

Ewa Rowińska-Zakrzewska¹, Maria Korzeniewska-Kosela², Kazimierz Roszkowski-Śliż³

¹Emeritus Professor, MD, PhD, National Tuberculosis and Lung Diseases Research Institute

²Department of Epidemiology and Control of Tuberculosis, National Tuberculosis and Lung Diseases Research Institute, Warsaw, Poland
Head: M. Korzeniewska-Kosela, MD, PhD, Professor of the National Tuberculosis and Lung Diseases Research Institute

³Third Department of Lung Diseases, National Tuberculosis and Lung Diseases Research Institute, Warsaw, Poland
Head: Prof. K. Roszkowski-Śliż, MD, PhD

Epidemiological situation of tuberculosis in Poland: Part II. What are the causes of the different epidemiological situation in various regions of Poland?

Sytuacja epidemiologiczna gruźlicy w Polsce: Część II. Jakie są przyczyny różnic
w zapadalności na gruźlicę w różnych regionach Polski?

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Abstract

Introduction: The different epidemiological situation of tuberculosis in various regions of Poland (higher and lower notification rates) was described previously by our group. The patients diagnosed with tuberculosis in the higher notification rate areas were younger and there were more cases of primary tuberculosis (tuberculous pleurisy and tuberculosis of chest lymph nodes) than in the patients diagnosed in the lower notification areas.

The aim of the present study was to assess the possible causes of the different epidemiological situation of tuberculosis in various regions of Poland.

Material and methods: Analysis was done at the same regions as in the previous paper. A comparison was made between two groups: Group I, which included three voivodeships with higher rates of notification, from 23.7 to 32.3/100,000 (mean rates in the analysed period of time); and Group II, which included five voivodeships with lower notification rates (mean rates from 12.2 to 18.6/100,000).

The wealth of the regions (GDP, gross domestic product per capita), the level of unemployment, and social status of the patients were analysed. We compared the population density in both regions. The results of treatment in both regions were also analysed.

Results: We did not find any differences in GDP and unemployment rates between the compared regions. The results of treatment were different in particular regions, but there was no clear tendency for worse results in voivodeships in Group I compared to voivodeships in Group II. However, the number of patients lost from observation was significantly higher in the regions from Group I than in those from Group II. There was also a significantly higher death rate from tuberculosis in younger patients (≤ 59 years) from Group I than from Group II. This is additional proof that the epidemiological situation in the two regions was different. Finally, we found that the mean density of population in the regions from Group I was higher than that from Group II. The density of population may influence transmission of tuberculosis. There is also the possibility that the differences in the epidemiological situation in various regions of Poland are caused by historical events. In the past the epidemiological situation of tuberculosis was much worse in the east of Europe than in the west. Just after the Second World War, according to the changes of the Polish territory, many Polish citizens (mainly ancestors of those from Group I) were displaced from the east to the west.

Conclusions: In conclusion, the greater number of patients lost from observation, together with the higher density of population in the regions from Group I in comparison with those from Group II, seems to be partly responsible for the difference in the epidemiological situation in the two regions. It is also possible that some patients from Group I are more susceptible to infection and disease caused by *Mycobacterium tuberculosis* due to their ancestors, who lived in the east of Europe.

Adres do korespondencji: Prof. Maria Korzeniewska-Kosela, MD, PhD, Zakład Epidemiologii i Organizacji Walki z Gruźlicą, Instytut Gruźlicy i Chorób Płuc, Płocka 26, 01-138 Warszawa, e-mail: m.korzeniewska@igichp.edu.pl

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Key words: tuberculosis, epidemiology of tuberculosis, differences in the notification of tuberculosis in various parts of Poland, indicators of wealth, social status, results of treatment, deaths from tuberculosis, patients with tuberculosis lost from observation, population density, historical changes in epidemiology of tuberculosis

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Streszczenie

Wstęp: W pierwszej części pracy przedstawiono różnice sytuacji epidemiologicznej gruźlicy w regionach Polski o wysokich i niskich wskaźnikach zapadalności. Chorzy na gruźlicę w województwach o wyższej zapadalności byli młodszy, częściej też byli w tych województwach przypadki gruźlicy pierwotnej (gruźlicze zapalenie płucnej i gruźlica węzłów chłonnych klatki piersiowej) w porównaniu z województwami o niższej zapadalności.

Celem przedstawianej, drugiej części, pracy była ocena prawdopodobnych przyczyn różnej sytuacji epidemiologicznej gruźlicy w różnych regionach Polski.

Materiał i metody: Analiza dotyczyła tych samych regionów, co w poprzedniej części pracy. Porównano 3 województwa z wyższymi wskaźnikami zapadalności (średnio w ciągu 3 lat od 23,7 do 32 na 100 000) — grupa I i 5 województw z niższymi wskaźnikami zapadalności (średnio od 12,2 do 18,6 na 100 000) — grupa II. Oceniono zamożność obu grup województw mierzoną wartością produktu krajowego brutto (PKB) przypadającą na mieszkańca, poziomem bezrobocia i statusem społecznym chorych. Porównano zagęszczenie ludności w obu regionach, oceniono wyniki leczenia.

Wyniki: Nie wykazano różnic w profilu PKB i poziomie bezrobocia w obu grupach. Wyniki leczenia różniły się w poszczególnych województwach, ale przy rozpatrywaniu wszystkich województw łącznie nie było wyraźnej tendencji do wyników gorszych w grupie I w porównaniu z grupą II. Odsetek chorych, których wyniki leczenia nie były znane, był jednak istotnie większy w województwach grupy I. Istotnie większy był także w województwach grupy I odsetek zgonów z powodu gruźlicy osób w wieku do 59 lat, co stanowi kolejny dowód, że sytuacja epidemiologiczna gruźlicy w obu regionach była rzeczywiście różna. Na koniec stwierdzono, że zagęszczenie ludności w województwach grupy I było większe niż w grupie II. Wydaje się, że zagęszczenie ludności pełni znaczącą rolę w transmisji zakażenia prątkiem gruźlicy.

Jest jednak możliwe, że na różnice w epidemiologii gruźlicy w obu porównywanych regionach mają również wpływ wydarzenia historyczne. Sytuacja epidemiologiczna gruźlicy była znacznie gorsza na wschodzie niż na zachodzie Europy. Bezpośrednio po zakończeniu II wojny światowej, zgodnie ze zmianą polskich granic, duża część populacji (obecnie zamieszkująca częściowo rejon województw grupy I) została przeniesiona ze wschodu na zachód.

Wnioski: W konkluzji można stwierdzić, że większa liczba chorych straconych z obserwacji, łącznie z większym zagęszczeniem ludności w województwach grupy I w porównaniu z województwami grupy II, mogą być przyczyną różnic sytuacji epidemiologicznej gruźlicy w obu regionach. Dodatkową rolę może odgrywać fakt, że część populacji na terenie województw grupy I pochodzi historycznie ze wschodnich regionów i stąd może być bardziej wrażliwa na zakażenie prątkiem i na zachorowanie na gruźlicę, z powodu swoich przodków, którzy żyli na wschodzie Europy.

Słowa kluczowe: gruźlica, epidemiologia gruźlicy, różnice w epidemiologii gruźlicy między województwami, wskaźniki dobrobytu, status społeczny, wyniki leczenia, zgony z powodu gruźlicy, chorzy na gruźlicę straceni z obserwacji, zagęszczenie ludności, zmienność w czasie epidemiologii gruźlicy

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Introduction

In the previous paper we showed that the epidemiological situation of tuberculosis is different in various regions of Poland [1]. The aim of the present study was to find reasons for this phenomenon. The factors that influence the incidence of tuberculosis may be connected with poverty, excessive population density, and poor living conditions [2]. The epidemiological situation of tuberculosis also depends on treatment effectiveness and appropriate isolation of infectious cases.

The aim of the study was to evaluate wealth indicators, social status, and treatment results of patients from the examined regions. The population density in the compared areas of Poland was also assessed.

Material and methods

Similarly as in the previous paper, the material of the study constituted of patients registered in the three regions in Poland with the highest TB incidence rates (voivodeships: Lubelskie, Łódzkie, and Śląskie) — Group I; and patients registered in the five regions with the lowest incidence rates in Poland (voivodeships: Wielkopolskie, Podlaskie, Opolskie, Kujawsko-Pomorskie and Małopolskie) — Group II. The figures concerning the GDP and unemployment rates in particular regions were taken from the Central Statistical Office of Poland (*GUS, Główny Urząd Statystyczny*). A social description of the patients was obtained from the National TB Register. Data concerning treatment results were obtained from the medical

centres where the patients had been treated. The data were published in bulletins [3–6]. All medical facilities, including hospitals, are called clinics for the purpose of this paper. Because the evaluation of treatment results was carried out and published one year after the patients' notification, the results concerned a slightly different group of patients than in the first part of the study [1], i.e. patients whose treatment results were available and presented in 2010, 2011, and 2012 were registered in the years 2009, 2010, and 2011. The same rule concerned deaths from TB: the ones published by the Central Statistical Office and those reported by the clinics.

Statistical significance of correlation between the variables was checked with the help of the chi-squared test. $P < 0.05$ was assumed as a significant value.

Results

No correlation was found between wealth measured by the GDP value per capita, the proportion of unemployed people, and the epidemiological situation in a given region. The highest mean GDP and the lowest mean unemployment rate was found in Śląskie, which was distinguished by one of the highest TB incidence rates. A relatively low GDP and high level of unemployment was found in Podlaskie, which was distinguished by one of the lowest incidence rates (Table 1).

A large proportion of the patients registered in the years 2010–2012 were homeless and unemployed. Paradoxically, the proportion of homeless

people was markedly higher in the regions with lower incidence of TB than in the remaining areas ($p < 0.0001$). The proportion of people with poor education and office workers was also comparable in both groups (Table 2).

The effects of treatments were different in various voivodeships irrespective of the analysed group. The worst results were observed in one voivodeship from Group I and in one from Group II. However, very good results of treatment were observed in one of the areas with the highest incidence rate, i.e. in the Lubelskie. The differences between the groups are more pronounced when comparing patients lost from observation. Although the patients lost from observation occurred in greater numbers in some voivodeships from both groups, their proportion was significantly higher in Group I, compared to Group II ($p < 0.0001$) (Table 3).

The number of deaths due to tuberculosis, registered by the Central Statistical Office, was different in different voivodeships (Table 4). However, there was a distinct tendency for a greater number of deaths in the voivodeships from Group I than from those in Group II.

Deaths due to TB in younger age groups (≤ 59 years of age), registered by the clinics, were found significantly more frequently ($p < 0.01$) in regions from Group I, compared to Group II (Table 5). In Group II, no deaths were observed in the subjects under 30 years of age, whereas in Group I there were three cases of death in this age group. The reports presented by the clinics showed a large number of deaths due to reasons other than TB (Table 3).

Table 1. Gross domestic product (current prices) per capita, in PLN (GDP), and registered unemployment rates in selected voivodeships

Voivodeship	Average GDP (2010–2012)	Average unemployment (%) in 2010–2012
Lubelskie	25,216	13.5
Łódzkie	34,364	13.0
Śląskie	40,089	10.4
Altogether voivodeships from Group I	33,223	12.3
Wielkopolskie	39,113	9.4
Opolskie	30,010	13.8
Podlaskie	27,140	14.2
Kujawsko-pomorskie	31,179	17.4
Małopolskie	31,943	10.8
Altogether voivodeships from Group II	31,877	13.1
Poland	37,324	12.8

Data derived from Statistical Yearbooks of the Republic of Poland published by the Central Statistical Office

Table 2. Social status of patients registered in selected voivodeships in 2010–2012

Voivodeships		All patients	Social status of patients						
			Homeless	Unemployed	Pensioner, Retired	White collar worker	Labourer, Farmer	Pupil, Student	No data
Lubelskie	N	2,099	38	408	935	131	476	93	18
	%	100.0	1.8	19.4	44.5	6.2	22.7	4.4	0.8
Łódzkie	N	2,267	95	549	886	132	553	41	11
	%	100.0	4.2	24.2	39.1	5.8	24.4	1.8	0.5
Śląskie	N	3,666	74	1,041	1,321	218	682	100	230
	%	100.0	2.0	28.4	36.0	5.9	18.6	2.7	6.3
Altogether voivodeships from Group I	N	8,032	207	1,998	3,142	481	1,711	234	259
	%	100.0	2.5	24.9	39.1	6.0	21.3	2.9	3.2
Wielkopolskie	N	1,255	43	299	475	96	253	24	65
	%	100.0	3.4	23.8	37.8	7.6	20.2	1.9	5.2
Opolskie	N	445	17	122	139	33	113	9	12
	%	100.0	3.8	27.4	31.2	7.4	25.4	2.0	2.7
Podlaskie	N	491	12	112	189	25	118	12	23
	%	100.0	2.4	22.8	38.5	5.1	24.0	2.4	4.7
Kujawsko-pomorskie	N	1,162	56	433	362	64	205	32	10
	%	100.0	4.8	37.3	31.1	5.5	17.6	2.7	0.9
Małopolskie	N	1,558	74	292	699	100	337	44	12
	%	100.0	4.7	18.7	44.9	6.4	21.6	2.8	0.8
Altogether voivodeships from Group I	N	4,911	202	1,258	1,864	318	1,026	121	122
	%	100.0	4.1	25.6	37.9	6.5	20.9	2.5	2.5
			p < 0.00001	NS	NS	NS	NS	NS	NS

N — number; NS — difference not significant

The different number of deaths reported by the Central Statistical Office and the clinics may have two reasons. On the one hand, it is possible that the Central Statistical Office registered all cases treated from this disease as death from tuberculosis, even if the cause of death was different. The proportion of such cases may be very high. On the other hand, a great number of patients lost from observation by the clinics show that these institutions were not able to include all deaths in their reports.

The last element examined while comparing the regions of higher and lower TB incidence was the population density per km². Group I was spread over an area of 55,647 km², which was inhabited by 9,334,078 people, whereas Group II was spread over an area of 92,645 km², which was inhabited by 11,003,558 people. The mean population density per km² was higher in the regions from Group I; however, it was different in particular voivodeships within each group (Table 6).

Discussion

Analysis of the presented data confirm something that was discussed in the first part of the present study [1], i.e. particular regions have different epidemiological situations. This is particularly clear from the differences in the number of deaths due to TB and the fact that in the group of higher TB incidence there were significantly more cases of death in younger age groups. It was not shown that the standard of living or unemployment allowed us to distinguish between the regions of lower and higher incidence of TB.

It should be emphasised that in some voivodeships there were relatively low proportions of patients who were treated successfully and large numbers of patients lost from observation. Among them could be sputum smear-positive subjects. There could be several reasons for this. On the one hand, the registered patients included

Table 3. Results of treatment of TB patients registered in selected voivodeships in 2009–2011

Voivodeship	Total number of TB patients	Success of treatment	Failed	Defaulted	Lost to follow-up	Death from other causes	Death from TB
Lubelskie	2184	1664	3	149	74	115	89
	100%	76.2%	0.1%	6.8%	3.4%	5.3%	4.1%
Łódzkie	2305	1535	4	307	231	75	33
	100%	66.6%	0.2%	13.3%	10.0%	3.2%	1.4%
Śląskie	3600	1703	3	331	1069	123	57
	100%	47.3%	0.1%	9.2%	29.7%	3.4%	1.6%
Altogether voivodeships from Group I	8089	4902	10	787	1374	313	179
	100%	60.6%	0.1%	9.7%	17.0%	3.9%	2.2%
Wielkopolskie	1340	512	6	93	372	77	22
	100%	38.2%	0.4%	6.9%	27.8%	5.7%	1.6%
Opolskie	486	305	0	96	6	13	21
	100%	62.7%	0	19.7%	1.2%	2.7%	4.3%
Podlaskie	512	391	0	52	11	22	20
	100%	76.3%		10.1%	2.1%	4.3%	3.9%
Kujawsko-pomorskie	1166	890	0	97	8	63	43
	100%	76.3%		8.3%	0.6%	5.4%	3.7%
Małopolskie	1592	1013	2	168	27	95	71
	100%	63.6%	0.1%	10.5%	1.7%	6.0%	4.5%
Altogether voivodeships from Group II	5096	3111	8	506	424	270	177
	100%	61.0%	0.15%	10.0%	8.3%	5.3%	3.5%
		NS	NS	NS	p < 0.0001	NS	NS

NS — difference not significant

Table 4. Numbers and rates of TB deaths according to the Central Statistical Office and proportion of TB deaths among all TB patients registered in selected voivodeships in 2009–2010

Voivodeship	All patients	Number of TB deaths	% of TB deaths	Rates of TB deaths per 100,000
Lubelskie	2,184	141	6.4	2.2
Łódzkie	2,305	157	6.8	2.0
Śląskie	3,600	456	12.7	3.3
Altogether voivodeships from Group I	8,089	754	9.3	2.5
Wielkopolskie	1,340	109	8.1	1.1
Opolskie	486	40	8.2	1.3
Podlaskie	512	43	8.3	1.2
Kujawsko-pomorskie	1,166	62	5.3	1.0
Małopolskie	1,592	127	8.0	1.3
Altogether voivodeships from Group II	5,096	381	7.4	1.2

many homeless, unemployed, or poorly educated people. Such patients often do not visit the doctor for long periods of time and are diagnosed when TB reaches an advanced stage; moreover, they often have other serious diseases. Studies conducted in other regions of Poland have shown that in homeless and poorly educated people,

TB is often diagnosed late, even 6 or 12 months after the occurrence of symptoms. According to other studies conducted in Poland and other countries, many patients from this group default from the treatment of tuberculosis, which poses a real danger of transmission of infection within society [7–10].

Table 5. Deaths from tuberculosis in the age groups according to information from TB clinics in selected voivodeships in 2009, 2010, 2011

Voivodeships	All patients	Number and % of TB deaths	Age groups in years, patients who died from tuberculosis							
			0–14	15–19	20–29	30–39	40–49	50–59	60–69	> 70
Lubelskie	2184 100%	89 4,1%	–	–	–	8	10	15	16	40
Łódzkie	2305 100%	33 1,4%	–	1	–	1	4	11	6	10
Śląskie	3600 100%	57 1,6%	1	–	1	7	12	17	8	11
Altogether voivodeships from Group I	8089 100%	179 2,2%	1	1	1	16	26	43	30	61
Wielkopolskie	1340 100%	22 1,6%	–	–	–	1	3	9	3	6
Opolskie	486 100%	21 4,3%	–	–	–	1	4	5	4	7
Podlaskie	512 100%	20 3,9%	–	–	–	1	2	2	2	13
Kujawsko-pomorskie	1166 100%	43 3,7%	–	–	–	2	8	9	10	14
Małopolskie	1592 100%	71 4,5%	–	–	–	4	8	12	15	32
Altogether voivodeships from Group II	5096 100%	177 3,5%	–	–	–	9	25	37	34	72

The proportion of deaths up to 59 years of age significantly higher in group I ($p < 0.01$)

Table 6. Density of population in selected voivodeships

Voivodeships	Average population in 2009–2011	Area of voivodeship in km ²	Population per km ²
Lubelskie	2,155,532	25.115 km ²	85,8 / km ²
Łódzkie	2,539,452	18.223 km ²	139,3/ km ²
Śląskie	4,639,094	12.309 km ²	376,8/ km ²
Altogether voivodeships from Group I	9,334,078	55.647 km²	167,7/ km²
Wielkopolskie	3,412,275	29.942 km ²	113,9/ km ²
Opolskie	1,030,128	9.412 km ²	109,4/ km ²
Podlaskie	1,189,443	20.180 km ²	58,9/ km ²
Małopolskie	3,302,398	15.141 km ²	218/ km ²
Kujawsko-pomorskie	2,069,314	17.970 km ²	115,1/ km ²
Altogether voivodeships from Group II	11,003,558	92.645 km²	118,7/ km²

However, unsatisfactory treatment results cannot be the main reason for the different situation in the two discussed groups of voivodeships. In both groups, there are voivodeships in which good treatment

results are obtained and voivodeships with poor results. The only real difference between the two groups was a significantly smaller proportion of patients lost from observation in Group II, compared to Group I.

The number of deaths due to TB in all analysed material was higher than in the majority of European countries [11]. The large number of deaths from TB is possibly related to the advanced stage of the disease at the moment of diagnosis.

Deaths due to TB in treated patients worldwide concern mainly the elderly, alcoholics, or people infected with HIV. The risk factors of death due to TB are unemployment and a low level of education [12–18]. According to official data, the number of HIV infected patients with TB in Poland is low [19]. No data concerning alcoholism in the study groups were available, but it is known that in Poland, alcoholism poses a crucial problem among TB patients [7, 20].

According to the analysis presented by the clinics, deaths concerned mainly the elderly. However, in the regions from Group I, there were more deaths among younger people (under 30 years of age) than in Group II. This confirms the worse epidemiological situation in these regions and is in accordance with the first part of this study, which showed that in the regions of higher TB incidence, the changes typical of primary TB, affected chest lymph nodes, and exudative pleurisy occur more frequently [1].

An additional factor that distinguished the regions of higher TB incidence from the lower ones was population density. A high population density is becoming a vital factor in transmission of infection, especially when a significant number of patients with positive sputum smears interrupt their treatment. Such a conviction is supported by the figures from the Central Statistical Office, which show a lower TB incidence in the countryside than in the cities [4–6].

However, all of the above-mentioned factors do not entirely explain the significant differences in the epidemiology of TB in the examined regions. An additional reason for the differences may be related to historical aspects. The early epidemic of TB had a different course in eastern than in western parts of Europe. At first it concerned the countries of Western Europe, and then Eastern Europe, including Russia. In the countries where the epidemic of TB started earlier, TB incidence slowly lowered. Therefore, there were differences in the incidence between the western and eastern parts of Europe. Data concerning the end of the 19th century have shown that in the Grand Duchy of Poznań, the mortality rate from tuberculosis was 175/100,000, whereas in the areas under Russian rule it was 400/100,000 [21]. After the Second World War the Polish borders were changed. A huge number of inhabitants

from the former eastern regions of the country were moved to the west. This may be one of the reasons for higher TB incidence in the Silesian region (Śląskie).

Conclusions

To conclude, it should be stated that although significant differences in epidemiology of TB between the two regions of Poland chosen for analysis have been shown, the reasons for the phenomenon have not been explicitly identified. Theoretically, a worse epidemiological situation could be caused by: high population density, unsatisfactory treatment results, or possible historical aspects that mean that the societies from certain regions are the ancestors of people who once lived in areas with a worse epidemiological situation. The mentioned factors presumably impacted the epidemiological situation in particular regions to different extents.

It should be emphasised that, irrespective of other reasons, the fact that in all the examined regions there were patients who defaulted from the treatment for tuberculosis, has shown the necessity of better control and management of the situation.

Conflict of interest

The authors declare no conflict of interest.

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