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THE EFFECTS OF ENVIRONMENTAL FACTORS ON THE PREVALENCE OF *HELICOBACTER PYLORI* INFECTION IN INHABITANTS OF LUBLIN PROVINCE

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Abstract: The aim of the study was to analyse the prevalence of *H. pylori* infection in adult inhabitants of Lublin Province. The effects of living conditions and lifestyle on the infection frequency were evaluated. The study included 585 adults randomly chosen for the epidemiological analysis of *H. pylori* infection in the Lublin region within the project commissioned by the Ministry of Health (PCZ 08-09) and State Committee for Scientific Research (C007/P05/2000). The study was based on a personal questionnaire and determinations of anti/Hp antibodies in IgG class using the ELISA method. High titres of anti/Hp antibodies (>24 IU/ml) were demonstrated in 78.5% of the subjects. In Lublin Province the infected individuals constitute 72% of inhabitants, in the big towns - 74% and in small towns - 95%. According to the place of birth: among those born in the country 87% are infected, compared to 78.4% in the small towns and 64% in the big towns, respectively. Positive test results were observed in 79% of farmers, 78% of manual workers and 75% of mental workers. The percentage of the affected neglecting basic hygienic rules exceeded 90%. With increased frequency of hygienic measures the number of the *H. pylori* infected individuals decreased to 65%. The prevalence of *H. pylori* infection among the inhabitants of the Lublin region is lower than that found in town inhabitants. Lublin Province shows the lowest level of *H. pylori* infection in Poland. The *H. pylori* infection is strongly affected by the lack of basic rules of personal hygiene and improper diet.

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INTRODUCTION

Helicobacter pylori infection is thought to be the most common factor of morbidity and mortality in upper digestive tract diseases. It is associated with about 95% of duodenal ulcers and 76% of gastric ulcers. It contributes to the development of MALT (mucosa-associated lymphoid tissue) lymphoma and stomach cancer [7, 8]. Recently, reports were published suggesting the effects of *H. pylori* infection on the development of such extra-alimentary ailments as coronary disease, myocardial infarction, Raynaud's syndrome, migraine, dermatological disorders, iron deficiency ischaemia and some autoimmune diseases [3, 6].

The *H. pylori* infection is a widespread phenomenon, its intensification in the individual populations is strongly related to economic conditions and increases with age. An increased risk of *H. pylori* infection is observed in the developing countries and ethnic minorities of some industrialized countries living in poor social conditions (Asia, Africa, Central and South America, Eastern Europe) [19]. The factors increasing the infection risk

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include: overpopulation (substantially congested houses, family sizes, common crockery and beds), sanitary conditions, poor hygiene and unsafe sources of water supply [21]. In the developing countries, the infection occurs already in the first years of life and increases successively involving almost 100% of the 50-years-old. In the developed countries, it affects only a small percentage of children below 10 years of age and does not exceed 40% in adults [24].

The epidemiological studies reveal that the infection spreads by person-to-person contact and that the main reservoir of *H. pylori* is probably a human being. Moreover, potential reservoirs of bacteria are thought to be animals having contact with people: cats, dogs, pigs, rodents or even birds. However, the studies do not demonstrate that these reservoirs could be the basic source of infection in humans [2]. It seems that the oral-oral mode may be the most widely spread and frequent mechanism of transmission worldwide, amongst children and young people, particularly. This mode also dominates in the highliving standard countries with proper sanitary habits. There is increasing evidence that the oral cavity is likely to be the place of colonization of this bacterium. The detection of *H. pylori* in the saliva, dental plaque and oral mucosa indicates possible transmission of the bacterium by physical contact, especially among family members [4]. The children of infected parents are more susceptible to infection. There are reports, however, showing that in 30% of cases the infection is likely to originate from non-family sources [1, 26].

The second mode of transmission – faecal-oral (dirty hands) dominates in the developing countries and those with low hygiene [19]. It was demonstrated that *H. pylori* was capable of surviving the passage through the unfavourable conditions of bilious intestinal environment, although the living forms of bacteria able to grow in vitro cannot be actually found in faeces [12]. Moreover, it is believed that the water supply system is likely to be a risk factor. In some countries, the consumption of raw vegetables is also a risk factor, likewise the consumption of food purchased from street stalls [9].

The aim of the study was to analyse the prevalence of *H. pylori* infection in the adult population of the Lublin region. The *H. pylori* prevalence in the rural group was compared to that in the urban group. The effects of living conditions and lifestyle on the infection prevalence were assessed. The Lublin region results were compared with the nationwide data.

MATERIAL AND METHODS

The study was performed in 2000-2003 within the project commissioned by the Ministry of Health (PCZ 08-09) and State Committee for Scientific Research (C007/P05/2000). The project was carried out simultaneously in 10 Polish centres. Its subject was "The Helicobacter pylori infection in Poland – epidemiological studies in children and adults including the risk of gastric and duodenal ulcer diseases and stomach cancer". In the Lublin centre, the studies concerned exclusively adults. The epidemiological analysis was conducted in 1,600 randomly selected individuals, including 500 from the town region (Lublin), 500 – from the communal region (Garbów) and 600 – from district regions (Puławy and Krasnystaw). From this group, 585 individuals entered the study. The most abundant population was the group living in the rural region (45.8%), followed by those living in the town region (43.2%); the smallest population came from the district region (25.3%). The selected subjects underwent physical examinations, their case histories were taken and personal questionnaires completed. The questionnaire data were sorted, systematized, processed using professional computer programmes and compiled in tables and figures. Additionally, 2 ml of venous blood were collected from each person to determine titres of anti/Hp antibodies in the HgG class. The titre > 24 U/ml was considered positive.

RESULTS

Of 1,600 selected adults, 585 individuals (36.5%) reported for studies. The serological blood tests for anti/*H. pylori* were performed in 512 subjects (in the remaining cases the patients did not give consent for collecting blood, the samples were inappropriately collected or damaged during transport). Positive test results were found in 402 subjects (78.52%). In the other centres dealing with adults in Poland the average prevalence of *H. pylori* infection was 84.19%.

Significant differences were observed with regard to the place of residence. In the group of inhabitants of the Lublin Province, the infected account for 72% (n=163), in the big town group – 74% (n=118), and in the small town group – 95% (n =121; $p<0.001$). According to the place of birth the results were as follows: 87% (n =199), 64% (n=87) and 78.4% (n=116), respectively ($p<0.001$) (Tab. 1).

The examined adults were divided into age groups. In the first age group range (20-29), the positive antibody results were observed in 65% of subjects (big town – 62%,

Table 1. Number of subjects and prevalence of *H. pylori* infection among adults (%) according to place of residence (provincial or ex-provincial town, district town, rural region) [9].

	big town		district town		country	
	N	%	N	%	N	%
Białystok	96	94.8	1	100	225	86.7
Katowice	309	79.6	104	79.8	285	86.7
Lublin	159	74.8	129	94.6	224	71.9
Szczecin	305	81.6	91	93.4	271	87.4
Warszawa	157	87.9	153	92.8	180	84.4
Wrocław	146	80.1	150	88	96	93.8
Other centres	37	67.6	100	84	89	76.4
Total	1,209	81.5	728	89.2	1,370	83.9

district town – 73%). In the 30-39 and 40-49 age groups the infection was detected in 83% of country inhabitants (big town inhabitants – 75%, small town – 88%). A further increase in the *H. pylori* prevalence to 92% was observed in 2 successive age groups: 50-59 and 60-69, both in the country and town inhabitants. In the group above 70 years of age, 8% of subjects were infected while in the >80 group – 75% of the country population. Amongst town inhabitants the prevalence of *H. pylori* infection in the oldest age groups reached 92-100% (Tab. 3). Moreover, the prevalence of *H. pylori* infection was assessed according to profession. Positive test results were found in 79% of farmers, 77.8% of manual workers (employed in food industry), 78% of manual workers working outside agriculture and 75% of white collar workers (Tab. 2).

In total, farmers were infected in 76% while non-farmers in 82%. No differences in the prevalence of *H. pylori* infection were observed with regard to the use of natural fertilizers. The infection prevalence in fertilizer and non-fertilizer groups ranged from 75-77% (Tab. 6). Furthermore, the storage of manure near houses did not significantly affect an increase in the infection number. The individuals storing manure in their farmyards were infected in 77% while those not storing it in 75%.

The relations between water supply system, sewage system and prevalence of *H. pylori* infection were assessed. In the Lublin centre, in the group using the communal water supply system 79% of subjects were *H. pylori* infected, while among those using wells – 87% (Tab. 4).

Analysis of the ways of sewage disposal showed that 82% of individuals are infected in the group using the sewage system and 75% of those using septic tanks (Tab. 5). No relation, however, was observed between the prevalence of *H. pylori* infection and running water or toilets inside the houses (*H. pylori* infection occurs in 79% of those with sanitary devices vs. 75% of those without them).

Moreover, the study dealt with relations between the occurrence of *H. pylori* infection and the presence of pets and farm animals. Positive test results were found in 75%

Table 3. Number of subjects and prevalence of *H. pylori* infection according to age and place of residence (provincial or ex-provincial town, district town, rural region) [9].

		Big town		District town		Country	
age		M	F	M	F	M	F
19-29	n	82	125	39	53	72	134
	%	65.8	60	66.7	79.2	66.7	64.9
30-39	n	67	86	34	83	76	132
	%	77.6	68.6	85.3	86.8	84.2	81.8
40-49	n	96	158	69	129	145	188
	%	78.1	80.4	94.2	88.4	85.5	82.4
50-59	n	112	185	57	89	112	182
	%	90.2	91.4	93	92.1	90.2	94
60-69	n	73	97	42	73	82	124
	%	90.4	91.8	97.6	97.3	91.5	91.1
70-79	n	33	56	17	26	36	70
	%	93.9	94.6	100	80.8	83.3	88.6
80-89	n	9	14	1	10	5	7
	%	100	100	100	100	80	71.4
Total	n	478	731	261	467	530	840
	%	82	81.1	90	88.9	84.3	83.7

Table 4. Number of cases and prevalence of *H. pylori* infection among adults according to household water supply system [9].

	Communal water supply		Well		Deep water well		p
	n	%	n	%	n	%	
Białystok	261	88.2	7	100	2	100	n.s.
Katowice	`420	81.6	68	81.9	82	88.2	n.s.
Lublin	390	78.6	7	87.5	3	60	n.s.
Szczecin	533	84.7	6	100	13	100	n.s.
Warszawa	319	87.9	39	92.9	48	87.3	n.s.
Wrocław	325	86	7	100	3	100	n.s.
Other centres	155	77.9	7	87.5	1	50	n.s.
Total	2,403	83.6	141	87.6	152	87.9	n.s.

Table 2. The number of cases and prevalence of *H. pylori* infection in working individuals according to type of job [9].

	Farmer		Manual worker of food industry		Manual worker outside agriculture		White collar worker		p
	N	%	n	%	n	%	n	%	
Białystok	51	91.1	6	75.0	28	90.3	50	89.3	n.s.
Katowice	27	79.4	6	85.7	72	84.7	115	79.3	n.s.
Lublin	30	79.0	7	77.8	61	78.2	96	75.6	n.s.
Szczecin	1	50.0	6	100.0	140	88.0	156	78.8	0.039
Warszawa	10	83.3	15	83.3	58	90.6	104	84.6	n.s.
Wrocław	9	100.0	5	83.3	51	81.0	75	86.2	n.s.
Other centres	19	70.4	6	60.0	37	88.1	43	84.3	n.s.
Total	147	82.6	51	79.7	447	85.6	639	81.2	n.s.

Table 5. Number of cases and prevalence of *H. pylori* infection among adults according to sewage disposal system [9].

	Sewage system		Septic tank		Village latrine		p
	n	%	n	%	n	%	
Białystok	117	89.3	115	89.2	20	87	n.s.
Katowice	361	79.9	166	86.5	42	89.4	0.061
Lublin	244	81.6	118	75.2	37	69.8	n.s.
Szczecin	508	85.4	32	80	7	100	n.s.
Warszawa	307	89.2	106	86.9	6	85.7	n.s.
Wrocław	280	84.8	54	91.7	1	100	n.s.
Other centres	120	80.5	40	69	5	100	n.s.
Total	1,937	84.2	631	83.6	118	82.5	n.s.

of subjects having farm animals and in 76% of those looking after them. The same percentage of the infected was found in the group without farm animals and not taking care of them (79%). The frequency of *H. pylori* infection among the individuals owing pets was 82% while in those without pets 75%. The combined farm buildings and houses had no influence on the number of the infected (in both groups – 75%).

Furthermore, the effects of sources of meat and vegetables and consumption of raw meat and unboiled water on the prevalence of *H. pylori* infection were examined. *H. pylori* infection developed in 78% of subjects purchasing meat exclusively in shops and in 79% of those consuming meat from their own stock-farming. The subjects purchasing vegetables in shops were *H. pylori* infected in 79% while those using their own crops in 78%. Statistically significant differences were demonstrated in the group consuming raw meat – 92% of the infected (76% of those not consuming raw meat). Drinking of unboiled water did not affect *H. pylori* infection. The subjects drinking unboiled water were infected in 75% while those drinking only boiled water in 79% (Tab. 7).

An increase in the *H. pylori* infection was observed with regard to the consumption of uncleaned fruits and vegetables. In this group, 90% of individuals had positive anti/*H. pylori* antibodies results (in the group always washing fruits and vegetables before consumption *H. pylori* infection was found in 78% of subjects.

Moreover, the relation between *H. pylori* infection and basic hygienic rules was evaluated. The evaluation included washing hands, frequency of baths and personal underwear changes. The number of infected in the group

Table 6. The number of cases and prevalence of *H. pylori* infection among adults according to farm work [9].

	Farm or allotment work					Use of natural fertilizers				
	no		yes		p	no		yes		p
	n	%	n	%		n	%	n	%	
Białystok	69	93.2	216	88.2	n.s.	19	100.0	193	87.7	n.s.
Katowice	311	81.6	265	83.6	n.s.	90	80.4	171	83.4	n.s.
Lublin	151	82.1	251	76.5	n.s.	66	75.0	194	77.3	n.s.
Szczecin	330	84.0	239	87.9	n.s.	91	84.3	128	87.7	n.s.
Warszawa	286	88.0	141	89.8	n.s.	97	91.5	63	86.3	n.s.
Wrocław	168	83.6	170	89.5	0.089	74	86.0	106	87.6	n.s.
Other centres	60	74.1	116	81.1	n.s.	16	59.3	92	81.4	0.014
Total	1,375	83.9	1,398	84.6	n.s.	433	83.0	1,400	83.6	n.s.

Table 7. The number of cases and prevalence of *H. pylori* infection among adults according to raw meat and unboiled water intake [9].

	Raw meat consumption					Drinking of unboiled water				
	no		yes		p	no		yes		p
	N	%	n	%		n	%	n	%	
Białystok	153	87.9	133	90.5	n.s.	110	92.4	175	87.1	n.s.
Katowice	467	82.4	109	83.8	n.s.	425	81.4	151	86.3	n.s.
Lublin	347	76.8	55	91.7	0.007	284	79.8	118	75.6	n.s.
Szczecin	364	84.3	204	87.9	n.s.	379	84.2	189	88.3	n.s.
Warszawa	302	88.3	129	88.4	n.s.	290	89.5	140	85.9	n.s.
Wrocław	293	87.2	45	81.8	n.s.	214	84.9	124	89.2	n.s.
Other centres	128	76.2	48	84.2	n.s.	79	78.2	97	78.2	n.s.
Total	2,054	83.1	723	87.4	0.003	1,781	83.8	994	84.8	n.s.

without proper hygienic habits exceeded 90%. With increased frequency of hygienic procedures the number of the *H. pylori* infected dropped to 65%.

DISCUSSION

Poland belongs to the countries with moderate intensity of *H. pylori* infection. The number of infected individuals ranges between 50-60% depending on the region studied, on average – 58%. In the adult population the infection is observed in 84% of subjects. Compared to the other centres, the prevalence of infection in the Lublin region is the lowest one in Poland (78%). Significant differences in *H. pylori* infection can be observed with regard to the place of residence. The lowest percentage of the infected live in the country (72%), followed by those living in big towns (74%; *H. pylori* infection is most commonly found in inhabitants of district towns (95%). Lublin Province is the area with the lowest level of *H. pylori* infection in Poland – 72% (average 83%). The highest number of the *H. pylori* infected are observed in rural inhabitants of the West-Pomeranian (87%) and Lower-Silesian provinces (93%) [9]. In these regions the highest peptic ulcers incidence rates was observed [16]. The results are different with regard to the place of birth and residence in the first years of life. The highest percentage of the infected is found in those born in the country (87%), followed by the individuals born in small towns (78%) and big towns (64%). Similar tendencies are observed in all the centres studied in Poland [9]. The observed differences between the place of birth and residence are likely to result from the migration from the country to towns, in the period of intensified industrialization particularly, and recently also the migration from towns to the country. The differences are substantial if we take into account that the Polish population is definitely resident. The census data reveal that almost 60% of population live in the same town (commune) since their birth. The rural inhabitants are found to be more resident (67% of them live in the country since birth; in towns only 54%). Thus the mobile population accounts for less than 40% of the total population. The migration is stimulated by job market changes, mostly new places created, education, improvement of professional qualifications or setting up a family [14].

The evaluation of the total population studied, in the Lublin centre as well as nationwide, demonstrates a systematic increase in the number of the infected in the consecutive age groups. This increased prevalence with age results from the so-called cohort effect (specific frequency of infection in a given generation dependent on the infection in childhood) and, to some extent, from infections acquired in adulthood. The infection frequency in childhood greatly determines the infection prevalence in adult population [1, 26]. The highest percentage increase in the infected is observed between the 5th and 6th decade of life. This group is represented by people born after World War II. This is likely to be associated with the bad economic situation of the country in that period and intensive internal and external migration. Besides the general tendency to an increase in morbidity in the successive age groups, certain differences in relation to the place of residence can be observed. In the 4th and 5th decade of life the number of *H. pylori* infected in the country and small towns is about 10% higher than that in big town inhabitants. This is likely to be related to worse socio-economic conditions of the rural population. Peptic ulcer occurred more frequently among people with a lower education level and among respondents who described their material standard as poor [17, 25]. The percentage of the infected becomes equal in the next age groups and becomes more favourable for rural inhabitants over 70 years of age (100% of the infected among the town inhabitants and about 80% among rural inhabitants). This fact demonstrates that the *H. pylori* infection may be acquired in any period of life, irrespective of age. The possibility of becoming infected with this bacterium increases with the number of person-to-person contacts (close physical contact, kisses, objects contaminated with saliva) [11]. The number of person-to-person contacts throughout the lifespan is significantly higher for town population compared to rural.

According to numerous worldwide studies, there is a reverse correlation between *H. pylori* incidence, socio-economic status and education of a particular country [15, 18]. These factors are the main reasons for differences in the prevalence of *H. pylori* infection between developed and developing countries [2]. The highest number of the infected is found in the population with no education or elementary education, the lowest number is observed in the group with higher education. On the other hand, the frequency of *H. pylori* infection is poorly affected by professional activity and the kind of job. The highest number of the infected is observed in the group of working farmers (79%), the lowest one amongst white collar workers (75%). A positive phenomenon observed for several years is a constant increase in the number of people with secondary education. Moreover, the number of individuals with higher education increased 1.5 times. The distance in attaining education between rural and town inhabitants is getting smaller and smaller. The percentage of individuals with secondary education in the country increased from 39% in 1988 to almost 56% in 2002 (in towns 73%) [10]. This is reflected in decreased *H. pylori* prevalence in town and rural communities in the recent years.

The spread of *H. pylori* infection is promoted by bad sanitary conditions and poor personal hygiene. According to our studies, washing hands, frequency of baths and underwear changes as well as oral cavity hygiene greatly affected the intensification of *H. pylori* infections. The frequency of *H. pylori* infection in individuals neglecting basic hygienic rules exceeds 90%. Among the subjects with proper hygienic habits the frequency of *H. pylori* infection is lower by 15-18%. The observed correlation between hygiene and *H. pylori* infections demonstrates

the importance of a faecal-oral route in infection transmission [19]. According to basic hygienic rules, the examined Lublin region population had positive results. Basic hygienic procedures were carried out properly by 96% of the examined subjects (average values for Poland-90%). The importance of this route of transmission may also be confirmed by the effects of sewage disposal on the frequency of *H. pylori* infection. A higher amount of infected persons was observed in the group using sewage systems (82%). The percentage in the group using septic tanks was found to be 75%.

It should be stressed that the frequency of *H. pylori* infection increases in subjects neglecting hand hygiene after contact with animals. Therefore it should be taken into account that man is not the only reservoir of bacteria. The infection may also develop after contact with domestic and farm animals [5, 12, 23]. Our epidemiological studies do not show that the fact of having farm animals influenced increased frequency of infection. However, statistically significant differences were found in the group having pets.

It was noted that consumption of raw meat clearly affected the frequency of *H. pylori* infection. Amongst the subjects who consumed raw meat, *H. pylori* infection occured in 91.7% of cases, while in those using only thermally processed meat this percentage was 76.8%.

The ability of *H. pylori* to form resting spores enables it to survive in the biological layer of water even for 8 days. In this form the bacterium was also found in milk. Therefore consumption of faeces-contaminated food products, especially fruits and vegetables purchased from a street stall, is likely to increase the risk of infection. The infection may also be caught by consumption of raw meat and unboiled water [4, 5]. Our results showed that the place of purchasing food did not affect *H. pylori* infection. The prevalence of infection among the subjects purchasing those products in shops or using their own farming is similar (78% and 79%, respectively). However, *H. pylori* infection is observed more frequently in the group who do not wash fruits before consumption (90.0%). In the group always washing fruits in running water, the frequency of *H. pylori* infection was 78%. The studies in our region demonstrate that the number of the infected is not affected by drinking unboiled water. In those drinking unboiled water the frequency *H. pylori* infection is 75.6% while in those who drink only boiled water – 79%. The possible *H. pylori* survival in water and spread of the infection in this way may be seen in the results examining the prevalence of *H. pylori* infection in relation to water supply systems. A great nationwide problem is the contamination of underground waters, which is mostly caused by agriculture and rural immigration. The application of mineral fertilizers, sewage from feed preparation and domestic sewage are serious sources of water pollution (in the rural region, particularly) [10, 20]. Our studies do not demonstrate that the use of natural fertilizers or the place of manure storage may affect the frequency of *H. pylori* infection.

The quality of drinking water strongly depends on the method of maintenance of devices supplying water to households. The Chief Central Statistical Office data show that water supplied by network pipes is better in quality than well water. The lowest quality is found in rural domestic wells [13, 20, 22]. This is also reflected in the frequency of *H. pylori* infection with regard to the household water supply system. 87% of subjects using wells as a source of water are infected with *H. pylori* while those using communal water supply system are infected in 78%.

Moreover, it should be noted that in the Lublin region among subjects using wells the *H. pylori* infected constitute the lowest percentage of the population nationwide, which indicates low water pollution in our region.

CONCLUSIONS

1. Lublin Province is the region with the lowest level of *H. pylori* infection in Poland.
2. The prevalence of *H. pylori* among rural inhabitants in the Lublin region is lower than that observed in town inhabitants.
3. *H. pylori* infection is strongly affected by the lack of basic hygienic rules and improper diet.

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