Occupational characteristics of respiratory cancer patients exposed to asbestos in Lithuania

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Abstract. Objective: To assess characteristics of asbestos exposure in respiratory cancer patients in Lithuania. Methods. Information on occupational exposure to asbestos was collected by personal interviews and occupational characteristics were evaluated among 183 lung cancer and mesothelioma patients with cumulative asbestos exposure ≥0.01 fibre years hospitalized at the Institute of Oncology, Vilnius. Additionally, some results of workplace air measurements were reviewed. Results. Cases with estimated cumulative exposure ≥5 fibre years had worked mainly in the construction industry (49%), installation and maintenance (13%), foundry and metal products manufacturing (6%), heating trades and boilerhouses (6%) as fitters/maintenance technicians, construction workers, welders, electricians or foremen. Typical asbestos materials used by the patients were asbestos powder, asbestos cement sheets and pipes, asbestos cord, brake and clutch linings. Patients were exposed to asbestos when insulating boilers, furnaces, pipes in power stations, industrial facilities, ships, locomotives, buildings, while covering and repairing roofs, at the asbestos cement plant or unloading asbestos products. Most patients with estimated cumulative exposure of ≥0.01-4.9 fibre years worked as lorry, bus or tractor drivers and motor vehicle mechanics. In 2002-2007 workplace air asbestos concentrations exceeded the limit value of 0.1 f/cm$^3$ in 11 samples out of 208 measurements. Conclusion. The results of this study indicate that since the 1960s occupational exposure to chrysotile asbestos was extensive in Lithuania.

1. Introduction
Since the year 1961 in Lithuania about 700,000 tons of raw chrysotile asbestos were used for the production of asbestos cement sheets and pipes, for the insulation of boiler stations and pipes and as
friction materials [1,2]. All asbestos was imported from Russia. There were two factories manufacturing asbestos cement products as well as four main shipyards situated in western Lithuania. The production of corrugated asbestos cement sheets started in 1956. The annual output rose to over 100 million asbestos cement sheets annually in the 1970s, remaining high until 1991 and then declining (figure 1) [3].

![Figure 1. Production of corrugated asbestos cement sheets in Lithuania.](image)

The first regulations on the production and use of asbestos were passed in 1998. Asbestos import and use were banned completely in 2004. The current limit for the concentration of asbestos fibres in the workplace air is 0.1 f/cm$^3$ for all types of asbestos [4].

In Lithuania no cancer case has been diagnosed or compensated for as an asbestos-related occupational disease so far, although about 1500 new lung cancer cases and 10 mesotheliomas are registered annually [5,6]. Few explanations for this situation were suggested, including insufficient recognition among workers and physicians of the occupational etiology of asbestos-related cancers and unclear criteria for occupational disease certification [5]. There is little information about the past occupational exposure to asbestos in Lithuania in relation to duration, latency period and distribution of asbestos-exposed workers over industries and about the sources of definite, probable and possible exposure to asbestos. Such knowledge could be useful for informing workers on their individual risk or its assessment, planning preventive measures, medical follow-up and for occupational disease diagnosis.

The aim of this study is to assess characteristics of asbestos exposure in respiratory cancer patients in Lithuania.

2. Methods
Information on occupational exposure to asbestos, as well as demographic characteristics and smoking habits, was collected by personal interviews of 302 lung cancer and mesothelioma patients who were hospitalized at the Institute of Oncology, Vilnius, between November 1, 2003 and May 15, 2005. Here we provide a description of occupational data on 183 persons exposed to asbestos. From the occupational history of each patient, the main source of asbestos exposure was assessed. The duration of exposure and time since the first exposure was evaluated based on dates of employment if not indicated otherwise by the patient. Exposure assessments were based on job descriptions and the German BK-report “Faserjahre” [7]. For diagnostic and compensation purposes this documentation is used to evaluate the cumulative lifetime exposure of a patient with suspected occupational disease. A
dosis exceeding 25 fibre years/cm³ has been estimated to cause a two-fold risk of lung cancer [7]. The cumulative exposures were classified as 0.01 – 4.9 fibre years, 5 – 24.9 fibre years, and ≥25 fibre years. Nonexposed persons or persons with an estimated exposure to asbestos of <0.01 fibre years (119 persons) were not included into the present study.

Measurements of asbestos fibre concentrations in the air for the period 2002-2007 were performed at the Laboratory of Chemical Hazards Investigation of Hygiene Institute using phase–contrast optical microscopy.

3. Results
Details of 302 study participants and results of the assessment of their cumulative exposure to asbestos as well as findings of fibre burden analysis on 23 lung tissue samples were reported previously [8]. In this paper we focused on 183 patients for whom the estimated cumulative exposure to asbestos was ≥ 0.01 fibre years.

Among the group of 67 patients (65 men and 2 women) with cumulative exposure ≥ 5 fibre years, most cases had worked in the construction industry (49%, 33 cases), the installation, maintenance and metal constructions industry (13%, 9 cases), heating trades and boilerhouses (6%, 4 cases), and foundry and metal products manufacturing (6%, 4 cases). The rest had worked in asbestos cement production, shipbuilding, glass factories, power stations or railways. Fitters/maintenance technicians (19%), construction workers (13%), welders (9%), electricians (8%) and foremen (6%) were the most frequent occupations in this group (table 1). The majority of patients (94%) had started their work with asbestos exposure before the year 1990. The mean time between the first asbestos exposure and the disease diagnosis was 34 years (min 9, max 53). A majority of patients (76%) had worked with asbestos for more than 10 years. Typical asbestos materials used by the patients were asbestos powder, corrugated asbestos cement sheets, asbestos cement pipes, asbestos cord and brake/clutch linings. The patients were exposed to asbestos when insulating boilers, furnaces, pipes in power stations, industrial facilities, ships, locomotives and buildings.

Table 1. Industries, occupations and materials reported by 67 patients with a cumulative exposure of ≥5 fibre years.

| Industry | Occupation | Asbestos materials                                                                 | No of patients |
|----------|------------|------------------------------------------------------------------------------------|----------------|
| Asbestos cement or building materials | Fitter/maintenance technician Workman | Asbestos powder, asbestos cement Pipes, corrugated asbestos cement sheets; bystander (asbestos dust) | 1 2 |
| Construction | Warehouse worker, loader Brickerlayer Plasterer Welder Joiner-woodworker Tractor driver, crane operator Builder; laborer | Corrugated asbestos cement sheets, asbestos powder in sacks, asbestos cement products Corrugated asbestos cement sheets, pipes, asbestos powder, asbestos cord, sheets, other asbestos cement products Asbestos sheets, asbestos powder, corrugated asbestos cement sheets Asbestos sheets, cord, powder, asbestos cement products, asbestos insulation removal Corrugated asbestos cement sheets Asbestos cord, asbestos cement products, brakes, clutch, bystander Corrugated asbestos cement sheets, seals, cord, cardboard, asbestos powder, asbestos insulation removal | 2 6 1 4 1 2 9 |
| Occupation                                      | Asbestos Products                                                                 | Quantity |
|------------------------------------------------|----------------------------------------------------------------------------------|----------|
| Foreman                                        | Asbestos cord, powder, removal of asbestos insulation, asbestos cement pipes, corrugated asbestos cement sheets | 4        |
| Insulator                                      | Asbestos powder, asbestos insulation removal                                      | 1        |
| Construction smith                             | Asbestos powder, asbestos cardboard, sheets                                       | 1        |
| Electrician, pipe fitter                       | Asbestos cord, sheets, cardboard, pipes, removal of insulation, laminate           | 2        |
| Installation, maintenance technician, assembler | Asbestos cord, cardboard, sheets, textile, removal asbestos insulation             | 3        |
| Plumber                                        | Asbestos cord, pipes, powder                                                      | 2        |
| Foreman                                        | Asbestos cord, sheets, cardboard, paronit, asbestos powder                         | 1        |
| Concrete worker                                | Asbestos cord, asbestos pipes, corrugated asbestos cement sheets                  | 1        |
| Boilerhouse, heating company                   | Asbestos sheets, cardboard, cord, bystander                                       | 4        |
| Foundry, metal products or metal construction manufacturing | Asbestos powder, cord, sheets, cardboard, asbestos, textiles, asbestos insulation removal | 3        |
| Metal worker                                   | Bystander                                                                        | 1        |
| Welder                                         | Asbestos powder, asbestos insulation materials                                    | 2        |
| Electrician                                    | Asbestos insulation on wires, asbestos powder                                    | 1        |
| Fitter/maintenance technician, assembler       | Asbestos powder, cord, sheets, patterns, cardboard, asbestos insulation removal    | 1        |
| Railway                                        | Asbestos powder, sheets                                                          | 1        |
| Glass factory                                  | Asbestos cord, cardboard, laminate                                                | 1        |
| Sheet metal worker                             | Asbestos sheets, cords, seals                                                     | 1        |
| Smith, electrician                             | Asbestos cords, cardboard, powder                                                 | 1        |
| Fishing ship                                   | Asbestos gloves, cord, board                                                     | 1        |
| Shipyard                                        | Brake linings, asbestos cord                                                     | 1        |
| Fitter/maintenance technician                  | Asbestos powder                                                                  | 1        |
| Port Clearing and forwarding agent             | Bulk asbestos in sacks                                                           | 1        |
| Electrician                                    | Asbestos cord, sheets, cardboard, textiles, pipes, insulation removal, laminate   | 2        |
| Rubber factory                                 | Asbestos sheets, bystander                                                       | 1        |
| Fitter/maintenance technician                  | Corrugated asbestos cement sheets                                                | 1        |

* – heavily exposed patient (cumulative exposure ≥25 fibre years)

* – mesothelioma case

Heavily exposed patients (≥ 25 fibre years) had worked as fitter/maintenance technicians, welders, foremen, insulators or electricians in foundries, construction, installation, shipyard, asbestos-cement products manufacture, glass industry, power plant, maintenance of railway locomotives and in the chemical industry. The occupations and industries, as well as asbestos materials used by heavily exposed patients, are presented in Table 2. Their first occupational exposure to asbestos occurred during the period 1958-1978 (table 2).

Most of the 116 patients with estimated cumulative exposure of 0.01-4.9 fibre years worked as lorry, bus or tractor drivers (40%) and motor vehicle mechanics (13%). Welders, fitters/maintenance technicians or metal workers accounted for 12% of all patients in this group. The most common industries were construction, agriculture, transport and land reclamation, heating companies and power stations. The main sources of asbestos exposure were brake/clutch linings and corrugated asbestos cement sheets.
All patients who worked at shipyards or in the asbestos cement industry reported some exposure to asbestos or were bystanders. No interviewed patient mentioned spraying asbestos. One patient had removed sprayed asbestos while working abroad.

Table 2. Industry, occupation and asbestos materials reported by 10 heavily exposed patients with a cumulative exposure of ≥25 fibre years.

| No | Industry                        | Occupation                        | Years of exposure | Asbestos materials used                        |
|----|---------------------------------|-----------------------------------|-------------------|-----------------------------------------------|
| 1  | Asbestos cement plant           | Fitter/maintenance technician     | 1970-1976         | Asbestos powder, asbestos cement              |
| 2  | Installation, maintenance       | Foreman, plumber                  | 1978-1994         | Asbestos powder, cord, sheets, cardboard, laminate |
| 3  | Construction                    | Foreman/insulator                 | 1978-1992         | Asbestos powder                               |
| 4  | Metal products manufacturing    | Welder                            | 1960-1971         | Asbestos powder                               |
|    | Construction                    | Plumber                           | 1981-1983         | Asbestos cord, asbestos powder                |
| 5  | Power station                   | Fitter/maintenance technician     | 1958-2004         | Asbestos powder, rope, sheets, forms, cardboard |
| 6  | Railway                         | Fitter/maintenance technician     | 1958-2000         | Asbestos powder, board                        |
| 7  | Glass factory                   | Sheet metal worker                | 1967-1993         | Asbestos sheets, cord, seals                 |
| 8  | Shipbuilding                    | Fitter/maintenance technician     | 1965-1991         | Asbestos cord, cardboard, powder              |
| 9  | Foundry                         | Fitter/maintenance technician     | 1970-1991         | Asbestos powder, cardboard, cord, sheets, textiles, insulation removal |
| 10 | Chemical industry               | Electrician                       | 1964-1974         | Asbestos powder                              |

Most of the 208 measurements of asbestos fibres in the workplace air during the period 2002-2007 were performed at the plants in the energy sector (64%) and construction (11%) (table 3). In 11 samples workplace air asbestos concentrations exceeded the limit value of 0.1 f/cm³. High levels of asbestos fibres were found in the workplaces of insulators and plumbers. The highest concentration was measured in the construction industry during the demolition of structures containing asbestos (1.8 f/cm³).

Table 3. Concentrations of asbestos fibres in workplace air in 2002-2007.

| Economic activity of the plant | Occupation                        | Number of measurements exceeding 0.1 f/cm³/total | Concentration of asbestos fibres in the workplace air, f/cm³ | Average | Min. | Max. |
|-------------------------------|-----------------------------------|-------------------------------------------------|-----------------------------------------------------------|---------|------|------|
| Energy                        | Insulator                         | 3/133                                           | 0.03                                                      | 0.03    | < 0.01 | 0.63 |
| Construction                  | Plumber                           | 1/23                                            | 0.09                                                      | 0.09    | < 0.01 | 1.8  |
| Machinery production          | Smith-repairer, machine tool setter, pressman | 3/16                                           | 0.04                                                      | 0.04    | < 0.01 | 0.19 |
| Public service                | Officer                           | 0/13                                            | < 0.01                                                   | < 0.01  | < 0.01 | < 0.01 |
| Transport                     | Motor vehicle mechanic, pressman  | 2/12                                            | 0.05                                                      | 0.05    | < 0.01 | 0.13 |
| Chemistry                     | Smith-repairer                    | 2/7                                             | 0.06                                                      | 0.06    | < 0.01 | 0.15 |
| Food production               | Operator                          | 0/4                                             | < 0.01                                                   | < 0.01  | < 0.01 | < 0.01 |
| All                           |                                   | 11/208                                          | 0.04                                                      | 0.04    | < 0.01 | 1.8  |
4. Discussion

In our previous publication it was estimated that 3.4% of Lithuanian lung cancer cases could be attributed to heavy asbestos exposure at work (≥ 25 fibre years) [8]. The results of the present study confirm that chrysotile asbestos was widely used in Lithuania. Construction, maintenance, heating, boilerhouse and foundry workers constitute a big group among patients heavily/moderately exposed to asbestos (≥ 5 fibre years). Most patients with relatively low estimated exposure worked as lorry, bus or tractor drivers, motor vehicle mechanics, welders, fitters/maintenance technicians or metal workers. No patient reported spraying asbestos, and one patient had removed sprayed asbestos abroad. Our interview data suggests that the most common method of insulation was mixing asbestos powder with water and cement and its application on pipes, furnaces and other machinery. Workplace air of insulators and plumbers had the highest concentrations of asbestos fibres.

Our results are similar to those from a survey in Estonia where it was found that mechanics-locksmiths, machine operators, construction workers and thermal insulators were most exposed to asbestos. Thermal insulation was particularly dangerous, because asbestos fibres are readily released, producing airborne concentrations from 0.30-0.49 f/cm³ [9].

As was discussed in our earlier publication, the strength of the present study is a detailed questionnaire, including 33 specific questions about job tasks, asbestos materials used and location, the duration and frequency of every job activity involving asbestos exposure presumably increased the accuracy of exposure assessment. However, some misclassification of exposure could occur, because the exact estimation of cumulative asbestos exposure was complicated by the high number of jobs in the past, and because the workers were not able to know their past exposures. Another limitation is the selection of the patients for the study. As few patients from the north or the west of Lithuania come to the Institute of Oncology for cancer treatment, the majority of the study patients (73%) were residents of the eastern part of Lithuania. The underestimation of patients from asbestos cement and shipbuilding industries cannot be ruled out. It is also difficult to evaluate the representativeness of measurement data of asbestos fibre concentrations in workplace air. Measurements were performed with various purposes, but it was not a specifically designed study with a carefully selected sample representative of all workplaces in the country. The number of asbestos fibre concentration measurements in the workplace air is rather small. Therefore, the results should be interpreted with caution. Despite this limitation, the results of asbestos measurements indicate that in some workplaces workers are still exposed to high asbestos concentrations that exceed permissible levels.

The results of this study have shown that occupational risks are important, in addition to the risks from smoking. Inquiring into them should be an important part in the medico-legal compensation of occupational diseases. This study may help to define more clearly diagnostic criteria of occupational lung cancer, to plan preventive measures and to inform workers about their individual risks.

Among most patients with cumulative asbestos exposure ≥ 5 fibre years, the first exposure to asbestos had occurred before the 1990s, when the import of raw asbestos and the manufacture of asbestos cement products was high. The decrease in the consumption of asbestos in Lithuania started about 20 years later than in Finland or the UK, and about 10 years later than in the Netherlands or Germany [10-12]. Therefore, it is likely that the incidence of asbestos-related diseases will still increase during the next years in Lithuania.

Acknowledgments

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