

OCCURRENCE OF CASES OF BORRELIOSIS CERTIFIED AS AN OCCUPATIONAL DISEASE IN THE PROVINCE OF WIELKOPOLSKA (POLAND)

Bartosz Bilski

Department of Preventive Medicine, University of Medical Sciences, Poznań, Poland

Bilski B: Occurrence of cases of borreliosis certified as an occupational disease in the province of Wielkopolska (Poland). *Ann Agric Environ Med* 2009, **16**, 211–217.

Abstract: The aim of the study was to analyze the occurrence of cases of borreliosis to classify as an occupational disease in the province [voivodeship] of Wielkopolska in the years 2000–2007. The data as a basis for this analysis originated from the database on the occupational disease certification created by the Public Health Service in Poznań. Documentation from the years 2000–2007 reviewed. The maximum number of the cases of borreliosis in the territory of Wielkopolska certified as the occupational disease fell in the years 2002–2003. In the territory of Wielkopolska, borreliosis as an occupational disease has been significantly more often certified in men. The population at the age of 41–60 prevailed in that case. The districts with the biggest number of certified cases of borreliosis as an occupational disease include the following: Miedzzychód, Poznań, Czarnków-Trzcianka, Gostyń, Jarocin, Leszno and Krotoszyn. Further analyses concerning real exposure to infection with spirochaetes *Borrelia burgdorferi* and its effects in the population of the workers of forestry and agriculture in the territory of Wielkopolska is recommended. It should be suspected that the epidemiologic data concerning the cases of borreliosis in the occupational conditions are understated.

Address for correspondence: Bartosz Bilski MD, PhD, Department of Preventive Medicine, University of Medical Sciences, ul. Smoluchowskiego 11, 60-179 Poznań, Poland. E-mail: bilski@ump.edu.pl

Key words: borreliosis, occupational disease, epidemiology, *Borrelia burgdorferi*, Poland.

INTRODUCTION

Borreliosis is one of the 3 most frequently certified occupational diseases (next to Vibration Syndrome and Noise-Induced Hearing Loss) in the employees of forestry in Poland – [18, 19]. Also farmers [6, 7, 9, 10, 13, 14, 40] belong to the group of particular exposure to infection with spirochaetes *Borrelia burgdorferi*. Borreliosis is a zoonosis, whose reservoir are vertebrata, wild and domestic (for example, horses, dogs, cattle), whereas ticks are both its reservoir and its vector [2, 26, 37]. Some authors suggest it is important to determine the percentage of the infected ticks, which is one of the parameters of the “ecological index” allowing us to specify the risk of acquiring the infection in a particular territory [35]. However, many other factors of medical, legal, socio-economical nature, among

others, jointly with the workers’ level of consciousness, have also influence upon the number of officially certified cases of the occupational diseases, besides real exposure of the workers and its effects. Also, is it important to introduce of effective health education concerning safety methods and easier access to diagnostics, etc. [1].

The aim of the present study was to analyze the occurrence of cases of borreliosis certified as an occupational disease in the province [voivodeship] of Wielkopolska in the years 2000–2007. The province of Wielkopolska is one of the biggest regions of Poland. Taking the area into consideration (29,825 square kilometre) it takes the second position in the country, whereas, the third position in reference to the number of inhabitants (3,3 million persons). In the Wielkopolska the forests occupy an area of about 756 thousand ha (8.51% of the whole Polish forests) and

constitute 25.3% of the total area of the province. Distribution of the forests in the territory of Wielkopolska is very irregular, and the area of the districts covered by the forests ranges from about 2.6%–50.3%. Relatively, the most afforested are the northern and western areas of the province of Wielkopolska, i.e. the districts: Czarnkowsko-Trzcianecki (50.3%), Złotowski (45.4%), Międzychodzki (44.2%) and Nowotomyski (37.8%). Whereas afforestation of the town areas, and also of the districts: Kolski (11.2%), Kościański (13.4%), Gostyński (13.9%), Gnieźnieński (14.5%) and Rawicki (14.8%), is relatively low. In respect of the species composition in the forests of the Wielkopolska the coniferous stands prevail, with the majority of pine and larch (about 80% of the forest area).

MATERIALS AND METHODS

The data as a basis for this analysis of occupational borreliosis in the province of Wielkopolska originated from the database on the occupational disease monitored by the Public Health Service in Poznań. The documentation from the years 2000–2007 was reviewed. An assessment the data considering the number of cases of borreliosis certified as the occupational diseases in the examined time interval, sex and age of the sick persons, the work places at which they were employed, dates and places of diagnosis, and certification of the occupational disease have been taken into consideration. The cases of borreliosis as an occupational disease have been related to the generally available data concerning work and employment conditions in forestry and agriculture in the territory of the province of Wielkopolska and Poland, the area of forests in the territory of particular districts of the province of Wielkopolska and the general data referring to the epidemiology of occupational diseases in Poland [18, 19, 28, 29, 30, 31, 32, 33, 34, 38]. In order to evaluate the statistical relationship of the dependence the Friedman test has been used.

RESULTS

The peak of number of the cases of borreliosis certified as the occupational diseases in Wielkopolska fell in the years 2002–2003, while in the successive years there was a sudden decrease in the number of certifications (Tab. 1). In Table 1 the number of the cases of borreliosis as a certified occupational disease has been related to the values presented in the generally accessible statistical data considering employment. It should be added that the detailed data concerning the real possible number of persons exposed (or potentially exposed) because of their occupational activity are quite limited. In Table 1 are the data that do not include the complete data concerning the employment in forestry; however, only such data were available in relation to the analyzed time interval and the territory of the province. In this case, they do not include the persons employed in small companies and running their own economic activity

Table 1. Number of certified cases of borreliosis as an occupational disease in the territory of the province of Wielkopolska in 2000–2007.

Year	Total number of all cases*	Number of cases in relation to those employed jointly in forestry, hunting and agriculture [per 100 thousand employees]**	Number of cases in relation to those employed in forestry [per 1000 employees]***
2000	5	1.4	0.93
2001	49	14.1	10.5
2002	69	22.0	14.8
2003	59	28.8	13.4
2004	10	4.8	2.4
2005	4	1.9	0.9
2006	13	6.2	2.9
2007	9	No data on employment available	No data on employment available
Total	218		

* – in forestry, hunting and agriculture – jointly; ** – in relation to those employed jointly in forestry, hunting and agriculture [per 100 thousand employees] in relation to the economic entities having the number of employees starting from 10 persons, and including those ones working in individual farms in agriculture [21, 22, 23, 24, 25, 26, 27]; *** – in relationship to statistical data originating from [13, 14].

Table 2. Number of certified cases of borreliosis as an occupational disease with division according to sex in the territory of the province of Wielkopolska.

Year	Number of cases in women	Number of cases in men	Total number of certified cases of borreliosis as an occupational disease
2000	1	4	5
2001	9	40	49
2002	11	58	69
2003	2	57	59
2004	0	10	10
2005	0	4	4
2006	0	13	13
2007	1	8	9
Total	24	194	218
Percentage	11.0	89.0	100

Peak of number of certified cases of borreliosis as an occupational diseases in 2000–2007 fell on the workers in the age range 51–60 (Tab. 3).

in forestry. However, in Table 1, in the fourth column, there are the relevant data considering the number of cases of borreliosis as an occupational disease appropriately related to employment in forestry [18, 19].

Among the certified cases of this occupational disease, men significantly prevail (89.0%), in comparison with the population of women (11.0%) (Tab. 2).

The peak of number of certified cases of borreliosis as the occupational disease in the years 2000–2007 fell on the workers in the age range 51–60 (Tab. 3).

Among the working places or occupations in which borreliosis is most often certified as an occupational disease quantitatively prevail, are the following: the position of a forest inspector, a forester and a deputy forester (Tab. 4). The cases of this occupational disease have been certified significantly less frequently in forestry workers practising the simplest manual work.

In Table 5, the frequency of certification of borreliosis as the occupational disease is presented in absolute numbers on the territory of particular districts in the province of Wielkopolska, and in relation to persons from the population exposed or potentially exposed on the basis of the official data concerning employment, collected in various manners by the Statistical Office in Poznań. In absolute numbers, definitely the biggest number of cases of certified borreliosis as the occupational disease referred to the district of Poznań. Definitely the biggest number of cases of certification of borreliosis as the occupational disease in relation to the population of the persons employed in the particular branches of economy refers to the districts of, as follows: Miedzichód, Poznań, Czarnków-Trzcianka, Gostyń, Jarocin, Leszno and Krotoszyn. No significant statistical relationship between the area of forests in the territory of particular districts and the number of the cases of borreliosis as the certified occupational disease in their territory has been found ($p < 0.05$) (Tab. 5).

Summarizing, the maximum number of the cases of borreliosis in the territory of Wielkopolska certified as the occupational disease fell on the years 2002–2003. In the territory of Wielkopolska, borreliosis as the occupational disease has been significantly more often certified in men. The population at the age of 41–60 prevailed in that case. The districts with the biggest number of the cases of certification of borreliosis as an occupational disease include the following: Poznań, Miedzichód, Jarocin, Czarnków-Trzcianka, Krotoszyn and Leszno.

DISCUSSION

The number of cases of certified borreliosis as an occupational disease in the years 2000–2007, in comparison to the number of the cases on a country wide scale, oscillates in very wide limits between ca. 1 and up to 26.7%, with the maximum value in 2002 and a significant decrease thereafter (Tab. 1). In other parts of the country, there was a slightly growing tendency then, as far as the certifications of new cases of that disease as the occupational disease [38] are concerned. It is interesting that the number of cases in the territory of Wielkopolska in that period was big enough to reflect itself even in the shape of the curve of certified cases of borreliosis as the occupational disease for the whole Poland [38]! It should be also added that since the year 2000 borreliosis has occupied the first place in Poland in

Table 3. Number of certified cases of borreliosis as an occupational disease with division according to the age groups in the territory of the province of Wielkopolska in 2000–2007.

Year of diagnosis	Age ranges [age in years] of persons in which borreliosis has been diagnosed and certified as an occupational disease						Total
	20–30	31–40	41–50	51–60	61–70	71–80	
2000	–	–	–	4	1	–	5
2001	–	7	15	17	9	1	49
2002	–	11	21	23	13	1	69
2003	3	5	17	18	14	2	59
2004	–	2	2	6	–	–	10
2005	–	–	1	3	–	–	4
2006	1	2	6	2	2	–	13
2007	–	2	4	3	–	–	9
Total	4	29	66	76	39	4	218
Percentage of all cases	1.8	13.3	30.3	34.9	17.9	1.8	

Table 4. Number of certified cases of borreliosis as an occupational disease with division into working places or practised occupation in the territory of the province of Wielkopolska in 2000–2007.

Working place or occupation practised	Number of cases of borreliosis as an occupational disease, n=218	Percentage of the number of cases in relation to all cases of certification of borreliosis as an occupational diseases
Lumberman, sawman, manual worker in forest environment	38	17.4
Forest inspector, forester, deputy forester	127	58.3
Specialists in the scope of forestry and employed in stations of such profile	13	6.0
Persons in management positions in forestry	2	0.9
Farmer	5	
Forester assistant	5	2.3
Forest worker police	8	3.7
Driver	9	4.1
Others – forestry workers	11	5.0
Total	218	100

respect of the certified cases among the infectious and invasive occupational disease [38]. What factors might cause the peak of certifications of borreliosis as the occupational disease in the years 2002–2003 and the decrease having coming immediately after it? One might suspect that the socioeconomic conditions had the effect on the prevalence

Table 5. Number of certified cases of borreliosis as an occupational disease, taking into consideration the worker's place of employment and in relation to the number of cases of occupational borreliosis in comparison to the area of forests within the precincts of particular districts (administrative units of the territorial division in Poland) in the territory of the province of Wielkopolska in 2000–2007.

District	Number of certified cases of borreliosis as an occupational disease	Number of certified cases of borreliosis as an occupational disease in relation to the area of forests [per 100 km ²]*
Chodzieski	0	0
Czarnkowsko-Trzcianecki	11	1.2
Gnieźniński	14	7.8
Gostyński	11	9.6
Grodziski	2	1.3
Jarociński	18	16.5
Kalisz with the town with district rights	3	1.3
Kepiński	1	0.9
Kolski	3	2.7
Konin with the town with district rights	3	1.2
Kościański	8	8.6
Krotoszyński	10	7.6
Leszno with the town with district rights	17	8.7
Międzychodzki	15	4.5
Nowotomyski	1	0.3
Obornicki	0	0
Ostrowski	5	1.5
Ostrzeszowski	7	2.7
Piński	2	0.6
Pleszewski	1	0.7
Poznań with the town with district rights	54	11.8
Rawicki	1	1.2
Słupecki	0	0
Szamotulski	11	3.2
Średzki	2	2.0
Śremski	2	1.8
Turecki	1	15.9
Wągrowiecki	6	3.1
Wolsztyński	7	3.4
Wrzesiński	0	0
Złotowski	2	0.3
	218	2.9

* in relation to the statistical data originating from [21, 22, 23, 24, 25, 26, 27].

of borreliosis (among other things, changes in the number of employees – cuts in employment, characteristic in that period, also for the territory of the whole of Poland – with the maximum in the year 2002) [18, 19]. The results of other analyses also indicate the fact that socioeconomic conditions effect to a significant degree the quantitative data concerning the certified occupational diseases; for example: significant fluctuation of the number of the certified cases of the occupational disease of the locomotor system in stomatologists in the territory of the former province of Poznań – the researcher's own data, not published). Because of the increased number of certified cases of borreliosis as an occupational disease in some districts, one might also suspect the so-called “domino effect” that might testify to better access of the employees to information concerning certification in the scope of occupational diseases or better availability of specialized diagnostics (a significant part of the cases of infection with *Borrelia burgdorferi* has an asymptomatic course) [24]. The certified cases of borreliosis as an occupational disease in Poland might include newly diagnosed cases and also cases diagnosed even many years ago. In accordance with the current Polish regulations concerning notification of suspicion, diagnosis and certification of occupational diseases, the period in which the occurrence of the documented symptoms of the disease entitle one to diagnose and further certificate the occupational disease, despite an earlier ending of the occupational exposure in the case of infectious diseases, may be optionally long. This causes the situation that a part of the certified cases of occupational diseases with infectious aetiology may often concern diagnosed cases of disease from even many years ago. One may suspect that “cumulation” of cases diagnosed many years came out only in the years 2001–2003. The peak of the number of the certified occupational diseases was shifted slightly in time than assessed in other analyses [25]. This may constitute additional confirmation of this hypothesis. A significant number of the certified cases of borreliosis may concern cases that occurred at least several years earlier.

In certifications of borreliosis as an occupational disease in absolute numbers, men definitely prevail, which is connected with the greater number of men employed for work of such a nature (this especially concerns hard work in forestry). It confirms the data from other epidemiologic data (Tab. 3) [38].

To a significantly small degree, the population of farmers is represented in the cases of certifications of borreliosis as an occupational disease, in comparison with the serological markers of exposure presented in the literature data [24]. This may arise from the insufficient system of detection and diagnosis of occupational diseases in this population. It should be added, however, that the real levels of exposure differ considerably between the population of individual farmers and those employed in forestry.

In the geography of the occurrence of cases of borreliosis as an occupational disease the following districts

Table 6. Number of certified cases of borreliosis as an occupational disease in relation to those employed in: A) hunting and forestry, fishing, excluding agriculture, per 1,000 persons, in relation to the data of the year 2002, National Census of Population and Housing [23]; B) agriculture, hunting, forestry, fishing, per 1,000 persons, in relation to the data of the year 2002, National Census of Population and Housing [23]; C) in hunting and forestry, fishing, excluding individual farms (per 1,000 persons), in relation to the entities that employ 10 or more employees – the average number of employees for 2003–2006 (previously, other ways of collecting data – in 2002 – data of the National Census, previously generally as the collective data as “the agricultural sector”) [23, 24, 25, 26, 27].

District	A	B	C
Chodzieski	0.0	0.0	0.0
Czarnkowsko-Trzcianecki	8.3	1.9	1.2
Gnieźniński	8.2	1.7	7.8
Gostyński	5.5	1.3	9.6
Grodziski	1.3	0.3	1.3
Jarociński	17.3	3.3	16.5
Kalisz with the town with district rights	3.0	0.2	1.3
Kępniński	2.0	0.2	0.9
Kolski	4.0	0.3	2.7
Konin with the town with district rights	2.0	0.2	1.2
Kościański	3.5	1.1	8.6
Krotoszyński	9.0	1.3	7.6
Leszno with the town with district rights	10.2	2.7	8.7
Międzychodzki	19.7	5.8	4.5
Nowotomyski	0.9	0.2	0.3
Obornicki	0.0	0.0	0.0
Ostrowski	3.5	0.5	1.5
Ostrzeszowski	11.2	1.0	2.7
Piński	1.3	0.3	0.6
Pleszewski	1.0	0.1	0.7
Poznań with the town with district rights	16.3	4.4	11.8
Rawicki	0.9	0.2	1.2
Słupecki	0.0	0.0	0.0
Szamotulski	6.2	1.9	3.2
Średzki	1.6	0.5	2.0
Śremski	1.7	0.5	1.8
Turecki	1.7	0.1	15.9
Wągrowiecki	5.1	1.0	3.1
Wolsztyński	5.6	1.2	3.4
Wrzesiński	0.0	0.0	0.0
Złotowski	1.0	0.4	0.3

* in relation to the statistical data originating from [21, 22, 23, 24, 25, 26, 27].

prevail: Międzychód, Poznań, Czarnków-Trzcianka, Gostyń, Jarocin, Leszno and Krotoszyn (Tabs 5 and 6). In the case of the district of Poznań, a similar situation was previously presented in the case of other diseases of such aetiology [3]. This may probably result from better access of the employees to diagnostics and their better consciousness. Irregularity of distribution of the certified cases of borreliosis as an occupational disease in the case of other districts may be hypothetically connected with the endemic occurrence of the ticks infected with the disease in the particular forest sites; however, this requires further detailed research. In the territory of Wielkopolska, forest biocenoses are quite diversified. According to the literature, the moist and rich soils are conducive to development of plants of all floors of a forest, and rich vegetation, particularly forest undergrowth, favours the maintaining of sites of the ticks [33]. Distribution of the number of cases of borreliosis as an occupational disease in the years 2000–2007 does not correlate with the results of the selective studies concerning a few sites in the territory of Wielkopolska from the nineties concerning frequency of occurrence of the ticks *Ixodes ricinus* infected with spirochaetes *Borrelia burgdorferi* [15]. According to the studies conducted then, the most frequent of the infected ticks referred to the environs of Konin – 46.4%, and the least in the western part of the province – 11.5% (percentage of the ticks *Ixodes ricinus* infected with spirochaetes *Borrelia burgdorferi* sensu lato was appropriately in the environs of Kazimierz Biskupi (district of Konin) – 46.4%, of Międzychód (district of Międzychód) – 11.5%, of Oborniki Wielkopolskie (district of Oborniki) – 34.5%, of Obrzycko (district of Szamotuły) – 13.2%, of Poznań – 20.7%, of Sieraków (district of Międzychód) – 30.2%, of Wronki (district of Szamotuły) – 21.2%. It should be stressed, however, that the cited studies were carried out quite a long time ago, and in a few sites, so the present topography of the places in which there is the biggest risk of contacting ticks that may be the source of spirochaetes *Borrelia burgdorferi* may significantly differ. Yet even the places located not far from each other may significantly differ in this respect [20]. Further analyses concerning the percentage of the infected ticks and their activity seem to be more than advisable, as they provide a number of valuable data concerning exposure of the employees to the pathogen causing this disease [4, 8, 39]. According to the author’s knowledge, there is no appropriate analyses in the territory of Wielkopolska that would be methodologically close and that would constitute the reference point for research conducted in other parts of Poland and concerning the markers of the effects of exposure to spirochaetes *Borrelia burgdorferi* (e.g., presence of the specific antibodies against antigens of *Borrelia burgdorferi* or the genetic material of these spirochaetes in the serum of the persons employed in agriculture and forestry) [5, 11, 16, 21, 22, 23, 25, 27]. It should be emphasized that the influence on such distribution of the certified cases of the occupational disease may also have some socioeconomic conditioning.

Quite a significant number of the cases in the persons originating from the management of forest work in comparison to the real level of exposure may be explained by greater consciousness in the scope of certification and accessibility of medical diagnostics. According to the data originating from various countries, the population of forest workers – woodcutters are the most vulnerable to infection with spirochaetes *Borrelia burgdorferi* [17, 24, 27]. However, these data originate the serological analyses, therefore, because of the different methodology, they cannot have their direct translation into the presented official data concerning the certified occupational diseases in the example of the analyzed area of Poland.

The results of the present analysis may suggest that the real number of cases of the disease resulting from the occupational exposure, particularly in the population of farmers and also in the forest workers, is bigger.

CONCLUSIONS

1. The epidemiology of the cases of borreliosis certified as an occupational disease is influenced by both the level of real exposure to infection with spirochaetes *Borrelia burgdorferi*, socio-economic conditions, access to medical diagnostics, and the consciousness of the population exposed in the scope of the certification.

2. It is recommended that further analyses should be conducted concerning real exposure to infection with spirochaetes *Borrelia burgdorferi* and its effects on the population of workers of forestry and agriculture in the territory of Wielkopolska. It should be suspected that the epidemiologic data concerning the cases of borreliosis in the occupational conditions are understated.

3. It is recommended covering forest workers (and other persons occupationally exposed to spirochaetes *Borrelia burgdorferi*) with systematic and obligatory examinations in the direction of borreliosis, and also the complex medical care referring to this occupational disease.

Acknowledgements

Author wish to thank Dr Marcin Hemerling and Mr Marek Duszyński, M.Sc.Ing. for access to database of Public Health Service in Poznań.

REFERENCES

- Bartosik K, Kubrak T, Olszewski T, Jung M, Buczek A: Prevention of tick bites and protection against tick-borne diseases in south-eastern Poland. *Ann Agric Environ Med* 2008, **15**, 181-185.
- Bhide M, Yilmaz Z, Golcu E, Torun S, Mikula I: Seroprevalence of anti-*Borrelia burgdorferi* antibodies in dogs and horses in Turkey. *Ann Agric Environ Med* 2008, **15**, 85-90.
- Bilski B, Wysocki J, Hemerling M: Viral hepatitis in health care workers in the province of Wielkopolska. *Int J Occup Med Environ Health* 2002, **15**, 347-352.
- Cisak E, Chmielewska-Badora J, Dutkiewicz J, Zwoliński J: Preliminary studies on the relationship between *Ixodes ricinus* activity and tick-borne infection among occupationally-exposed inhabitants of eastern Poland. *Ann Agric Environ Med* 2001, **8**, 293-295.
- Cisak E, Chmielewska-Badora J, Zwoliński J, Wójcik-Fatla A, Polak J, Dutkiewicz J: Risk of tick-borne bacterial diseases among workers of Roztocze National Park (South-Eastern Poland). *Ann Agric Environ Med* 2005, **12**, 127-132.
- Cisak E, Chmielewska-Badora J, Zwoliński J, Wójcik-Fatla A, Zając V, Skórska C, Dutkiewicz J: Study of Lyme borreliosis focus in the Lublin Region (Eastern Poland). *Ann Agric Environ Med* 2008, **15**, 327-332.
- Cisak E, Chmielewska-Badora J, Zwoliński J, Dutkiewicz J, Patorska-Mach E: Incidence of tick-borne encephalitis virus and *Borrelia burgdorferi* infections in farmers of the Lublin province. *Med Pr* 2003, **54**, 139-144 (in Polish).
- Cisak E, Wójcik-Fatla A, Stojek N, Chmielewska-Badora J, Zwoliński J, Buczek A, Dutkiewicz J: Prevalence of *Borrelia burgdorferi* genospecies in *Ixodes ricinus* ticks from Lublin region (eastern Poland). *Ann Agric Environ Med* 2006, **13**, 301-306.
- Dutkiewicz J, Śpiewak R, Jabłoński L: The classification of biological hazards at the workplace and groups occupationally exposed to these factors. IMW, Lublin 1999 (in Polish).
- Dutkiewicz J (Ed.): *Biological hazards in agriculture*. IMW, Lublin 1998 (in Polish).
- Dobrcki W, Dobracka B, Paczosa W, Zięba J, Beres P: Epidemiology of borreliosis in workers of the district forestry offices in Lower Silesia. *Przegl Epidemiol* 2007, **61**, 385-391 (in Polish).
- Dybowska D, Koziulewicz D, Abdulgater A: Prevalence of borreliosis among forestry workers in Kujawsko-Pomorskie voivodeship. *Przegl Epidemiol* 2007, **61**, 61-71 (in Polish).
- Fahrer H, van den Linden SM, Sauvain MJ, Gern L, Zhioua E, Aeschlimann A: The prevalence and incidence of clinical and asymptomatic Lyme borreliosis in a population and risk. *J Infect Dis* 1991, **163**, 305-310.
- Granström M: Tick-borne zoonoses in Europe. *Clin Microbiol Infect* 1997, **41**, 253-266.
- Jenek J, Głazaczow A: The evaluation of *Borrelia burgdorferi* sensu lato spirochaetes distribution in *Ixodes ricinus* ticks collected in selected regions of Wielkopolska by polymerase chain reaction (PCR) method. *Przegl Epidemiol* 1996, **50**, 383-386 (in Polish).
- Kondrusik M, Grygorczuk S, Skotarczak B, Wodecka B, Rymszewska A, Pancewicz S, Zajkowska J, Swierzbńska R, Hermanowska-Szapakowicz T: Molecular and serological diagnosis of *Borrelia burgdorferi* infection among patients with diagnosed Erythema migrans. *Ann Agric Environ Med* 2007, **14**, 209-213.
- Kuiper H, de Jongh BM, Nauta AP, Houweling H, Wiessing LG, van Charante AW, Spanjaard L: Lyme borreliosis in Dutch forestry workers. *J Infect* 2001, **23**, 279-286.
- Forestry 2007*. Central Statistical Office of Poland, Warsaw 2007 (in Polish).
- Forestry 2004*. Central Statistical Office of Poland, Warsaw 2004 (in Polish).
- Michalik J, Hofman T, Buczek A, Skoracki M, Sikora B: *Borrelia burgdorferi* s.l. in *Ixodes ricinus* (Acari: Ixodidae) ticks collected from vegetation and small rodents in recreational areas of the city of Poznań. *J Med Entomol* 2003, **40**, 690-697.
- Niścigorska J: Assessment of the *Borrelia burgdorferi* infections occurrence in the Province of Szczecin in immunoserological studies of selected populations. *Prob Hig* 1997, **54**, 136-141 (in Polish).
- Niścigorska J, Skotarczak B, Wodecka B: *Borrelia burgdorferi* infection among forestry workers – assessed with an immunoenzymatic method (ELISA), PCR, and correlated with the clinical state of the patients. *Ann Agric Environ Med* 2003, **10**, 15-19.
- Niścigorska-Olsen J, Wodecka B, Morańska I, Skotarczak B: Genospecies of *Borrelia burgdorferi* sensu lato in patients with erythema migrans. *Ann Agric Environ Med* 2008, **15**, 167-170.
- Nuti M, Amaddeo D, Crovatto M, Ghionni A, Polato D, Lillini E, Pitzus E, Santini GF: Infections in an Alpine environment: antibodies to hantaviruses, leptospira, reckettsiae, and *Borrelia burgdorferi* in defined Italian populations. *Am J Trop Med Hyg* 1993, **48**, 20-25.

25. Pancewicz SA, Olszewska B, Hermanowska-Szpakowicz T, Kondrusik M, Zajkowska JM, Grygorczuk S, Świerzbńska R: Epidemiologic aspect of Lyme borreliosis among the inhabitants of Podlasie Province. *Przegl Epidemiol* 2001, **55 Suppl. 3**, 187-194 (in Polish).
26. Prokopowicz M: *Tick-borne diseases*. Büchner, Warsaw 1995 (in Polish).
27. Thorin C, Rigaud E, Capek I, Andre-Fontaine G, Oster B, Gastinger G, Abadia G: Seroprevalence of Lyme borreliosis and tick-borne encephalitis in workers at risk in eastern France. *Med Mal Infect* 2008, **38**, 533-542.
28. *Main data concerning districts and communes of the Province of Wielkopolska*. Statistical Office, Poznań 2001 (in Polish).
29. *Main data concerning districts and communes of the Province of Wielkopolska*. Statistical Office, Poznań 2002 (in Polish).
30. *Main data concerning districts and communes of the Province of Wielkopolska*. Statistical Office, Poznań 2003 (in Polish).
31. *Main data concerning subregions, districts and communes of the Province of Wielkopolska*. Statistical Office, Poznań 2004 (in Polish).
32. *The Province of Wielkopolska. Subregions-districts-communes 2005*. Statistical Office, Poznań 2005 (in Polish).
33. *The Province of Wielkopolska. Subregions-districts-communes 2005*. Statistical Office, Poznań 2006 (in Polish).
34. *The Province of Wielkopolska. Subregions-districts-communes 2005*. Statistical Office, Poznań 2007 (in Polish).
35. Schulze TL, Taylor RC, Taylor GC, Bosler EM: Lyme disease: a proposed ecological index to assess areas of risk in the northeastern United States. *Am J Public Health* 1991, **81**, 714-718.
36. Siuda K: Fauna of ticks (Acari: Ixodida) in Poland. *Wiad Parazytol* 1995, **41**, 277-281 (in Polish).
37. Stefanciková A, Adaszek Ł, Pet'ko B, Winiarczyk S, Dudinák V: Serological evidence of *Borrelia burgdorferi* sensu lato in horses and cattle from Poland and diagnostic problems of Lyme borreliosis. *Ann Agric Environ Med* 2008, **15**, 37-43.
38. Szeszenia-Dąbrowska N, Wilczyńska U: *Occupational diseases in Poland. Statistics and epidemiology*. IMP, Łódź 2007 (in Polish).
39. Wodecka B: Detection of *Borrelia burgdorferi* sensu lato DNA in *Ixodes ricinus* in North-western Poland. *Ann Agric Environ Med* 2003, **10**, 171-178.
40. Zagórski J (Ed.): *Occupational and work-related diseases in agriculture*. IMW, Lublin 2000 (in Polish).

