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EPIDEMIOLOGY OF SILICOSIS REPORTED TO THE CENTRAL REGISTER OF OCCUPATIONAL DISEASES OVER LAST 20 YEARS IN POLAND

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Abstract
Objectives: The aim of the study was to investigate and assess the incidence of silicosis cases acknowledged as occupational diseases in Poland in 2000–2019. **Material and Methods:** The cases of all medically recognized pneumoconioses, including silicoses, certified as occupational diseases were studied. The records were extracted from the Central Register of Occupational Diseases, the only official Polish central electronic data base of occupational diseases. **Results:** During the period 2000–2019, 2066 confirmed cases of silicoses and 10 665 cases of other pneumoconioses including asbestosis and coal workers' pneumoconiosis were reported to the Central Register of Occupational Diseases. Silicoses accounted for 12.8–21.2% of all pneumoconioses. The number of confirmed silicoses cases was growing along with the length of latency period and was the highest for the period of ≥40 years (513 cases). Over 70% of silicoses cases occurred after occupational exposure >20 years. The most workers who evolved silicosis were employed in manufacturing, predominantly casting of iron, mining and quarrying and construction. **Conclusions:** The number of confirmed cases of silicosis in Poland decreased in 2000–2019 but the disease still remains an important health problem. Prevention is crucial to reduce further disease incidence. The medical monitoring standards of exposed workers should be improved. Developing new diagnosing guidelines with the use of other imaging examinations, like high-resolution computed tomography, has to be considered. The analysis should contribute into the implementation of silicosis preventative programmes, both at the enterprise and national level. Int J Occup Med Environ Health. 2022;35(5)

Key words:
Poland, occupational diseases, epidemiology, silica, silicosis, pneumoconioses

INTRODUCTION

Pneumoconioses, including silicosis, are fibrotic lung diseases caused by inhalation of inorganic dusts and fibres present in a professional or non-occupational (municipal) environment. The development of a specific type of pneumoconiosis and the severity of the disease's course depend on many factors such as the duration and level of exposure to dusts and fibers, the size of the particles, their chemical nature and crystalline silica content in the inhaled dust. Although pneumoconioses belong to the oldest occupational diseases and have been talked about since Hipocrates' time they still remain incurable and irreversible [1].

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In compliance with regulations in many countries, including Poland, the case of pneumoconiosis related to workplace exposure can be recognized as an occupational disease on the basis of specified criteria [2]. The predominant types of pneumoconioses in Poland are coalworkers' pneumoconiosis (CWP), silicosis and asbestosis. Pneumoconioses have been listed in the Polish schedule of occupational diseases since 1928 [3]. The present schedule, issued in 2009, includes 8 types of the disease: silicosis, coal workers' pneumoconioses, silicotuberculosis, welders' pneumoconiosis, asbestosis and other pneumoconioses caused by dusts of silicates, talcosis, graphite pneumoconiosis and pneumoconioses caused by metal dusts [4].

In Poland, each medical opinion on the diagnosed occupational disease must be stated by the national sanitary inspector and afterwards, obligatorily reported to the Central Register of Occupational Diseases in the Nofer Institute of Occupational Diseases in Łódź, Poland by the occupational disease statement card. The disease entities are reported to the Central Register in accordance with the Polish schedule of occupational diseases. Nowadays, the Central Register is the only full and principal data source used to investigate the incidence of occupational diseases in Poland [4,5]. Information mandatory reported on the statement card include among others, the individual's personal data, the identification of the workplace where the occupational disease occurred, the type of job, the main occupational factor inducing the disease and the occupational exposure duration.

According to Statistics Poland in 2019 there were 50 353 persons employed in exposure to industrial dusts in Polish enterprises employing ≥10. Of them 34 201 were exposed to fibrous dusts, mostly in mining and quarrying, industrial manufacturing and construction [6]. Lately, several foreign studies have indicated silicoses emerging in new industries like artificial stone manufacturing and it becomes a new problem for occupational health care professionals [7]. There is a need for robust data on national as well as global prevalence of silicosis to draw attention to this threatening issue.

The aim of this paper is to investigate and assess the incidence of silicoses over the past 20 years in Poland.

MATERIAL AND METHODS

The cases of all medically recognized pneumoconioses, including silicoses, certified as occupational diseases, obligatorily reported to the Central Register of Occupational Diseases in 2000–2019 were studied. The analysis was based on the information compiled from submitted reporting forms on occupational diseases such as gender, age at the moment of issuing the decision on the occupational disease (<30 years, 30–39 years, 40–49 years, 50–59 years, 60–69 years, and ≥70 years), duration of exposure to the respirable crystalline silica (≤12 months, 1–4 years, 5–9 years, 10–14 years, 15–19 years, ≥20 years), sector of the national economy and province of Poland, latency period between the beginning of occupational exposure to silica and the date of occupational disease statement (<5 years, 5–9 years, 10–19 years, 20–29 years, 30–39 years, ≥40 years). For 626 cases (30.3%) details regarding the latency were not available because the calendar year of the beginning of occupational exposure to silica dust was not reported in the statement card.

RESULTS

Pneumoconioses belonged to the most frequently occurring occupational diseases in Poland. During the period 2000–2019, 12 731 confirmed cases of pneumoconioses were reported in the Central Register of Occupational Diseases. In the investigated period pneumoconioses accounted for 10.2–28.5% of all occupational diseases cases reported annually and 19.4% in total. The highest percentage of pneumoconioses falls on the last 10 years (Table 1).

The 3 most common types of pneumoconioses reported in Poland in 2000–2019 were:
– coal workers' pneumoconioses (8291 cases, 65.1%),
– silicoses (2066 cases, 16.2%),
– asbestoses with other pneumoconioses caused by dusts of silicates (1842 cases, 14.5%) (Figure 1).

These types also dominated in males:
– coal workers' pneumoconioses (8270 cases, 68.6%),
– silicoses (1977 cases, 16.4%),
– asbestoses and other pneumoconioses caused by dusts of silicates (1294 cases, 10.7%).

The remaining were:
– silicotuberculosis (259 cases, 2.1%),
– welders' pneumoconiosis (155 cases, 1.3%),
– talcosis (27 cases, 0.2%),
– pneumoconiosis due to metal dusts (6 cases, 0.05%),
– other types of pneumoconioses (4 cases, 0.03%)
– non-collagenous pneumoconioses (stannosis, barytosis, siderosis) (1 case, 0.01%)
– unspecified pneumoconioses (66 cases, 0.5%).

This structure was different in the group of women where:
– asbestoses and other pneumoconioses caused by dusts of silicates (548 cases, 81.5%),
– subsequently silicoses (89 cases, 13.2%),
– coal workers' pneumoconioses (21 cases, 3.1%),
– welders' pneumoconioses, talcoses and other types of pneumoconioses (2 cases each, 0.3% each),
– pneumoconiosis caused by metal dusts and silicotubercolosis (1 case each, 0.15% each),
– unspecified pneumoconioses (6 cases, 0.9%).

Between 2000 and 2019 the total of 2066 confirmed cases of silicoses were reported. In this period silicoses accounted for 12.8% in 2007 to 21.2% in 2017 of all pneumoconioses cases and 16.2% in total. There was a decreasing trend in number of pneumoconioses and silicoses. In the period 2000–2019, each year on average, there were almost 19 cases of pneumoconioses and 3 cases of silicoses less (Figure 2).

Table 1. Occupational diseases in total and pneumoconioses in Poland, 2000–2019

Year	Occupational diseases	
	total [n]	pneumoconioses [n (%)]
2000	7339	748 (10.2)
2001	6007	820 (13.7)
2002	4915	692 (14.1)
2003	4365	809 (18.5)
2004	3790	754 (19.9)
2005	3249	672 (20.7)
2006	3129	667 (21.3)
2007	3285	701 (21.3)
2008	3546	697 (19.7)
2009	3146	634 (20.2)
2010	2933	790 (26.9)
2011	2562	705 (27.5)
2012	2402	570 (23.7)
2013	2214	577 (26.1)
2014	2351	610 (25.9)
2015	2094	422 (20.2)
2016	2119	603 (28.5)
2017	1942	415 (21.4)
2018	2022	392 (19.4)
2019	2065	453 (21.9)
2000–2019	65 475	12 731 (19.4)

Silicoses as well as other types of pneumoconioses are a group of occupational diseases most frequently diagnosed in males. In the examined period of time >95% of silicoses (1977 cases) occurred in males. Only 89 out of 2066 cases were confirmed in females (Figure 3).

Silicoses usually occur a long time after the beginning of the occupational exposure. On the basis of reported data, for 1440 out of 2066 silicosis cases (69.7%) it was possible to calculate the latency period understood as a period between the beginning of occupational exposure to respirable crystalline silica and the date of diagnosing the occupation-

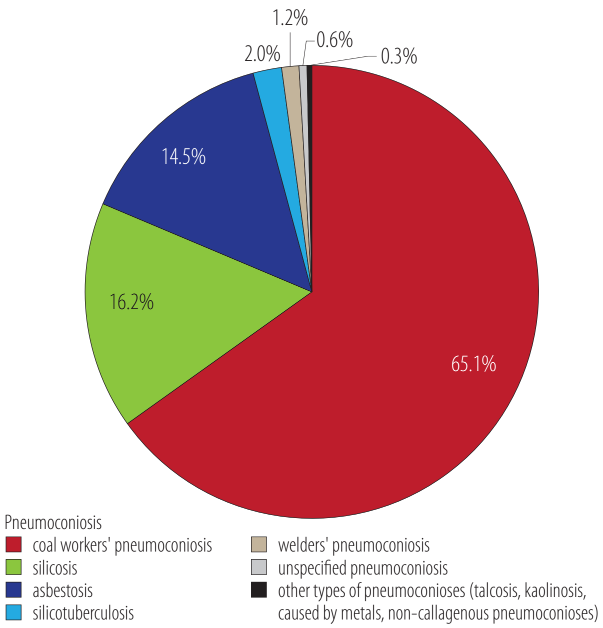

Figure 1. Distribution (structure) of pneumoconiosis cases in Poland by types, 2000–2019

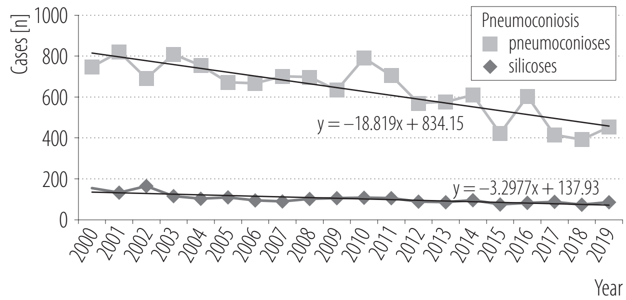

Figure 2. Pneumoconioses and silicoses cases reported in Poland, 2000–2019

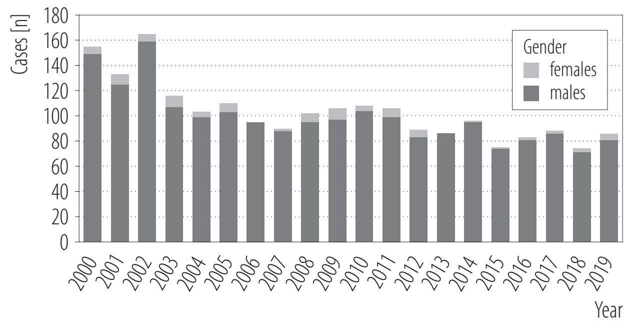

Figure 3. Silicoses cases in Poland by gender, 2000–2019

al disease (Figure 4). The number of confirmed silicoses cases was growing along with the length of latency period. For the period of ≥40 years the number was the highest and accounted for 513 cases (29 females, 484 males).

Silicoses due to workplace exposure evolve after a long-term professional activity related to inhalation of dusts. In the analysed period over 70% of silicoses cases occurred after occupational exposure >20 years. There was an increasing trend in number of silicoses in both male and female group, with the highest number of cases in the individuals who were occupationally exposed to crystalline silica for at least 20 years: 58 women (65.2%) and 1403 men (71.0%). There were also individuals who developed silicosis after a very short time of workplace exposure to crystalline silica. Two cases occurred after occupational exposure <1 year (0,1%) and 30 cases after exposure <5 years (1.4%) (Figure 5). In females there were only 2 cases that evolved after occupational exposure <5 years and there were no silicoses cases that evolved after exposure <1 year.

Silicoses were predominantly found in individuals >40 years. In the examined period of time there were also silicoses stated in younger individuals. Between 2000 and 2019, there were only 7 cases of silicoses confirmed in young adults, <30 years, all of them males. The number of cases has gradually risen from the 92 cases (4.5%) in the age group 30–39, 437 cases (21.1%) in the age group 40–49 years, and 745 cases (36.1%) in the age group 50–59 years. Subsequently, the number of cases has declined to 467 cases (22.6%) in the age group 60–69 years and 318 cases (15.4%) in the group of age >69 years. In Poland, the retirement age for men is 65 years and for women 60 years. Two last age ranges cover individuals >60 years thus it is possible to point out that >40% of females in this study had silicosis in their working age but no such data are available for males.

Between 2000 and 2019 nearly 70% of all silicoses cases were confirmed in 4 out of 16 Polish provinces:

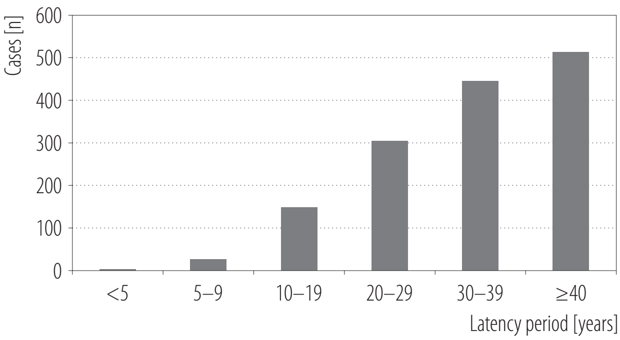

Figure 4. Silicoses cases in Poland by latency period between the beginning of occupational exposure to silica and the date of occupational disease, 2000–2019

Lower Silesia, Silesia, Świętokrzyskie and Wielkopolska. In the examined period of time only 4 cases of silicoses were confirmed in Podlasie and 3 cases were related to employment in plants outside of Poland (Figure 6).

Predominance of silicoses in the provinces indicated above stays in relationship with prevalence of occupational industrial sectors in these regions of the country. The majority of silicosis cases, both in men and women, occurred in the individuals employed in manufacturing.

Most men who evolved silicosis were employed in:
- the manufacturing industry (1392 cases, 70.4%),
- mining and quarrying (369 cases, 18.7%),
- construction (146 cases, 7.4%).

The dominant branches of manufacturing were:
- casting of iron (434 cases, 21.6% of manufacturing industry),
- manufacture of basic iron and steel ferroalloys (135 cases, 9.7%),
- cutting, shaping and finishing of stone (85 cases, 6.1%),
- casting of steel (82 cases, 5.9%).

In the mining and quarrying dominated such branches as:
- mining of non-ferrous metal ores (122 cases, 33.1% of mining industry),
- extraction of coal (93 cases, 25.2%),
- quarrying of ornamental and building stone, limestone, gypsum, chalk and slate (86 cases, 23.3%).

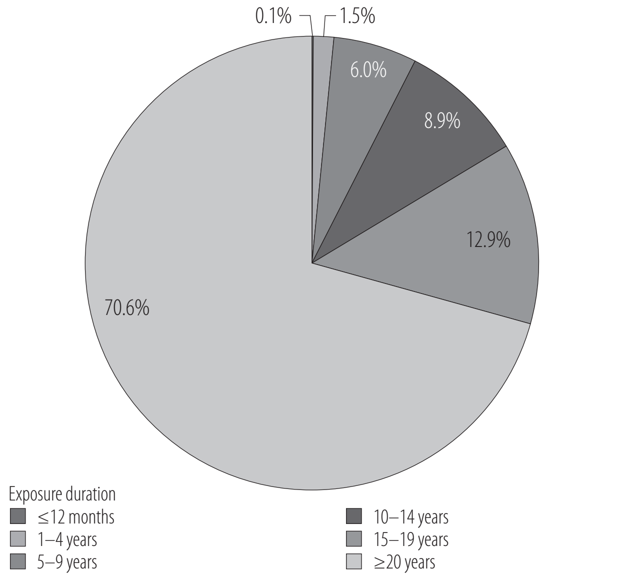

Figure 5. Structure of silicoses cases by duration of exposure to silica dust, 2000–2019

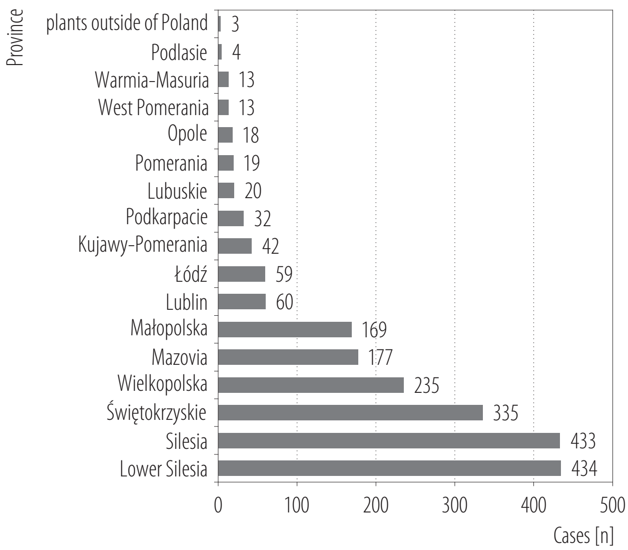

Figure 6. Silicoses in Poland by province, 2000–2019

In the female group near 90% of silicosis cases referred to manufacturing industry (80 cases, 89/9%) with predominance of casting of iron (19 cases, 23.7% of manufacturing industry), manufacture of motor vehicles (8 cases, 10.0%) and with equal number of cases: refractory goods manufacture, ceramic flags manufacture and manufacture of ceramic sanitary products (6 cases each, 7.5% each).

DISCUSSION

This is the one of the first papers providing a summary of silicoses incidence in Poland in years 2000–2019. The occurrence of silicosis is an important global concern. Despite feasible measures to prevent it, the disease is still widely spread in most parts of the world. In 1995, the World Health Organization (WHO) and the International Labour Organization (ILO) have initiated a campaign to eliminate silicosis from the world by 2030 [8]. Worldwide, the reported prevalence of silicosis in employees exposed to silica dust ranges from 14% to 96% depending on occupational activities [9]. According to some estimations about 5.3 million workers were exposed to crystalline silica in Europe in 2006 and >4 million of them were employed in construction industry [10]. In European countries like Belgium, Bulgaria, Hungary, Poland or Romania, pneumoconioses due to dust containing silica belong to the most often recognized occupational diseases [11]. In the United States there are about 2.3 million employees exposed to silica and although during 1999–2018 the number of silicosis deaths has decreased by 53%, new cases of the disease are still diagnosed [12,13]. In China, >23 million workers were employed in exposure to crystalline silica [14]. In 2013 >87% of all reported occupational diseases in China were pneumoconioses, of whom silicoses accounted for about 35% [15]. In India, the number of workers exposed to silica accounts for about 11.5 million and silicosis remains an important cause of respiratory deaths in this country [16]. In 2007 about 3.2 million workers were potentially exposed to silica dust in Brazil. Silicosis is one of the most prevalent pneumoconioses in Brazil and belongs to the diseases whose notification is compulsory in this country [9]. In South Africa silicosis is a serious occupational health problem in gold mining industry, in the first quarter of 2020 there were more than 0.4 million workers employed formally in mining [17,18].

During 2000–2019 the total of 2066 silicosis cases were confirmed in Poland. Most of them occurred in individuals older than 50 (74% of all cases) after an exposure duration >20 years (70.7% of cases). Since silicoses occur long time after the beginning of occupational exposure to silica dust, the total of cases reflects some aspects of employment and work conditions in the past as well as temporal modifications of employment level due to economic changes, average exposure and exceed of the permissible exposure limits, quality improvement of personal protection equipment or collective protection measures.

There were also 32 cases (1.5%) reported almost every year in 2000–2019 (≤4 cases annually) which occurred after shorter exposure to crystalline silica <5 years. We are aware that the length of the registered exposure time could be underestimated if the card form was misinterpreted and the employment period only from the last workplace was reported. However, 7 individuals (0.3%) developed silicosis in age <30 years and in these cases the exposure period could not be >15 years. Lately, more and more silicoses occurring after shorter exposure period to crystalline silica have been described by foreign authors.

Cumulative dose of crystalline silica is considered as the most important risk factor in developing silica related pneumoconioses. In a cohort study Vacek et al. [19] proved that individuals with longer occupational exposure to lower concentrations of crystalline silica were at higher risk for silicosis than workers with shorter exposure time in the same cumulative dose at higher concentration of crystalline silica. It is believed that deposition of 1–3 g of crystalline silica is sufficient to induce the development of chronic silicosis [20].

There was a decreasing trend in the number of silicoses in the analysed period of time. It is important to emphasise that diagnostic criteria of silicosis have not changed in Poland since 2000. Clinical and work history as well as radiographic findings in chest X-ray analyzed according to ILO Guidelines are still the basis for the disease diagnosis in our country. The development in occupational and pulmonary medicine enables to consider silicosis in differential diagnosis of such respiratory conditions as sarcoidosis or other thoracic lymphadenopathies and therefore new cases of silicosis could be found by medical practitioners [21]. Also, due to Polish labour regulations, every employer undergoes periodically a medical check-up in accordance with his work station. In individuals exposed to silica dust a chest X-ray is also performed what enables to find cases of asymptomatic silicoses and prevent further exposure to fibrous dusts [22]. The total number of employees exposed to industrial dusts in enterprises employing ≥10 persons has been declining over last years from >74 000 in 2006 to >50 000 in 2019. The exposure to fibrous dusts has also decreased, respectively from ca. 52 000 in 2006 to >34 000 in 2019 [6,23].

We are aware that despite the issues mentioned above, the number of diagnosed cases of silicoses in Poland might still be underestimated. In 21st century the Polish model of occupational medical care of working population has changed. Previously, a complex health care unit used to exist as a part of every company and a surveillance over harmful exposures was maintained on a higher level. Nowadays, employees undergo the medical check-ups in clinics outside their workplaces and the occupational medical professionals are not always well informed about all the harmful exposures at work station. For this reason early signs of silicosis can be missed. In these cases the disease can be diagnosed outside occupational health care what particularly refers to small and medium enterprises. Silicosis is a rather rare medical condition in general population and the diagnosis can be missed if there is no sufficient experience in diagnosing the disease in pulmonary and radiology departments or the silicosis is complicated by tuberculosis or cancer. Also, the work history might be quiet often ignored in the medical interview although it is crucial for the silicosis diagnosis if the current knowledge of harmful effects of industries and production processes using silica containing dust is considered [2,21].

Between 2000 and 2019 most of silicosis cases in Poland were stated in men. The risk of silicosis is associated with the industries less often chosen by women to work in. The majority of both female and male cases occurred in casting of iron, belonging to manufacturing section of industry, but the number of female cases was >20 times smaller than the number of males cases (19 vs. 434). According to Statistics Poland in 2019 a total of 263 161 workers were employed in section of manufacturing in enterprises employing ≥10 persons, out of which women accounted for 55 246 (20.1%) [6]. It is also worth to mention that in 1951–2002 a list of works prohibited to women used to apply in Poland. It included among others several branches of industry with high incidence of silicosis such as mining and metallurgy.

Nearly 70% of all silicoses cases were confirmed in 4 out of 16 Polish provinces: Lower Silesia, Silesia, Świętokrzyskie and Wielkopolska. Silesia, Wielkopolska and Lower Silesia belong to 5 voivodeships with the highest ranking positions by population in Poland. Silesia is a region with the highest number of employers working in exposure to fibrous dusts. In Silesia there is the highest concentration of establishments belonging to section of mining and quarrying. It is also the voivodship with the second highest number of manufacturing enterprises in Poland [6,24].

Our study is based on the information reported obligatorily according to a defined scheme to the only official Polish central electronic data base. Using the data from the Central Register of Occupational Diseases has some limitations resulting from the scheme of the Statement card of the occupational disease. The card does not include such data as severity of the disease, average exposure concentration, silica content in the dust, time point of the first respiratory symptoms or smoking habits. Therefore we have no information on workplace environment measurements, stage of the disease defined by the ILO international classification of pneumoconioses or respiratory impairment [25]. Also, we are not able to compare some important details of the courses of silicoses that occurred after a long and short occupational exposure or in workers from different age intervals and having various employment history. However, the exposure duration, exceed level of permissible exposure limits as well as crystalline silica content in the inhaled dusts play the crucial role in the disease development as mentioned above.

Every case of diagnosed and subsequently confirmed silicosis in Poland in 2000–2019 is covered by this study. The Central Register of Occupational Diseases collects data related to the cases that evolved due to occupational exposure and therefore the study does not include silicoses that might have occurred in non – occupational conditions [4]. To our knowledge no such medical conditions were diagnosed in Poland. Some rare cases of silicoses due to non-industrial dusts have been described in individuals from region of Himalayas and South Korea [26,27].

CONCLUSIONS

In Poland, pneumoconioses, including silicoses, are one of the most prevalent occupational diseases, with regional variabilities. Although the number of confirmed cases decreased in 2000–2019, silicoses still remain an important health problem. Since the effective treatment and withdrawal of adverse health effects of silicoses and other pneumoconioses are still unknown, prevention is crucial to reduce further disease incidence.

It is absolutely vital to monitor workplace environments and observe the permissive exposure limits of crystalline silica concentration, in large, medium and small enterprises. Efforts should be made to educate employers about harmful health effects of traditional and newly introduced technological processes and to provide support that will guarantee safer working conditions. General practitioners, respiratory physicians, radiologists as well as occupational medicine specialists should be educated both in harmful effects of already-used and newly introduced technologies, as well as the first alarming symptoms of pneumoconioses to help in early stage diagnosis of the disease and preventing further occupational exposure.

The medical monitoring standards of exposed workers should be improved. Chest X-ray examination is considered to be the principal diagnostic tool in identifying patients with pneumoconioses. We suggest that the frequency of this examination as part of the obligatory employee check-up should depend on the crystalline silica content in the inhaled dust. Developing new diagnosing guidelines with the use of other imaging examinations, like high-resolution computed tomography, should be considered.

Recent reports emphasizing the aggressiveness of silicoses related to the artificial stone dust should be of alarming nature for the medical professionals, occupational health care providers and employers, and should lead to the improvement of workplace environment monitoring as well as preventive and protective measures in this industry.

We believe this study will provide a better understanding of the silicoses occurrence in Poland and will help achieve a global insight into the issue. We hope it will contribute considerably into the implementation of silicosis preventative programmes, both at the enterprise and national level. The analysis can also be an initial response to the joint ILO/WHO Global Programme for the Elimination of Silicosis (GPES) and the encouragement for the Polish health and labour authorities to establish a national strategy in this field.

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