



# Asbestosis hospitalizations in Poland (2006–2016): results from the National Hospital Discharge Registry

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## Abstract

**Introduction and objective.** Occupational asbestos exposure is one of the major public health issues. Although asbestos use in Poland has decreased, asbestosis continues to remain an important health concern in the area of occupational medicine. The aim of the study is to perform a descriptive analysis of hospitalization cases in patients suffering from asbestosis in Poland.

**Materials and method.** The authors used hospital discharge records to conduct a retrospective, population-based study. To estimate the asbestosis hospitalization rate, data from the Nationwide General Hospital Morbidity Study conducted by the National Institute of Public Health were used. Events were defined as in-patient hospital discharges during 2006–2016. 1,101 hospitalization records of 764 patients were included in the study.

**Results.** In the study group of first-time hospitalized patients, the mean and median ages were 68.1 and 69 years, respectively; CI: 67.3–68.9; SD: 11.1, min-max:16–99 years. In this group, significant gender differences were observed (560 males vs. 204 female;  $P < 0.001$ ). No statistical differences were observed regarding the place of residence. During the observation period, 61 in-hospital deaths were reported (8% of all patients), 40 of whom (5.2 % of all patients) took place during the first-time hospitalizations. Asbestosis hospitalizations were mainly clustered in the south-western region, whereas the highest hospitalization rates were clustered in several areas of Poland.

**Conclusions.** The authors believe this study to be the first evaluation of asbestosis in Poland made on the basis of the hospital morbidity database. The data presented may be helpful in comparative studies on the epidemiology of asbestosis across European countries.

## Key words

public health, environmental health, lung disease, occupational exposure

## INTRODUCTION

Occupational asbestos exposure is a major public health issue. Being a carcinogen, it constitutes one of the most dangerous pollutants for humans. Asbestosis is a chronic lung disease which most commonly affects workers of particular industries, such as mining, construction, automobile, textiles and insulation products industries. National incidences of the disease have been strongly influenced by the industrial histories of countries. Although world asbestos use has declined since last decades of the 20<sup>th</sup> century [1], asbestosis continues to remain an important health issue in the area of occupational medicine due to its latent onset resulting from past exposures, and the enduring potential for new exposures. According to the World Health Organization (WHO), approximately 125 million people worldwide might be exposed to asbestos at work, and several thousand deaths annually can be related to asbestos exposure at home [2]. In

North Carolina, USA, the average annual age-standardized hospitalization rates for asbestosis was 71.2 hospitalizations per 1 million. However, the rate for asbestosis decreased significantly between 2002–2011 [3]. Results of a study from Louisiana, USA, show that over the period of 11 years, the level of asbestosis hospitalizations has remained stable with approximately 295 disease cases on an annual basis [4]. Another study from the USA indicates that not only former vermiculite workers, but also the general population may be experiencing asbestos-related effects [5]. A study in a group of asbestosis-diagnosed patients, conducted on the basis of hospital discharge data from Italy (covering the period 2001–2015), the hospitalization rate for all asbestosis cases amounted to 25.2 per 1,000,000 inhabitants [6]. During 1963–2010, there were 815 asbestosis cases in Spain [7]; in Germany during 2013–2016, about 4,100 of all asbestos-related disease cases, which in total amounted to approximately 9,400 per year, represented cases of occupational disease [8]. In Poland, data on occupational diseases related to asbestos are collected by local sanitary inspectors and sent to the Nofer Institute of Occupational Medicine in Łódź, where they are kept in the Central Register of Occupational Diseases. In the period

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between 1976–2010, exposure to asbestos dust in the working environment resulted in 4,253 reported disease cases, of which asbestosis (64.0%), lung cancer (12.2%), pleural mesothelioma (6.4%) and diseases of the pleura (9.7%), were the most common. Even though the number of patients with occupational lung cancer related to asbestos exposure was low, they constituted approximately 40% of all cases of the said disease in 1978–2010 [9].

Most developed countries have eradicated the use of asbestos. It was completely banned by the European Union in 1999 (Commission Directive 1999/77/EC of July 26, 1999). Even though no such ban has been introduced in the USA, the use of asbestos has been reduced due to the implementation of regulations and litigation [10]. The total amount of mined asbestos worldwide was reported to be close to stable level in this century [11].

In 1997, a statutory ban was imposed in Poland on the production, marketing and use of products containing asbestos. The National Programme for Asbestos Abatement in Poland in 2009–2032, schedules activities that can be used to estimate asbestos exposure and health protection, along with detailed measures regarding health protection. The Amiantus Project has been introduced by the Polish Ministry of Health and coordinated by the Nofer Institute of Occupational Medicine (IMP) in Łódź. The project has been implemented in 13 Occupational Medicine Centres as a result of which data on 5,466 patients, who had been subjected to 8,763 prophylactic examinations in 2000–2004, were collected. During the analysed 5-year period, an occupational disease was diagnosed in 728 patients and asbestosis diagnosed in 790 persons. An analysis of the database showed a growing trend in the incidence of asbestosis [12]. A study on the incidence of occupational diseases related to asbestos in Poland in 1970–2015, reported 4,983 asbestos-related disease cases, of which asbestosis, lung cancer, mesothelioma, diseases of the pleura and pericardium were the most common. There are other papers with information on asbestosis in Poland [13, 14, 15], but (to the authors' knowledge) the presented study is the first which can shed light on the current burden of this disease.

## OBJECTIVES

Although asbestos has been banned in Poland, asbestosis still counts as a major health concern for occupational medicine due to its latent onset that results not only from past exposures, but also from potential exposures. The aim of this paper is to conduct a descriptive analysis of asbestosis hospitalizations in order to increase knowledge of asbestos exposure in Poland.

## MATERIALS AND METHOD

This is a retrospective population-based study concerning in-patient hospitalizations with the diagnosis of asbestosis. The National Institute of Public Health collects in-patient hospital discharge data through the Nationwide General Hospital Morbidity Study from all hospitals in Poland, with the exception of military and psychiatric facilities. The study group concerned people with diagnosed asbestosis as either primary or secondary diagnoses. The following information

was shared: up to 5 primary and up to 25 secondary diagnoses coded by the tenth revision of the International Classification of Diseases (ICD-10), date of admission and discharge, date of birth, gender, and postal code of the place of residence. The names of patients were not included. Data of in-patients hospitalized in Poland with the diagnosis of asbestosis (ICD10=J61) was analysed for 2006–2016. It was presumed that asbestosis was diagnosed in hospitals pursuant to currently used criteria. In-patient Discharge Data are useful in large national analysis. Hospital Inpatient Discharge Data were also used for such analysis in a study in Louisiana, USA, based on period 1999–2009 [4].

**Statistical analysis.** Descriptive statistical analysis of all and first-time hospitalizations was carried out. The incidence was estimated with the use of the number of asbestosis cases and corresponding census data. Demographic information on the general population in Poland was obtained from Statistics Poland [16]. Poisson distribution of the analysed cases was assumed and 95% CIs were counted. If normality assumptions could not be met, nonparametric tests were applied. *P* was defined as statistically significant for values of <0.05. Incidence was calculated as a ratio of incident cases and the population size. In order to make a trend analysis, linear regression was used. Fisher's exact test or  $\chi^2$  test were used to compare categorical variables. Statistica Software [17] and WINPEPI [18] were used in statistical analysis.

## RESULTS

Descriptive statistical analysis of all and first-time hospitalizations are presented in Table 1. Data from the National In-patient Discharge Database revealed that there was a total of 1,101 hospitalizations of individuals diagnosis with asbestosis with the mean number of 2.6 hospitalizations per million (CI: 2.3–3.0) annually; after eliminating repeated admissions, there were 764 unique individuals first-time

**Table 1.** Data characteristics of inpatient hospitalizations in Poland 2006–2016

Variables	All hospitalizations		1 <sup>st</sup> time hospitalizations	
	n	%	n	%
<i>Age</i>				
<45	19	1.7	19	2.5
45–54	60	5.5	45	5.9
55–64	275	25	202	26.4
65–74	377	34.2	267	35
75–84	318	28.9	194	25.4
85+	52	4.7	37	4.8
<i>Gender</i>				
male	836	76	560	73.3
female	265	24	204	26.7
<i>Department</i>				
Pulmonology	348	31.6	216	28.3
<i>Tuberculosis</i>				
and lung disease	217	19.7	154	20.1
Internal medicine	209	19	151	19.8
Other	327	29.7	243	31.8

hospitalized for asbestosis, resulting in mean number of 1.8 new cases per million (CI: 1.6–2.0) annually in the analyzed period of time. In this study group of first-time hospitalized patients, the mean and median ages were 68.1 and 69 years, respectively; CI: 67.3–68.9; standard deviation 11.1, min-max:16–99 years. Sixty-two percent of the study cases occurred among hospitalized individuals above 65 years of age. In the study group, significant gender differences were observed (560 males vs. 204 females;  $P < 0.001$ ). With regard to the place of residence, no statistical differences were observed. Among asbestosis patients the presence of concomitant diseases of the circulatory system were observed in 53% of cases, diseases of the respiratory system other than asbestosis in 46%, endocrine, nutritional and metabolic diseases in 13%; other diseases were less than 5%. During the study observation, 61 patients (8% of all patients) died while hospitalized (50 males, 11 females; mean age 72 years, SD 12.9; min-max: 19–92 years). Forty deaths (5 % of all patients) occurred while the patients were hospitalized for the first time. In-hospital mortality among patients with asbestosis in Poland are presented in Table 2. Based on hospitalization data, hospital mortality rate per million people in Poland in 2006–2016 was estimated in this study to be 0.14 (CI: 0.08–0.21). Trends regarding the quantity of first-time hospitalizations and all hospitalizations of patients with asbestosis in 2006–2016 in Poland are presented in Figure 1. After 2010, the distance between curves seems steady and number of all hospitalizations, on average, were 1.6 higher than first-time hospitalizations (CI: 1, 48–1,8). The hospitalization rates were clustered in several regions of Poland as shown in Figure 2.

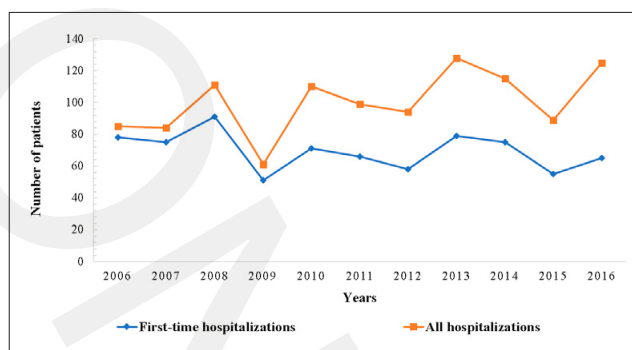


Figure 1. Annual case count of asbestosis hospitalizations in Poland 2006–2016

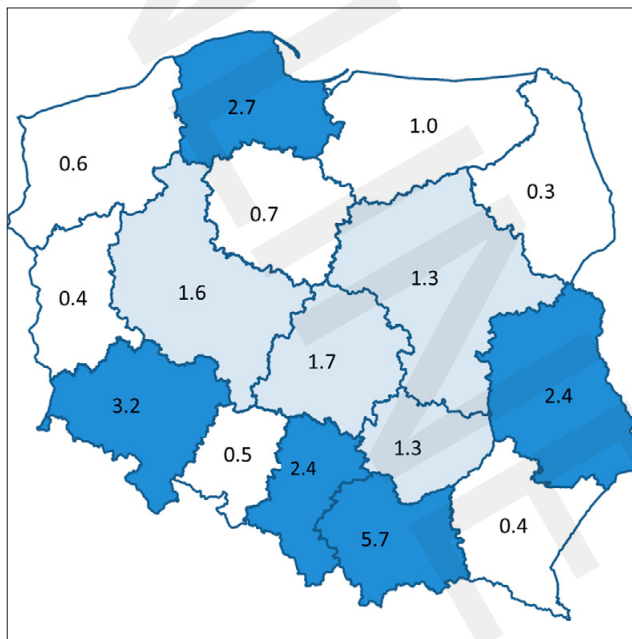


Figure 2. Asbestosis first-time hospitalization rates per 1,000,000 in all regions of Poland 2006–2016

Table 2. In-hospital mortality among patients with asbestosis in Poland 2006–2016.

Year	All hospitalizations			1 <sup>st</sup> time hospitalizations		
	Cases	Age <sup>a</sup> (years) mean (SD) <sup>b</sup>	Deaths (%) <sup>c</sup>	Cases	Age <sup>a</sup> (years) mean (SD) <sup>b</sup>	Deaths (%) <sup>c</sup>
2006	2	76 (12.7)	2.4	2	76 (12.7)	2.6
2007	9	67 (10.4)	10.7	8	69 (9)	10.7
2008	4	72 (10.5)	3.6	3	70 (12.3)	3.3
2009	2	69 (4.2)	3.3	2	69 (4.2)	3.9
2010	8	71 (13.8)	7.3	4	78 (13.1)	5.6
2011	6	65 (24.8)	6.1	5	62 (27)	7.6
2012	4	75 (9.8)	4.3	2	67 (0)	3.4
2013	10	75 (9.5)	7.8	7	78 (9.7)	8.9
2014	4	76 (7.3)	3.5	1	67	1.3
2015	1	81	1.1	1	81	1.8
2016	11	74 (14.3)	8.8	5	67 (17.2)	7.7
Overall						

<sup>a</sup> – Age = mean patients age; <sup>b</sup> – SD = standard deviation; <sup>c</sup> – Deaths (%) – percentage share of the number of deaths in relation to the number of cases in a given year

## DISCUSSION

First-time hospitalization cases of asbestosis patients were concentrated mainly in the south-western part of Poland. However, the highest hospitalizations rates were clustered in several regions of the country. Data from an Italian study showed that the hospitalized patients were mostly men and elderly from the north-west region of the country [6]. In

Poland, the majority of the former asbestos-producing plants are located in the southern part of the country [14], which may be an important factor relating to the higher number of asbestosis cases in this region of Poland. Another study reported that all patients who were not exposed to asbestos at work or were exposed to lower quantities of the substance, died of mesothelioma, although there were also other factors that caused the death of factory workers (lung cancer, asbestosis) [19].

The relatively low incidence of hospitalizations due to asbestosis in Poland may result from the limitations of both reporting the disease to the national register, and the organization of health care. One study reported that the main difficulties in conducting a study on diseases related to asbestos were the lack of data on exposure history in the medical records, and the lack of awareness of the workers themselves [20]. Another study reported that the poor completeness of recorded data hinders accurate knowledge of effects of asbestos on Spanish workers' health [21]. Thus, in Spain, the time trend and incidence rates related to occupational asbestosis might indicate that disease cases in that country are under-reported [7].

Another important problem may be proper diagnosis of asbestosis, especially in the case of cigarette smokers, since



mild asbestosis cannot be definitely distinguished from interstitial fibrosis in heavy smokers [22]. Asbestos-related lung cancer and asbestosis seem to be highly under-reported, which can be attributed to excessive reliance on unsound lung fibre counts [8]. A study from Italy conducted in a group of 51,988 workers reported that, although 54.2% of all workers were alive at follow-up, 42.6% of the total number were dead and 2.8% were not specified. The cause of death was known in 94.3% of cases: lung cancer in 2,548 cases, pleural cancer in 748 cases, peritoneal cancer in 173 patients, and asbestosis in 434 patients. [23]. Interestingly, lung cancer cases in Hungary were registered only extremely rarely as cases of occupational disease, leading to a serious under-diagnosis in that country [24]. Although asbestos was also commonly reported in Lithuania, no asbestos-related cancer cases were reported. However, about 50 lung cancer cases diagnosed in Lithuania annually could also include cases of occupational diseases related to asbestos [25].

The elevated case rate among males compared with females reflects gender differences in occupational patterns. This also indicates that men dominate in industries with the highest risk of asbestos exposure. In other countries, male predominance was also observed, e.g. in Louisiana, USA, data from the Current Population Survey (1999–2009) indicated that males comprised about 88% of the jobs, compared to 12% by females [4]. In China during 2006 and 2015, the level of burden of the disease attributable to asbestosis was higher in males than in females [26]. However, data on asbestos-related disease cases in one region in China in 1988–2014 showed a total of 625 patients (225 males and 400 females), 617 of whom were diagnosed with asbestosis [27].

Studies of workers from Louisiana, USA, found that males represented more than 90% of work-related mortalities and 75% of work-related hospitalizations [4]. In North Carolina in the USA, men had significantly higher rates for asbestosis hospitalizations than women [3]. With regard to the current burden of long-latency respiratory diseases in the United Kingdom, much of it was attributed to previous asbestos exposure in an estimation based on data from 1996–2014. The vast majority of cases were observed in males (95%), and as many as 92% of all disease cases were related to asbestos [28].

Asbestosis develops many years after exposure to asbestos. In the asbestosis pathogenesis, it is age that is a key factor. In the current study, 62% of the study cases occurred among hospitalized individuals above 65 years of age. In another study from Poland, total asbestos use was a strong predictor of the rate of asbestosis incidence [15]. Results of another study may be relevant as it reports that an increase in asbestos-related and other chronic disease mortality among patients in their 60s and 70s may be related to the decline in hospitalization rates among residents aged 85 years and older [4]. Even many years after the last exposure, asbestos fibres can be found in the lungs of asbestos worker. In a study of workers in Quebec, Canada, based on data collected between 1988–2007, even 30 years or more after the last exposure, chrysotile fibres were found in worker's lungs [29]. In North Carolina, USA, more than half of hospitalizations concerned persons aged 65–84 years [3]. In Germany, the rise in asbestos use and exposure resulted in the increase in diseases related to this substance. The mean latency period there was approximately 38 years, and was followed by a sudden rise in asbestos-related disease cases. The number of

cases remained at a steady level, with mean asbestos exposure of 18–20 years, and the mean age of workers with asbestosis at 67 years [8].

Hospitalizations for asbestosis were held mainly in the department of pulmonology, tuberculosis and lung diseases, internal medicine. These data may prove that the dominant symptoms of asbestosis concern the respiratory system. In the current study, based on hospitalization data, the hospital mortality rate per million people in Poland in 2006–2016 was estimated to be 0.14 (CI: 0.08–0.21). In another study, the age-adjusted mortality rate per million people in Poland in 1994–2010 (12 reported years) was reported to be 0.16 [30]. Among British asbestos workers, there were 15,496 deaths among 98,117 workers [31]. A study from Italy reported that in a community of about 400 workers, exposure to asbestos was responsible for the death of 81 workers exposed to asbestos at the Collotta-Cis factory in Ledro in the period 1928–1973, [32]. In the USA, the number of asbestosis-related deaths in 1968–2004 was 25,564 and it was projected not to decline substantially in the following 10–15 years [33]. In the USA, asbestos exposure contributed to 12,000–15,000 deaths a year in 1999–2013, which was 2,000–5,000 more cases than estimated previously. In this report the use of asbestos has declined substantially in the last few decades, no decrease in asbestos-related deaths has been noticed due to a considerable time-lag between the exposure to asbestos and the disease onset [34]. A study from the United Kingdom reported that there were 15,557 deaths between 1971–2005 in the group of 98,912 asbestos workers. The standardized mortality ratio for all causes was reported to be 1.42, and for asbestosis 51.3. In multiply-adjusted analysis, age and gender were significantly associated with asbestosis [35]. Another study showed that asbestosis mortality continued to grow in the UK with the increase from 0.04 in 1968–1972 (95% CI 0.03–0.05) to 0.12 in 2005–2008 (95% CI 0.10–0.13) [36]. Furthermore, no decrease in asbestosis deaths was observed in England and Wales in 1991–2000, as shown in an analysis of occupational mortality. The study indicated that asbestos-related mortality in the UK resulted from the aggregated asbestos exposure of workers aged under 45, who experienced the consequences of such exposure until old age [37]. In a cohort study from Italy, conducted in a group of 1,823 asbestos workers in the textile industry who were professionally active from 1946–1984, 51 asbestosis deaths were reported until November 2013. In the decades after the last exposure, the risk of death from asbestosis decreased significantly [38]. However, data on asbestos-related disease cases in one region in China in 1988–2014 showed mortality at the level of 38.74% [27].

Data from our study showed that during the 11-year period of the study, the rates of first-time hospitalizations due to asbestosis was not significantly increasing in Poland. Trends regarding the quantity of first-time hospitalizations and all hospitalizations of patients with asbestosis in 2006–2016 in Poland are presented in Figure 1. After 2010, the distance between curves seems steady and the number of all hospitalizations, on average, were 1.6 higher than first-time hospitalizations. The indicator of first-time hospitalizations may suggest a gradual decrease in hospitalization of asbestosis patients in Poland in the future. These data suggest that patients with asbestosis rarely required repeated hospitalizations. In other countries, the occurrence of asbestos-related diseases may be conditioned by the State policy regarding restrictions

on products made with the use of asbestos. In China, the burden of disease attributable to asbestosis had an upward trend for the period 2006–2015 [26]. A study in South Korea, based on data from 1998–2013, reported that the incidence of asbestos-related diseases tended to increase, even though asbestos stopped being used [39]. In turn, a study from Louisiana, USA, based on data from 1999–2009, indicated that the number of asbestosis-related hospitalizations was stable in the observation period of 11 years [4]. The Collegium Ramazzini reported in the decades to come, in the majority of industrialized countries there will probably not be an epidemic of asbestos-related diseases [40].

**Limitations.** There are certain limitations to this study. The first is the reliance on hospital discharge records of in-patients, and the exclusion of out-patients. Another limitation is related to the fact that the asbestosis diagnosis included in the records might not necessarily be the first-time diagnosis. This might lead to the over-estimation of asbestosis incident cases. However, the long duration of the observation period may have reduced the risk. Although the study design may lead to an inaccurate count of the cases, the advantages of an analysis based on the nationwide hospital database seem to balance this inaccuracy.

## CONCLUSIONS

The data presented in this study may be helpful in comparative analyses on the epidemiology of asbestosis across European countries. Further research into the epidemiology of this disease may be necessary.

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