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TUBERCULOSIS IN HOMELESS PERSONS IN POLAND

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ABSTRACT

The fall in rates of tuberculosis (TB) in many countries has been accompanied by the concentration of cases in the social risk groups including homeless persons.

AIM. Comparison of TB features in homeless persons and in non-homeless patients.

METHODS. TB cases reported to National TB Register in Poland in whom information about the social status was available (the data about the social status were collected obligatorily in the years 2004-2013 only) were analysed. The results of DSTs were obtained from laboratory records and were available for the cases reported since 2010. Treatment outcome after 12 months was analysed for the cases registered between 2004-2012. The significance (Si) of the differences in proportions was assessed with chi-square test. $P < 0.05$ was regarded as statistically significant. Test F was used to evaluate the significance of differences of the means of age. The multivariate logistic regression models were applied to find out the independently operating determinants of not achieving of success of treatment.

RESULTS. 2,349 homeless persons (HP) and 72,989 other patients (OP) with TB were included. In the group of HP, there was a greater proportion of males in comparison with OP (90.5% vs. 66.3%) (Si). The mean age of HP was 49.8 years ($SD \pm 10.9$); of OP- 52.9 years ($SD \pm 17.5$) (Si). 16.6% of HP and 10.4% of OP were previously treated for TB (Si). The previous treatment was adequate in 62.2% of HP and in 85.8% of OP (Si). Pulmonary TB was in 98.0%, extrapulmonary TB in 2.0% of HP and, respectively, in 92.5% and 7.5% of OP (Si). Pulmonary TB was confirmed by culture in 76.3% of HP and in 64.5% of OP (Si). Sputum smears were positive in 70.7% of HP and in 62.5% of OP (Si). Caseous pneumonia occurred in 2.7% of homeless subjects and in 1.1% of OP (Si); infiltrative TB in 95.5% of HP and in 97.5% of OP (Si). Resistance to isoniazid was observed in 2.9% of HP and in 3.1% of OP; to rifampicin in 0.0% of HP and in 0.2% of OP; to isoniazid and rifampicin in 0.4% of HP and in 0.8% of OP. These differences were not Si. Treatment success rate among HP was 44.1%; default rate 24.8%; 4.0% of HP died from tuberculosis; 3.2% died from other causes; 5.2% were transferred and their outcomes were unknown; 0.4% were still on treatment; 0.4% had treatment failure; in 17.9% of HP results of treatment were not available. Among other TB patients the rate of success was 66.8%; of default- 8.8%; 1.9% died from TB; 3.1% died from other causes; 2.6% were transferred; 0.5% were still treated; 0.2% had treatment failure; in 16.1% the results were not reported. Differences between both groups were Si, except for the category "died from other causes", "still on treatment" and "treatment failure".

CONCLUSIONS. In the group of homeless persons with tuberculosis phenomena which indicate a delay in diagnosis of disease and in some cases the possibility of a recent infection and also unfavorable treatment outcomes occur in a greater proportion than among other patients. Targeted screening for TB and directly observed treatment could likely improve the epidemiological situation of tuberculosis in the population of homeless.

Key words: *tuberculosis, homeless persons, types of tuberculosis, smear and culture positive cases, drug resistance, treatment success, treatment default, death from tuberculosis*

INTRODUCTION

In the countries with a low incidence of TB, new cases are concentrated in the social risk groups. Groups at increased risk of TB include migrants from the countries with high prevalence of TB, poor people, prisoners, homeless persons, those who abuse alcohol, drug addicts and HIV-infected persons. In 2013, in 18 countries from the European Union and European Economic Area, TB incidence was below 10 cases per 100,000 population. Poland with the incidence of 18.8 cases per 100,000 population in 2013 (17.4 in 2014), does not belong to the mentioned group of countries with the best epidemiological situation of TB, but, according to the WHO and ECDC criteria, it is already the low-incidence country. Epidemiological trends observed in low-incidence countries are also found in Poland. The Polish group of patients with TB includes a larger proportion of unemployed and homeless people, compared to the entire population (1, 2).

Homeless persons, due to their lifestyle, are particularly exposed to infection with *M. tuberculosis* and, according to data collected in numerous countries, they start treatment while being at advanced stage of disease, so they constitute the source of infection for a long time. Treatment in homeless persons rarely ends with success (3).

THE OBJECTIVE OF THE STUDY

The objective of the study was to compare TB phenomena in homeless persons to other patients. The comparison concerned demographic data (sex and age), the occurrence of treatment of TB in the past, the results of bacteriological examination, drug-resistance to isoniazid (INH) and rifampicin (RMP) and to isoniazid and rifampicin simultaneously (multidrug-resistant tuberculosis - MDR-TB), form of TB (pulmonary and extrapulmonary), type of radiological changes in case of pulmonary TB (disseminated TB, caseous pneumonia, infiltrative TB, fibrocavernous TB) and treatment results.

The objective of the study was also to learn whether the homelessness has an independent impact to non-success of treatment. Another objective was to reveal the full set of independent causal factors of not achieving treatment success.

The knowledge of characteristics of tuberculosis in homeless persons will help to increase efficiency in the fight against TB in this social group.

MATERIAL AND METHODS

The data concerning TB cases registered between 2004-2013 in the National TB Register maintained by

the National Tuberculosis and Lung Diseases Research Institute in Warsaw were evaluated. Information used in the analysis was included in TB (suspected TB) case report forms. The years 2004-2013 were chosen because only then information about the social status of the patient in a TB (suspected TB) case report form was required. Solely the cases with available information about the social status of the patient were evaluated. We compared the group of people that in the TB (suspected TB) case report form in the point 3 of additional information regarding social status were marked "homeless", with the cases who in the same point were marked "schoolgoer/student, worker/farmer, white-collar worker, unemployed, retired person/pensioner".

The results of drug susceptibility testing (DST) in the registered cases were obtained from laboratory records. DST results have been collected since 2010, therefore, the results concerning the patients registered between 2010-2013 were analysed.

The data regarding treatment results after 12 months from reporting the disease concerned the cases registered between 2004-2012. Treatment results were classified in accordance with commonly used guidelines (4). Reporting of treatment results was not mandatory and treatment outcomes were made available on a voluntary basis.

Statistical analyses included observation units that did not lack data necessary for the analysed variable. Statistical calculations were performed using the SPSS software, version 21. The significance of the differences in proportions was evaluated using chi-square test. $P < 0.05$ was regarded as statistically significant. The differences in the mean age were analysed with the help of MEANS procedure from the SPSS. Test F was used to evaluate the significance of differences of the means of age.

The multivariate logistic regression models were applied to find out the independently operating determinants of not achieving of success of treatment.

RESULTS

The group of 2,349 homeless persons included 2,126 males (90.5%) and 223 females (9.5%). The group of 72,989 remaining patients with TB comprised 48,374 males (66.3%) and 24,615 females (33.7%). The difference in proportions of both sexes between the group of homeless subjects and other patients was statistically significant ($p < 0.001$).

The mean age of homeless patients (2,349) was 49.8 years ($SD \pm 10.9$), of the remaining subjects (72,974) - 52.9 years ($SD \pm 17.5$). The difference was statistically significant ($p < 0.001$) (Table I).

Table I. Demographics of TB cases in the group of homeless persons and in the group of other patients

Gender and age of patients*	Homeless persons			Non-homeless patients			Significance
	Nc**	N***	%	Nc	N	%	
Males in the group of patients	2126	2349	90.5%	48374	72989	66.3%	p<0.001
Age	2349	mean 49.8	SD ±10.9	72974	mean 52.9	SD ±17.5	p<0.001

* Only cases with data on a given characteristic (presence or absence) were included in the individual analyzes

** The number of cases in which analyzed characteristic was present

*** The total number of cases with available information on the presence or absence of a given characteristic

Explanations apply to all tables.

325 out of 1,959 (16.6%) homeless persons and 6,436 out of 62,130 (10.4%) remaining patients were treated due to TB in the past. The difference was statistically significant ($p < 0.001$).

The previous treatment took its normal course in 202 out of 325 (62.2%) homeless persons and in 5,520 out of 6,436 (85.8%) remaining patients (statistically significant difference; $p < 0.001$).

Among the homeless subjects, pulmonary TB occurred in 2,303 out of 2,349 (98.0%) patients; and extrapulmonary TB - in 46 (2.0%) persons. Solely pulmonary TB was found in 67,484 out of 72,989 other patients (92.5%), extrapulmonary - in 5,505 (7.5%) subjects. The difference was statistically significant ($p < 0.001$).

Pulmonary TB was confirmed by culture in 1,757 out of 2,303 homeless patients (76.3%) and in 43,542 out of 67,484 remaining subjects (64.5%). The difference was statistically significant ($p < 0.001$).

In the group of homeless persons, positive results of sputum smears were found in 70.7% of subjects with known result of the examination (1,198/1,695). The result of sputum bacterioscopy was known in 42,398 remaining patients with bacteriologically confirmed pulmonary TB, and the outcome was positive in 26,492 (62.5%). The difference was statistically significant ($p < 0.001$).

In the group of homeless patients with pulmonary TB, in whom the form of TB was known, miliary tu-

berculosis occurred in 6 out of 2,291 cases (0.3%) and in the same proportion in the remaining patients with a known form of pulmonary TB (185/67,041). The difference was not statistically significant.

Fibrocavernous TB occurred in 34 out of 2,291 (1.5%) homeless persons and in 773 individuals out of 67,041 (1.2%) other patients with pulmonary TB, with a known form of disease. The difference was not statistically significant.

Caseous pneumonia was diagnosed in 62 out of 2,291 (2.7%) homeless persons and in 714 out of 67,041 (1.1%) remaining subjects with pulmonary TB and a known form of disease ($p < 0.001$).

Infiltrative TB was found in 2,189 persons out of 2,291 homeless patients (95.5%) and in 65,369 out of 67,041 (97.5%) remaining subjects with pulmonary TB and a known form of disease ($p < 0.001$).

The results of DST were known in 716 homeless persons and in 14,398 other patients. The resistance to isoniazid was found in 21 homeless subjects (2.9%) and in 446 other patients (3.1%), whereas resistance to rifampicin was observed in 27 (0.2%) other patients and in none of the homeless, resistance to INH and RMP was noticed in 3 (0.4%) homeless persons and in 110 (0.8%) other patients. The differences were not statistically significant (Table II).

In the group of homeless persons, treatment success was achieved in 927 (44.1% out of 2,104 patients). 522

Table II. Clinical characteristics of TB cases in the group of homeless persons and in the group of other TB patients

Clinical characteristics	Homeless persons			Non-homeless patients			Significance
	Nc	N	%	Nc	N	%	
Tb treatment in the past -yes	325	1959	16.6%	6436	62130	10.4%	p<0.001
The previous TB treatment was adequate -yes	202	325	62.2%	5520	6436	85.8%	P<0.001
Pulmonary TB	2303	2349	98.0%	67484	72989	92.5%	p<0.001
Extrapulmonary TB	46	2349	2.0%	5505	72989	7.5%	p<0.001
Sputum smears + (in pulmonary TB)	1198	1695	70.7%	26492	42398	62.5%	p<0.001
Culture +	1782	2349	75.9%	45361	72989	62.1%	p<0.001
Culture + (in pulmonary TB)	1757	2303	76.3%	43542	67484	64.5%	p<0.001
Resistance to INH	21	716	2.9%	446	14398	3.1%	****NS
Resistance to RMP	0	716	0.0%	27	14398	0.2%	NS
MDR-TB	3	716	0.4%	110	14398	0.8%	NS
Miliary TB	6	2291	0.3%	185	67041	0.3%	NS
Caseous pneumonia	62	2291	2.7%	714	67041	1.1%	p<0.001
Infiltrative pulmonary TB	2189	2291	95.5%	65369	67041	97.5%	p<0.001
Fibrocavernous TB	34	2291	1.5%	773	67041	1.2%	NS

****NS- not significant

Table III. Results of treatment in the group of homeless persons and in the group of other TB patients

Results of treatment	Homeless persons			Non-homeless patients			Significance
	Nc	N	%	Nc	N	%	
Success of treatment	927	2104	44.1%	45789	68511	66.8%	p<0.001
Treatment failure	8	2104	0.4%	153	68511	0.2%	NS
Treatment default	522	2104	24.8%	6007	68511	8.8%	p<0.001
Transferred to...	110	2104	5.2%	1767	68511	2.6%	p<0.001
Death	68	2104	3.2%	2109	68511	3.1%	NS
Death because of TB	84	2104	4.0%	1304	68511	1.9%	p<0.001
Still on treatment	8	2104	0.4%	371	68511	0.5%	NS
Results not reported	377	2104	17.9%	11010	68511	16.1%	p<0.02

(24.8%) patients defaulted from treatment, 84 (4.0%) died due to TB, 68 (3.2%) died from other causes, 110 subjects (5.2%) were transferred out, in 8 patients (0.4%) the result was classified as “still on treatment”, in 8 (0.4%) - as “treatment failure”, the results of 377 (17.9%) patients were not available. The differences between homeless and other patients were statistically significant apart from the subjects who died due to other causes, were still on treatment or were classified as treatment failure.

Treatment success was achieved in 45,789 other patients (non-homeless) (66.8% out of 68,511 patients), 6,007 (8.8%) subjects defaulted from treatment, 1,304 (1.9%) persons died due to TB, 2,109 (3.1%) died due to other causes. In 153 patients (0.2%) treatment failure was observed; 371 (0.5%) subjects - after 12 months were still treated, 1,767 (2.6%) belonged to the category – transferred out - and their treatment results remained unknown. In 11,010 cases (16.1%) the results were not available (Tab. III).

Treatment results could not be evaluated (not available, patients transferred to another centre, still on treatment) in 495 out of 2,104 (23.5%) homeless persons and in 13,148 out of 68,511 remaining patients (19.2%). The difference was statistically significant ($p < 0.001$).

The dependent variable in the multinomial logistic regression model was the non-success of treatment. The explaining variables (determinants) in this model were: age, gender, resistance to INH, resistance to RMP, MDR-TB, type of TB- pulmonary and extrapulmonary, previous treatment of TB, culture confirmation, microscopy result, and homelessness. It turned out that the only significant factors ($p < 0.001$) explaining the non-success of treatment were (in decreasing value of standardized regression coefficients): being male, positive result of culture, the resistance to RMP, resistance to INH and MDR-TB and homelessness.

DISCUSSION

Due to biological, social and environmental factors, the risk of TB is higher in some groups of society than in the entire population. The homeless constitute such

a high-risk group of development of TB. They stay in overcrowded shelters, live next to other homeless people, which exposes them to infection with *M. tuberculosis*. Commonly met among the homeless problems, such as malnutrition, alcoholism, cigarette smoking and in some countries drug addiction, are the factors that promote reactivation of an acquired TB infection (5-7). TB incidence among the homeless is several times higher compared to the remaining population (8-11).

In Poland, approximately twofold predominance of men among TB patients is observed over the years. In the group of homeless TB patients, the predominance of men in relation to women was 9.5 : 1, in the group of remaining patients - 2.0 : 1. In the entire population of the homeless, the predominance of men in 2013 was 4 : 1 (in 2013, they constituted 80% of all counted homeless persons) (12). A substantial proportion of men among homeless patients with TB was also found in other countries (13). Homeless persons with TB were statistically significantly younger than other patients, which may be related to the fact that in Poland, the majority of the homeless are under 60 years of age (12). Furthermore, younger age of homeless TB patients may indicate in this group a bigger proportion of cases that were infected recently, and not the cases with infection that had been acquired many years ago, and then was reactivated. Such possibility is supported by frequent occurrence of caseous pneumonia among the homeless, which is attributed to primary TB (statistically significant differences). The proportion of homeless persons with typical for post-primary disease infiltrative form of pulmonary TB, was lower than the remaining patients.

Epidemiological - conventional and molecular examinations that were carried out in various countries, indicate the current transmission of infection with *M. tuberculosis* among the homeless. The homeless get infected in shelters, hostels, also in emergency rooms in hospitals, where they are waiting for medical care, e.g. due to complications related to alcoholism. Poorly ventilated and overcrowded rooms where homeless people live, facilitate infection. In Poland, homeless people are also more exposed to *M. tuberculosis* than other groups. The study conducted in Cracow showed that homeless persons had positive tuberculin skin test

results and positive IGRA test results more frequently than the persons who seemed to be most exposed to infection, i.e. those who had close contact with TB patients (14-16).

The proportion of homeless patients with resistance to isoniazid, rifampicin and the two drugs simultaneously was in the present analysis not statistically significantly lower, compared to other subjects. Earlier conducted examinations allowed to identify the risk factors for MDR-TB. The highest risk factor for MDR-TB that is repeated in the studies is previous treatment. It seems that it is not the fact of previous treatment alone that counts but its regularity and the use of drugs adequate for drug-sensitiveness of *Mycobacterium tuberculosis* (17). In the present study, a larger proportion of homeless persons were treated for TB in the past, compared to the remaining patients. However, it did not result in a larger proportion of disease caused by drug-resistant bacilli. It may be caused by the fact that when homeless people stop treatment they do it completely. They do not take a single drug, which results in selection of resistant strains. They often abandon treatment definitely, usually at its initial stage, during their stay in hospital (17, 18). In the literature, homelessness is not considered to be a risk factor for MDR-TB.

According to information included in the TB case report forms, previous treatment was appropriate merely in 62.2% of homeless subjects (in other patients - 85.8%). So it is very probable that a wide group of homeless patients stopped treatment. Early termination of properly matched treatment results in the higher risk of recurrence of the disease but not in drug-resistance (17).

A lower proportion of homeless persons had extrapulmonary TB, compared to other patients. The difference may be explained by more frequent among the homeless alcohol abuse and cigarette smoking, which are the factors that promote pulmonary TB, reducing the probability of the occurrence of extrapulmonary forms of TB (19-21).

The persons living on the margins of society: homeless, unemployed, abusing alcohol, living alone, have TB diagnosed at more advanced stage, compared to other patients (13, 21, 22).

Due to late diagnosis of TB (in the American study, TB was treated in homeless people on average after 10 months of infectivity) homeless persons are the source of new cases of the disease (23, 24).

One reason for such situation may lie in poor functioning of health care system. It occurs that homeless persons inform their doctors about symptoms typical of TB, and despite the fact that they are commonly considered the risk group for TB, they are not examined for TB (25).

In the present paper, it was shown that among homeless patients, pulmonary TB was confirmed bacteriologi-

cally in a statistically significantly larger proportion. A statistically significantly larger proportion of homeless patients, compared to other patients, had positive results of sputum bacterioscopy and fibrocavernous TB (insignificant difference). It indicates more advanced TB at diagnosis, so, indirectly, late diagnosis.

In Poland, treatment results of tuberculosis are worse than average results in the European Union countries. The most crucial cause may be a voluntary character of reporting them by doctors. A large proportion of patients whose treatment results are unknown, reduces the proportion of cases with treatment success in a cohort analysis. The proportion of patients registered in Poland in 2012 who achieved treatment success amounted to 58.2%, whereas in the European Union - 74% (4). Reporting the results of treatment of tuberculosis should be obligatory in Poland as it is in most countries. Knowledge of treatment results enables effective supervision of tuberculosis

In the present study, treatment results of homeless persons were worse compared to other patients; the proportion of patients who achieved treatment success, in the group of homeless subjects, was statistically significantly lower.

The homelessness was revealed in regression analysis the independent causal factor operating on non-success of treatment. Therefore, the smaller chances of homeless people to achieve the success of treatment are not the simple consequence of the fact that majority of homeless people are men who as a rule have worse outcome of treatment (2). Homelessness determines chances of treatment success independently to other variables. The positive culture which is also more common among homeless people operates similarly to homelessness and is an independent factor determining the non-success of treatment. Also resistance to the first-line anti-TB drugs which is less common among homeless people has an independent causal impact that decreases the probability of success of treatment.

A statistically significantly larger proportion of homeless patients defaulted from treatment or were transferred to another centre, and their treatment results were unknown at the place of previous stay. A statistically significantly larger proportion of homeless persons died due to TB, which is also indicative of delayed both diagnosis and treatment. Defaulting from treatment by homeless patients with TB and poor treatment outcome are common phenomena (18, 26-28). In the group of homeless subjects described between 2007-2010 by the Japanese authors, a large proportion of deaths due to TB were also observed (13)

The actions aimed at reducing the number of TB incidence among the homeless are undertaken in many countries. The use of directly observed therapy (DOT) in this group of patients is likely to improve treatment

results and reduce the proportion of disease recurrences. Better effects of DOT may be obtained with the help of awards and incentives (11,29).

Screening programmes aimed at TB detection among the homeless are being conducted in countries at the forefront in fighting with tuberculosis but data on the outcomes of such actions are sparse. For example, the British National Institute for Health and Care Excellence (NICE) recommends that screening radiological examinations are performed in shelters for the homeless (30). The activities should be supported by directed social care.

In the United States coercive measures in the fight against tuberculosis are applied. In New York, the patients who avoid treatment are subject to law on public health and by court decision are incarcerated. Then most patients achieve good treatment results (29).

For actions aimed at improving the epidemiological situation of tuberculosis in the group of homeless persons it is necessary to know who is homeless among patients with tuberculosis and what is the scale of the co-occurrence of homelessness and tuberculosis. Information about the social status of the patient should find its place on the notification form of TB cases.

SUMMARY

A larger proportion of homeless persons with TB were males, they were also younger, compared with the remaining patients. In comparison with other patients, a larger proportion of homeless subjects were treated for TB in the past and the treatment course in most cases was incorrect. A smaller proportion of homeless subjects had extrapulmonary TB, compared to other patients. Homeless persons had more advanced TB at diagnosis than the remaining patients, which has been confirmed by a larger proportion of persons with positive sputum smears and culture results. A larger proportion of homeless patients, compared to other subjects, had caseous pneumonia, which may be indicative of recent infection. The mentioned differences in proportions were statistically significant. A lower proportion of homeless persons with TB, although statistically insignificantly, had resistance to isoniazid and/or rifampicin.

A smaller proportion of homeless patients, compared to other subjects, achieved treatment success, a larger proportion defaulted from treatment and died due to TB.

CONCLUSIONS

The phenomena that are indicative of late diagnosis of the disease, and in some cases, of the possibility of

recent infection and poor treatment results occur more frequently in the group of homeless persons with TB, compared to other patients. Screening tests targeted at TB and DOT could improve epidemiological situation of TB among the homeless.

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CORRIGENDUM: In the article entitled „Chickenpox in Poland in 2013” authored by M. R. Korczyńska and J. Rogalska which was published in the Przegląd Epidemiologiczny – Epidemiological Review 2015;69(2):p.219, incorrect term was used in the summary part of the abstract i.e. “smallpox” instead of “chickenpox”

ERRATA: In the article entitled “Measles in Poland in 2013” authored by J. Rogalska, which was published in the Przegląd Epidemiologiczny – Epidemiological Review 2015;69(2):pp.205-207, tables and figure were not inserted. Omitted tables and figure are presented below (page 452 and page 478).

Table I. Measles in Poland during 2007-2013. Number of suspected and confirmed cases and incidence per 100 000 population by voivodeship

Voivodeship	Median 2007 - 2011						2012						2013					
	suspected cases		confirmed cases		incidence per 100 000		suspected cases		confirmed cases		incidence per 100 000		suspected cases		confirmed cases		incidence per 100 000	
	number	incidence per 100 000	number	incidence per 100 000	number	incidence per 100 000	number	incidence per 100 000	number	incidence per 100 000	number	incidence per 100 000	number	incidence per 100 000	number	incidence per 100 000	number	incidence per 100 000
POLAND	147	0.39	40	0.1	127	0.33	70	0.18	258	0.67	84	0.22						
1. Dolnośląskie	10.5	0.37	9	0.31	24	0.82	18	0.62	3	0.1	1	0.03						
2. Kujawsko-pomorskie	5	0.24	2	0.1	6	0.29	1	0.05	9	0.43	-	-						
3. Lubelskie	7	0.32	7	0.32	3	0.14	-	-	3	0.14	-	-						
4. Lubuskie	1.5	0.15	1	0.1	1	0.1	-	-	1	0.1	-	-						
5. Łódzkie	7	0.27	4	0.16	1	0.04	1	0.04	3	0.12	-	-						
6. Małopolskie	12	0.36	2.5	0.08	7	0.21	3	0.09	46	1.37	24	0.71						
7. Mazowieckie	22	0.42	10	0.19	30	0.57	21	0.4	47	0.89	14	0.26						
8. Opolskie	7	0.68	3	0.29	1	0.1	-	-	14	1.39	-	-						
9. Podkarpackie	5.5	0.26	12.5	0.6	3	0.14	1	0.05	2	0.09	-	-						
10. Podlaskie	3	0.25	-	-	1	0.08	-	-	-	-	-	-						
11. Pomorskie	1	0.04	1	0.04	7	0.31	1	0.04	4	0.17	1	0.04						
12. Śląskie	10	0.22	5	0.11	30	0.65	22	0.48	86	1.87	30	0.65						
13. Świętokrzyskie	1	0.08	1	0.08	0	0	-	-	2	0.16	-	-						
14. Warmińsko-mazurskie	1	0.07	1	0.07	0	0	-	-	1	0.07	-	-						
15. Wielkopolskie	8	0.24	10	0.3	11	0.32	1	0.03	22	0.64	1	0.03						
16. Zachodniopomorskie	2.5	0.15	1	0.06	2	0.12	1	0.06	1.5	0.87	1.3	0.76						

Table II. Number and percentage of children vaccinated against measles in Poland 2010-2013 according to birth year (primary and booster vaccinations)*

Year of birth	As of 31th December 2010		As of 31th December 2011		As of 31th December 2012		As of 31th December 2013	
	number	% of children vaccinated	number	% of children vaccinated	number	% of children vaccinated	number	% of children vaccinated
2007	402 018	99	379 510	99.4	377 818	99.5	377 446	99.5
2008	400 927	98.1	402 018	99	403 615	99.3	401 608	99.4
2009	340 509	84.4	400 927	98.1	404 820	98.9	405 744	99.1
2010	x	x	340 509	84.4	395 336	97.9	398 282	98.7
2011	x	x	x	x	318 126	83.6	370 876	97.5
2012	x	x	x	x	x	x	314 402	82.8
Booster dose								
2001	156 428	44.5	210 997	60.1	235 086	67.1	257 018	73.6
2002	3 437	1	181 325	53.7	239 103	70.8	260 467	77.3
2003	1 259	0.4	x	x	255 409	76.6	309 837	93.2
2004	x	x	x	x	x	x	267 231	79
2005	x	x	x	x	x	x	x	x

* vaccination against measles, rubella and mumps - MMR (based on “Vaccinations in Poland in 2013”, NIPH-NIH, Warsaw 2014)