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SPATIAL AND TEMPORAL VARIABILITY OF IDIOPATHIC PULMONARY FIBROSIS CASES IN SILESIAN VOIVODESHIP IN YEARS 2006–2010

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Abstract

Objectives: Idiopathic pulmonary fibrosis (IPF) (J84.1 by the International Statistical Classification of Diseases and Related Health Problems, 10th revision – ICD-10) is a rare disease of unknown cause. Among many risk factors, occupational exposure to metal dust is enumerated. Because of metal industry concentration in the Silesian Voivodeship, Poland, an attempt of spatial and temporal variability of the idiopathic pulmonary fibrosis occurrence evaluation in 2006–2010 is made. **Material and Methods:** The research is a descriptive analysis. Data of the number of new treated cases and first-time hospitalization due to idiopathic pulmonary fibrosis in the years 2006–2010 was obtained from the National Health Found (Narodowy Fundusz Zdrowia – NFZ). We also assessed spatial and temporal variability of both rates. Data concerned adults aged ≥ 19 years old inhabited the Silesian Voivodeship. **Results:** The standardized incidence rate due to idiopathic pulmonary fibrosis increased in the study period and was in the range of 2.9–3.8/100 000 population. The highest values of incidence were observed in districts localized in the centre of the Silesian Voivodeship. **Conclusions:** Incidence of idiopathic pulmonary fibrosis is not so high in the Silesian Voivodeship but the number of newly treated cases slightly increased in 2006–2010. Spatial and temporal variability of incidence rates for treated registered cases of idiopathic pulmonary fibrosis in the Silesian Voivodeship was observed. It could be an effect of occupational exposure to metal dust, however, final conclusions need more precise studies to the extent of analytical epidemiology. Int J Occup Med Environ Health 2017;30(4):593–601

Key words:
Occupational exposure, Idiopathic pulmonary fibrosis, Maps, Incidence rate, Descriptive epidemiology, Hospitalization rate

INTRODUCTION

Idiopathic pulmonary fibrosis (IPF) (J84.1 by the International Statistical Classification of Diseases and Related Health Problems, 10th revision – ICD.10) is a chronic disease of interstitial characterized by destruction of lung tissue related to interstitial fibrosis [1–4]. It is manifested by chronic dry cough, dyspnoea, shortness and breath acceleration, weakness, weight loss and occurrence of characteristic clubbing fingers (disfigurement of the fingers) caused by phalanges hypoxia [3,4]. Symptoms of idiopathic pulmonary fibrosis are implied by changes occurring in the lung because of alveoli and bronchioles chronic

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inflammation, and formation of fibroblast foci causing fibrosis in the lung parenchyma, and it finally leads to deterioration of pulmonary ventilation [1,2]. Etiology of idiopathic pulmonary fibrosis is unknown as for now, but the following factors contributing pulmonary fibrosis are enumerated: some drugs and chemotherapeutic agents [5–7], X-ray therapy, exposure to tobacco smoke [8–10], occupational exposure to organic dust (e.g., textile fiber, wood dust) or inorganic dusts (e.g., mineral or metallic) [10–13], viral or bacterial lung infections, the occurrence of gastro-oesophageal reflux [9,10], age and genetic predisposition [1,9,10,12,14,15].

According to the report of the European Lung White Book, real incidence of idiopathic pulmonary fibrosis remains unknown [16]. The increase of new cases of idiopathic pulmonary fibrosis was observed in Great Britain in 2000–2008, in general population the crude incidence rate was between 5.77/100 000 and 8.04/100 000 [17]. The results of the research conducted in the years 1996–2000 in the USA showed that the value of standardized incidence rate of disease was between 6.8 and 16.3/100 000, and standardized prevalence rate was between 14 and 42.7/100 000 [18]. Current data in Poland suggests that the incidence is smaller, i.e., 5/100 000 [19]. The incidence rate of idiopathic pulmonary fibrosis estimated in population aged ≥ 14 years old inhabited Radom City was equal to 5/100 000, and the prevalence rate amounted to 50/100 000 [20]. At the same time, in the years 2000–2009, the significant increase (i.e., 33%) in the number of hospitalizations due to idiopathic pulmonary fibrosis was observed. The disease usually affects elderly people at the age of 50–70 years old, more frequently men than women [1,2,4,7,9,20].

Because of the lack of epidemiological data on registered incidence and frequency of first-time hospitalizations because of IPF in the Silesian Voivodeship (southern part of Poland), as well as reports suggesting an increased incidence of idiopathic pulmonary fibrosis in other countries, it is reasonable to recognize the current situation in the studied region. It is also important to reveal the spatial and temporal variability of the epidemiological situation in various districts of the Silesian Voivodeship.

MATERIAL AND METHODS

The presented research is an epidemiological descriptive study with elements of ecological research and concerns adult inhabitants of the Silesian Voivodeship (southern part of Poland) at the age of ≥ 19 years old with diagnosed idiopathic pulmonary fibrosis (J84.1 by ICD-10, broad and narrow case definitions).

The number of newly treated cases and first-time hospitalizations due to idiopathic pulmonary fibrosis in the Silesian Voivodeship in the years 2006–2010 was obtained from the National Health Fund in Katowice. The database contains anonymous data such as: date of birth, patient gender, inhabitancy in districts, main recognition, first diagnosis date, first hospitalization date, the number of subsequent medical advice and subsequent hospitalizations, year of death. Patients out of the Silesian Voivodeship are excluded from the research.

Evaluation of the demographic structure of patients with idiopathic pulmonary fibrosis was established by determining the number and proportion of people treated in the reported years, i.e., 2006–2010. The particular values are presented in the following age groups: 19–34, 35–54, 55–64, ≥ 65 years old. Moreover, patients are described separately in 5-year aged groups. The epidemiological situation of idiopathic pulmonary fibrosis has been described for the total population of the Silesian Voivodeship, and in addition to separate district – local administrative units according to NTS-4 (Nomenclature of Territorial Units for Statistics). Crude incidence rate and first-time hospitalizations rate per 100 000 population aged ≥ 19 years old has been evaluated for newly treated (medical visits and hospitalizations) and hospitalized cases and standardized based on the World Standard Population.

Averaged values of rates: incidence and first-time hospitalizations have been presented on maps of the Silesian Voivodeship. It allows to reveal spatial variability of epidemiological situation of idiopathic pulmonary fibrosis. The maps have been generated with geographical information system ArcGIS 9.2.

Statistics

Data was elaborated using the statistical package R 2.11.1 (GNU GPL license). Methods of descriptive statistics have been applied to analyze changes of both rate (incidence and first-time hospitalizations) in the time. We also assessed the impact of gender and age of patients to the value of both rates. Moreover, we tried to explain observed variability in incidence rates according to available indicators of socio-economic and environmental determinants collected in the Central Statistical Office database [21] by Spearman correlation coefficients and their statistical significance. The assessment of their compatibility with the normal distribution has been made by Shapiro-Wilk test. Interpretation of statistical significance has been based on $\alpha = 0.05$ criterion.

RESULTS

Results of the analysis summarized in the Table 1 show that the number of newly treated cases of idiopathic pulmonary fibrosis among adults aged ≥ 19 years old in the Silesian Voivodeship slowly increases in the study period. Moreover, it is worth noting that the number of first-time hospitalizations in the total number of treated cases is very high ca. 85.5–99.1%. The highest number of deaths among people with recognized idiopathic pulmonary fibrosis was observed in 2007.

The mean value of age at the moment of the first diagnosis is 58.7–62.5 years old, and the age of patients at the moment of death is 68.6±13.1 years old. It is worth noting that the highest number of patients applies to elderly people aged ≥ 65 years old, and the lowest – refers to younger people ≤ 34 years old (Table 2).

The Figure 1 presents demography of patients with recognized idiopathic pulmonary fibrosis in the years 2006–2010. In this period we have noted that the disease affects mostly men in all age groups and the highest percentage of patients is related to the oldest group of people aged ≥ 70 years old, and the group of people between 50–59 years old.

The list of most frequently registered comorbidities among patients with idiopathic pulmonary fibrosis shows the Table 3. As we may have observed there are other respiratory diseases such as chronic obstructive pulmonary disease (COPD), respiratory failure,

Table 1. Idiopathic pulmonary fibrosis (ICD-10: code J84.1) among the adults ≥ 19 years old, Silesian Voivodeship, Poland, 2006–2010

Variable	Idiopathic pulmonary fibrosis in consecutive years					
	2006	2007	2008	2009	2010	total
Newly treated cases (total) [n]	171	220	214	242	227	1074
First-time medical visits [n (%)]	3 (1.8)	2 (0.9)	6 (2.8)	20 (8.3)	33 (14.5)	64 (6.0)
First-time hospitalization [n (%)]	168 (98.2)	218 (99.1)	208 (97.2)	222 (91.7)	194 (85.5)	1010 (94.0)
Next medical outpatient visits [n]	8	16	17	35	46	122
Next hospitalizations [n]	294	353	300	310	231	1488
Deaths [n (%)]	67 (39.2)	83 (37.7)	68 (31.8)	73 (30.2)	65 (28.6)	356 (33.1)
Age at death [years] (M±SD)	66.3±11.7	66.6±10.7	69.3±10.3	69.2±10.9	68.5±13.1	68.6±13.1

ICD-10 – International Statistical Classification of Diseases and Related Health Problems, 10th revision.
M – mean; SD – standard deviation.

Table 2. Idiopathic pulmonary fibrosis (ICD-10: code J84.1) among the adults aged ≥ 19 years old by age at diagnosis, Silesian Voivodeship, Poland, 2006–2010

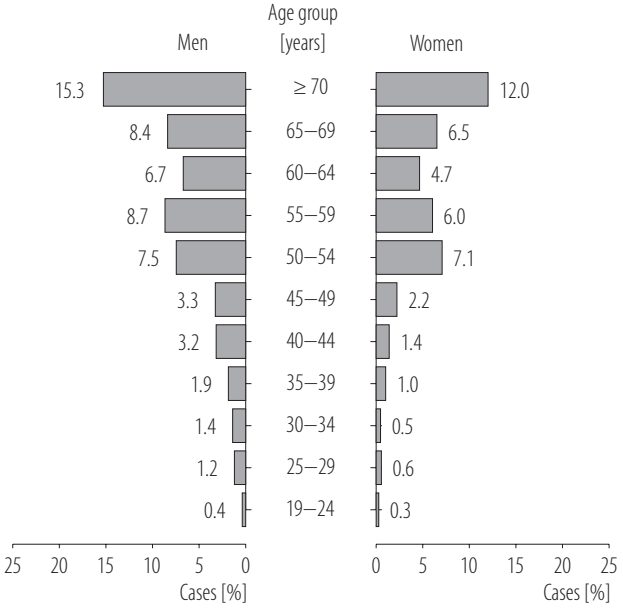
Year	Idiopathic pulmonary fibrosis in age groups (cases)					Age of patients [years] (M±SD)
	total [n]	19–34 years [n (%)]	35–54 years [n (%)]	55–64 years [n (%)]	≥ 65 years [n (%)]	
2006	171	9 (5.3)	48 (28.1)	52 (30.4)	62 (36.3)	58.9±13.5
2007	220	14 (6.4)	66 (30.0)	56 (25.5)	84 (38.2)	58.7±14.2
2008	214	5 (2.3)	55 (25.7)	54 (25.2)	100 (46.7)	61.8±12.5
2009	242	5 (2.0)	64 (26.4)	67 (27.7)	106 (43.8)	62.5±12.5
2010	227	13 (5.7)	62 (27.3)	51 (22.5)	101 (44.5)	60.8±14.4

Abbreviations as in Table 1.

Table 3. Registered coexisting diseases in the case of patients with idiopathic pulmonary fibrosis (ICD-10: code J84.1) among adults aged ≥ 19 years old, Silesian Voivodeship, Poland, 2006–2010

Comorbidities of idiopathic pulmonary fibrosis	Cases in age groups [n (%)]		
	total (N = 1 332)	19–64 years (N = 774)	≥ 65 years (N = 558)
Respiratory diseases			
total	317 (23.8)	128 (16.5)	189 (33.9)
J40–J44 (chronic obstructive pulmonary disease – COPD)	119 (8.9)	49 (6.3)	70 (12.5)
J96 (respiratory failure)	100 (7.5)	37 (4.8)	63 (11.3)
J18 (pneumonia)	36 (2.7)	8 (1.0)	28 (5.0)
J47 (bronchiectasis)	22 (1.7)	10 (1.3)	12 (2.2)
J60–J67 (pneumoconiosis)	10 (0.8)	7 (0.9)	3 (0.5)
Cardiovascular diseases			
total	332 (24.9)	112 (14.5)	220 (39.4)
I10–I11 (hypertension)	141 (10.6)	60 (7.8)	81 (14.5)
I25–I27 (heart disease)	85 (6.4)	29 (3.7)	56 (10.0)
I50 (heart failure)	38 (2.9)	6 (0.8)	32 (5.7)
Other diseases			
total	224 (16.8)	110 (14.2)	114 (20.4)
E07–E14 (diabetes)	47 (3.5)	17 (2.2)	30 (5.4)
M05.3–M06.9 (rheumatoid arthritis)	13 (1.0)	6 (0.8)	7 (1.3)
R04 (hemoptysis)	9 (0.7)	4 (0.5)	5 (0.9)
Total	873 (65.5)	350 (45.2)	523 (93.7)

ICD-10 – as in Table 1.



ICD-10 – as in Table 1.

Fig. 1. Adults aged ≥ 19 years old with newly diagnosed idiopathic pulmonary fibrosis (ICD-10: code J84.1) by gender and age groups, Silesian Voivodeship, Poland, 2006–2010

pneumonia and cardiovascular diseases (hypertension, heart disease and heart failure). Moreover, in the case of older patients (≥ 65 years), the number of registered comorbidities is 2 times higher than in the case of younger people.

According to the assumed methodology, crude incidence rates were evaluated for the whole Silesian Voivodeship, and then the incidence was standardized. Detailed data is presented in the Table 4. In particular years, crude incidence rates of idiopathic pulmonary fibrosis were different and ranged 4.6–6.4/100 000 adults aged ≥ 19 years old. Values of the standardized rates were slightly lower and ranged 2.9–3.8/100 000. A disproportion was also observed between males and females population, larger values of standardized rates were observed in men 3.5–4.6/100 000.

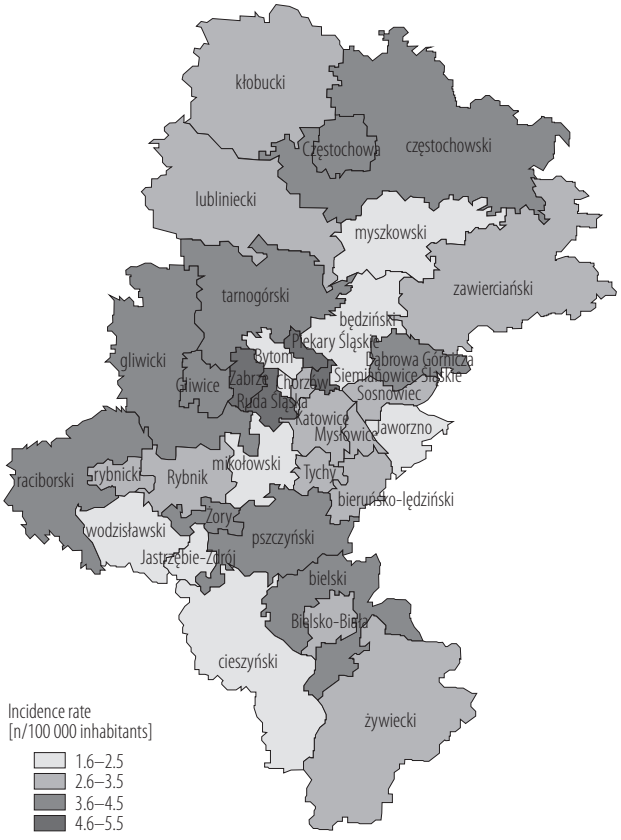
The Figure 2 illustrates spatial variability of the average value of the standardized incidence rate in the Silesian Voivodeship (the value was averaged for the period 2006–2010). The highest values of idiopathic pulmonary fibrosis incidence were noted in cities: Siemianowice Śląskie, Piekary Śląskie, Ruda Śląska and Zabrze. The lowest values were observed in the districts of: wodzisławski, Jastrzębie-Zdrój and Świętochłowice.

The Table 5 presents obtained results of Spearman correlation test in relationship between incidence of idiopathic pulmonary fibrosis and available socio-economic indicators. There were no significant associations between compared variables.

Table 4. Crude and standardized incidence rates and first-time hospitalization due to idiopathic pulmonary fibrosis (ICD-10: code J84.1) among the adults aged ≥ 19 years old, the Silesian Voivodeship, Poland, 2006–2010

Year	Incidence [n/100 000 inhabitants]				First-time hospitalization [n/100 000 inhabitants]			
	crude rate (total)	standardized rate			crude rate (total)	standardized rate		
		total	women	men		total	women	men
2006	4.6	2.9	1.7	4.2	4.5	2.9	1.7	4.2
2007	5.9	3.6	2.7	4.6	5.8	3.6	2.6	4.6
2008	5.7	3.4	3.2	3.5	5.5	3.3	3.1	3.4
2009	6.4	3.8	3.1	4.5	5.9	3.5	2.9	4.2
2010	6.0	3.8	3.2	4.6	5.1	3.3	2.6	4.0

ICD-10 – as in Table 1.



ICD-10 – as in Table 1.

Fig. 2. Standardized incidence of idiopathic pulmonary fibrosis (ICD-10: code J84.1) in population aged ≥ 19 years old, Silesian Voivodeship, averaged for 2006–2010

DISCUSSION

Results of the analysis of registered data on incidence and hospitalization due to idiopathic pulmonary fibrosis in the Silesian Voivodeship suggest that about 171–242 treated cases of disease in adults aged ≥ 19 years old inhabiting the region were recognized on the annual basis. It was confirmed that the highest number of patients with diagnosis was registered for people ≥ 65 years old in the whole study period. The percentage of this age group in the total number of diagnosed patients with idiopathic pulmonary fibrosis was stable in the years 2006–2010 and amounted to about 45%. The average age of patients at the moment of diagnosis was 60.7±13.5 years old.

Table 5. Correlation of the idiopathic pulmonary fibrosis (ICD-10: code J84.1) standardized incidence rate with selected socio-economic and environmental determinants of health, Silesian Voivodeship, Poland, 2006–2010

Factor	R	p
Socio-economic		
unemployment rate	–0.14	0.41
industrialization rate	0.09	0.61
average salary	0.08	0.63
Environmental		
No. of hospital beds per 10 000 inhabitants	–0.07	0.66
No. of physicians	0.06	0.73
dust emission	–0.04	0.98
gas emission	–0.04	0.83
forest area	–0.23	0.18
arable land area	–0.08	0.64
breeding cattle	–0.09	0.58
pig farming	–0.06	0.70
poultry farming	–0.14	0.39

ICD-10 – as in Table 1.
R – correlation coefficient.

Our observations are consistent with the results of other authors [1,2,7]. It is well known that physiological changes in lungs related to the lung parenchyma loss of elasticity are significant in the case of elderly people [22–24]. The age is also a significant factor stimulating other diseases. Among major comorbidities in the case of patients with idiopathic pulmonary fibrosis there are other respiratory diseases such as: chronic obstructive pulmonary disease, respiratory failure, pneumonia, bronchiectasis and also cardiovascular diseases (hypertension and coronary heart disease). Moreover, the number of comorbidities is 2 times higher for the elderly (≥ 65 years old) than younger patients. It is worth noticing that in the group of patients there are more frequently males (except 2008) – the percentage is in the range of 56.1–67.4%. These results are consistent with the results of the research

in the region of Radom (central Poland) in 2000–2009, where in a group of patients with idiopathic pulmonary fibrosis, males are 1.2 times more frequently reported than women [20].

The standardized incidence rate of idiopathic pulmonary fibrosis shows an increasing trend in the whole study period from the value 2.9/100 000 in 2006 to 3.8/100 000 in 2010. Obtained results are similar to those observed in other countries: 0.93/100 000 in Greece [25], 0.74–1.28/100 000 in the Czech Republic, 4.3/100 000 in Norway, 4.6–7.4/100 000 in Great Britain, and 6.8–17.4/100 000 in the USA [12]. It is worth adding that the standardized incidence rate of disease is much higher for males (3.5–4.6/100 000) than for females (1.7–3.2/100 000) in the Silesian Voivodeship. Similar observation applies to the USA population in which the standardized incidence rate for men is 10.7/100 000 and for women – 7.4/100 000, respectively [26].

The values of the standardized first-time hospitalization rate in the Silesian Voivodeship were in the range of 2.9–3.6/100 000 and very close to the values of the standardized incidence rate. It should be noted that the increase in the hospitalization rate is not necessarily associated with an increase in incidence rate but may be possibly associated with implementations of new diagnostic methods requiring hospitalization or heavier course of disease. The percentage of death for patients with recognized idiopathic pulmonary fibrosis has been about 28.6–39.2%. Unfortunately, the lack of information on the cause of death in the examined database makes it impossible to evaluate specific mortality.

The observed increase in patients' number could be explained by improvements of diagnostic process [19], and revealed spatial diversity of incidence may result from irregular location of reference centers in which final diagnosis is agreed between a clinician, radiologist and pathologist. Similar explanation is probably possible in the case of the first-time hospitalization rate of idiopathic pulmonary fibrosis, averaged for the years 2006–2010 in the Silesian Voivodeship.

The highest values of the standardized incidence rate were observed in the following cities: Siemianowice Śląskie, Piekary Śląskie, Ruda Śląska and Zabrze. The analysis of correlation coefficients did not confirm any significant relations between idiopathic pulmonary fibrosis and available socio-economics or environmental indicators. However, it is worth noticing that some published data suggests possible relationship between disease and occupational exposure to metallic dust [11–13].

Results of the American study reveal that the risk of death due to idiopathic pulmonary fibrosis is the highest for metal miners (odd ratio (OR) = 2.34, 95% confidence interval (CI): 1.3–4.0) and metallurgical industry workers (OR = 1.9, 95% CI: 1.1–3.1) [27]. Moreover, scientists in Japan have obtained a significant relationship between exposure to metal dust and idiopathic pulmonary fibrosis (OR = 9.55, 95% CI: 1.68–181.12) [28]. This information may indirectly suggest that the highest incidence rate observed in the central part of the study region may be related to an iron and steel industry. Current data suggests that almost 1/4 (22.8%) of the total number of metallurgical industry companies in Poland is located in the Upper Silesian Industrial Region [29], which is the region with the worse epidemiological situation.

On the other hand some published data has revealed an occupational exposure to organic dust related to farming, textile industry or livestock farming as a significant hazard. Results of earlier data (1989–1993) suggest that the risk of idiopathic pulmonary fibrosis is the highest for farmers (OR = 1.6, 95% CI: 1.0–2.5), livestock farmers (OR = 2.7, 95% CI: 1.3–5.5), hairdressers (OR = 4.4, 95% CI: 1.2–16.3), metal workers (OR = 2.0, 95% CI: 1.0–4.0), bird farmers (OR = 4.7, 95% CI: 1.6–14.1) and stone workers (OR = 3.9, 95% CI: 1.2–12.7) [11].

However, the newest Egyptian data has confirmed that the main risk of idiopathic pulmonary fibrosis for males is related to wood industry (OR = 2.56, 95% CI: 1.02–7.01)

and chemical or petrochemical industries (OR = 6.47, 95% CI: 1.66–25.12) [30]. In the case of female population, disease is related to farming and livestock farming (OR = 3.34, 95% CI: 1.17–10.12) or bird farming (OR = 1.82, 95% CI: 1.03–3.85). Finally, results of the meta-analysis have confirmed a significant impact of metallic dust (OR = 2.44, 95% CI: 1.74–3.40), wood dust (OR = 1.94, 95% CI: 1.34–2.81), stone dust, sand and silica (OR = 1.97, 95% CI: 1.09–3.55), farming dust (OR = 1.65, 95% CI: 1.20–2.26) and tobacco smoke (OR = 1.58, 95% CI: 1.27–1.97) on the risk of idiopathic pulmonary fibrosis [13]. Since our study is a descriptive study with elements of ecological research, it is impossible to explicitly account for this issue. Moreover, there is no detailed data in the analyzed database on types of diagnosed IPF (narrow or broad), so no distinction between broad and narrow IPF cases may be done. Therefore, applied methods in this study don't allow to compare results with quoted data.

In 2000, the American Thoracic Society (ATS), European Respiratory Society (ERS) and American College of Chest Physicians (ACCP) improved guidelines on diagnosis and treatment of idiopathic pulmonary fibrosis. Experts emphasize the possibility of spatial variability in relation to different occupational or environmental exposure. Perhaps, periodical assessments of health needs governed by the Law of July 22, 2014 [31] will help us to identify the main reason for idiopathic pulmonary fibrosis and recognize its variability in the Silesian Voivodeship.

CONCLUSIONS

Idiopathic pulmonary fibrosis is a rare disease in the Silesian Voivodeship, but the number of newly treated cases slightly increased in the years 2006–2010. Significant spatial variability of incidence was observed in the whole study period. Still we couldn't explain such observation without results of analytical studies.

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