duration of asbestos exposure was 21 (range, 4–40) years. [8]

The "asbestos sprayer" cohort consisted of 133 asbestos sprayers who were identified in 1987 from employee registers and other sources. The mean duration of the asbestos exposure of the 60 sprayers who took part in the health examinations was 3 (range, 0.2–13) years. Asbestos spraying with crocidolite was performed in Finland between the years 1955 and 1976, after which spraying and the use of crocidolite was prohibited [8].

The largest and most recent of the four cohorts is the "asbestos screening" cohort. The asbestos-related illnesses of exposed workers were screened in Finland in 1990–1992. A questionnaire was sent to study participants, based on the registers of trade unions and employment pension institutions. The final cohort consisted of 24,214 people. At the time of the screening project, the mean duration of work that exposed workers to asbestos was 26 years. A total of 71% of the workers of this cohort were construction workers who had a history of at least 10 years of employment in the construction industry, starting before 1980. Asbestos use in construction materials in Finland ceased at the end of the 1980s, which can be regarded as materially decreasing any potential exposure in the construction industry. Of course, the material that was already in place also contained asbestos, which may have caused some exposure in renovation work even after the end of the 1980s. In Finland, asbestos cement products were manufactured between 1923 and 1988. Asbestos cement contained 10–15% chrysotile. In shipbuilding, crocidolite asbestos was sprayed in 1955–1975. Boards containing amosite were used in the interior furnishing of ships until the 1970s [9]. The screening cohort also had 672 workers who participated voluntarily. Their interviewed asbestos exposure was similar to the other workers' in the cohort. There were also 5,693 workers who answered the preliminary questionnaire but did not participate in the actual screening study. Their detailed asbestos exposure remained unclear, although they had been employed in asbestos exposing industry over 10 years [10].

The participants were identified and followed up for death and emigration in 1967−1994 via the Population Register Centre, using the unique identification number given to everyone residing in Finland since January 1, 1967 as the key. Three men from the cohort of asbestos sprayers had to be excluded because of missing identification data. Follow-up for cancer was carried out automatically using the files of the Finnish Cancer Registry. The follow-up started on January 1, 1967; on January 1 of the year following the first periodic health examination since 1977 for the asbestosis patients, on January 1 of the year following the year of first employment as an asbestos sprayer, or from the date of screening. or from January 1 1991 for the screening cohort. The calculation of person-years ended at emigration or death, or on December 31, 2012, whichever occurred first. The number of incident cancer cases and the person-years at risk, were counted separately for 5-year (1st period 6 years) calendar periods (1967−1972, 1973−1977, 1978–1982,

Table 1
The number of workers (*N*), followup period, and person years at followup, and percentages of men and current and ex-smokers in the different cohorts and subcohorts

Cohort	*n*	Follow up period	Person y by age		Men %	Smokers %*
			< 60 y	≥ 60 y		
Asbestos mine workers	734	1967−2012	11,049	8,333	80	67
Moderate exposure	257		4,316	3,199	76	55
Heavy exposure	477		6,733	5,134	82	74
Asbestosis patients	128	1978−2012	684	1,211	92	82
Asbestos sprayers	133	1967−2012	3,468	504	97	83
Screening cohort	24,214	1988−2012	187,024	254,849	96	69
Construction	17,236		130,343	187,724	97	70
Shipyard	117		283	1,658	91	67
Asbestos industry	496		4,120	4,619	80	61
Spontaneous†	672		7,965	5,085	94	68
Questionnaire‡	5,693		44,313	55,763	96	NA

* Percentage out of persons with known smoking status.
† Those who spontaneously contacted the researchers willing to participate.
‡ Those who only answered the preliminary questionnaire.
NA, not applicable.

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