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The Use of the Health Disparities Calculator in Analysis of the Lung Cancer Burden in Urban and Rural Populations in the Świętokrzyskie Province (Poland): 1999–2010

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Abstract. The purpose of the study was a comparative analysis of the burden of lung cancer in urban and rural areas in the Świętokrzyskie Province in the years 1999–2010. The material for the study accounted for information about the number of new cases of lung cancer obtained from the Świętokrzyskie Cancer Registration Office in Kielce and data from the Central Statistical Office concerning the number of deaths due to lung cancer in the years 1999–2010. Crude and age-standardized incidence, mortality, and potential years of life lost rates were calculated separately for groups of men and women in urban and rural areas. A comparative analysis of coefficients in urban and rural areas based on Rate Ratio (RR) and Rate Difference (RD) was performed by using the Health Disparities Calculator. The average annual incidence of lung cancer among men was 18% lower in the urban population than in the rural, while the mortality rate was 16% lower. For women, the incidence and mortality rates were higher in urban areas as opposed to rural areas – by 48% and 54% respectively. The comparative analysis of the burden of lung cancer showed great diversity between urban and rural populations in the Świętokrzyskie Province.

Introduction

Lung cancer has been the most frequently occurring cancer in the world for a few decades. In 2012 alone, 1.8 million new cases were noted, and it is estimated that it is also responsible for 1/5 of cancer deaths (Ferlay et al., 2012).

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In Poland, lung cancer is the most common cancer among men and one of the most common cancers among women. It is also the main cause of cancer death, among both men and women (Wojciechowska et al., 2014).

Inequalities in health status are an important problem for many societies (Lipowicz, 2015; Whitehead et al., 2007). The main factors responsible for their formation are poverty, unemployment, risks in the workplace, education level, availability of health care and place of residence (urban-rural). Human behaviors, such as smoking, consumption of alcohol, physical activity and eating habits also play an important role. In Poland, one of the inequalities in health is the variation observed in the burden of cancers dependent on place of residence (urban-rural) (World Health Organization Regional Office for Europe, 2012). Wherefore in the National Health Programme for the years 2007–2015 (2007), reducing social and territorial differences in the health condition of the population was assumed as one of the strategic objectives. The analysis of differences in incidence, mortality, and potential years of life lost due to lung cancer between urban and rural areas is an important tool in assessing activities aimed at eliminating inequities in health.

The purpose of the study was a comparative analysis of the burden of lung cancer in urban and rural areas in the Świętokrzyskie Province in the years 1999–2010.

Materials and Methods

The material was based on data on the number of new cases of lung cancer registered in the urban and rural populations in the Świętokrzyskie Province in the years 1999–2010, which was obtained from the Świętokrzyskie Cancer Registration Office in Kielce (CR). Data on the number of lung cancer deaths in the urban and rural populations, in the same years, were obtained from the Central Statistical Office (CSO) (Główny Urząd Statystyczny, 2015). Data concerning cancer of the trachea, bronchus, and lung were extracted from both databases using the code C33-C34 according to the 10th revision of the International Classification of Diseases (ICD-10) (World Health Organization, 2004).

"Urban area" was defined as an area having the status of town, established in accordance with the relevant legal act (Ustawa z dnia 29 sierpnia 2003 r. o urzędowych nazwach miejscowości i obiektów Fizjograficznych, 2003). Place of residence in the incidence analysis was defined by the CR in Kielce and in the mortality analysis by the CSO pursuant to

the *Act of 29 August 2003 on official names of localities and physiographic objects*. The population of the Świętokrzyskie Province between the years of 1999 and 2010 consisted, on average, of 1,287,214 inhabitants, 45.54% living in urban areas (Główny Urząd Statystyczny, 2015).

An annual number of new lung cancer cases and lung cancer deaths were calculated separately for men and women, in both urban and rural populations. Crude and standardized incidence, mortality, and potential years of life lost rates, according to the World Standard Population, were calculated and expressed per 100,000 persons at risk. Potential years of life lost (PYLL) were calculated using the method proposed by Romeder et al. (1977), according to which premature mortality was defined as death before 70 years of age. The calculations were made according to the formula:

$$PYLL = \sum_{i=1}^{70} d_i \cdot (70 - i)$$

where

- 70 is the cut-off age before the occurrence of death,
- i is the average number of potential years of life lost due to causes of death registered for the given age group (e.g. 42.5 years for the age group 25–29),
- d_i is the number of deaths in i age group.

A comparative analysis of coefficients in the urban and rural populations was performed using the Health Disparities Calculator (Version 1.2.4) (National Cancer Institute, Division of Cancer Control and Population Sciences, Surveillance Research Program and Applied Research Program, 2013) developed by the US National Cancer Institute. The program enables the assessment and monitoring of health inequalities as well as the examination of trends of inequality among the compared groups. It allows one to generate four absolute and seven relative measures illustrating the differences in health that may be affected by such characteristics as race, ethnicity, income, education or place of residence. The results are displayed as tables and charts, which may be exported for use in other applications (Breen et al., 2014).

The comparative analysis of coefficients in the urban and rural areas was made based on Rate Difference (RD) (absolute measure) and Rate Ratio (RR) (relative measure). They are recommended for pairwise comparisons.

Rate Difference is a simple arithmetic difference between two indicators that reflects the state of health of the compared groups. A Rate Difference

value equal to 0 means there is no difference between the groups that were compared, and it is expressed in the same units as r_1 and r_2.

Rate Ratio is the quotient of the two indicators reflecting the health status of compared groups. A Rate Ratio value equal to 1 indicates no difference between the compared groups. The calculations were made according to the formulas:

$$RD = r_1 - r_2$$

$$RR = r_1 \div r_2$$

where r_1 and r_2 are indicators of health status in two social groups:
- r_1 is the incidence rate, mortality rate, or PYLL rate in the urban areas,
- r_2 is the incidence rate, mortality rate, or PYLL rate in the rural areas, and is the reference group.

To determine statistical significance, standard errors and 95% confidence intervals (CI) for the indicators' inequalities were estimated at each time point (Harper et al., 2005, 2007). The calculations were made according to the formula:

$$SE_{RD} = \frac{r_1 - r_2}{\sqrt{SE_{r_1}^2 + SE_{r_2}^2}}$$

$$SE_{RR} = \frac{r_1}{r_2}\sqrt{\left(\frac{SE_{r_1}}{r_1}\right)^2 + \left(\frac{SE_{r_2}}{r_2}\right)^2}$$

where:
- SE_{r_1} is the standard error of incidence rate, mortality rate, or PYLL rate in urban areas,
- SE_{r_2} is the standard error of incidence rate, mortality rate, or PYLL rate in rural areas (the reference group),
- r_1 is the incidence rate, mortality rate, or PYLL rate in urban areas,
- r_2 is the incidence rate, mortality rate, or PYLL rate in rural areas.

The standard errors for crude rates of incidence, mortality and PYLL were calculated according to the formula:

$$SE = \frac{\sqrt{d}}{n}$$

where:
- d is the number of incident cases, deaths, or potential years of life lost,
- n is the population size.

For age-standardized rates, the standard error was calculated according to the formula (Esteve et al., 1994):

$$SE = \sqrt{\sum_{x=1} \left(\frac{w_x^2 \cdot k_x}{m_x^2} \right)}$$

where:

- k_x is the number of cases, deaths, or potential years of life lost for the x^{th} age group,
- m_x is the population size in each age group x,
- w_x is the structure of the standard population by age for the x^{th} age group.

The *Joinpoint* model was used to analyze time trends on the basis of the linear regression model, in which the natural logarithm of incidence or mortality or PYLL rate was a dependent variable, and the calendar year was an independent variable ($y = a + bx$, where $y =$ ln(incidence or mortality or PYLL rate), $x =$ calendar year). Annual percent changes (APCs) of incidence, mortality, and PYLL rates were determined. To determine the statistical significance of APCs, a 95% confidence interval was adopted in the analyzed period (Kim et al., 2000). The Joinpoint Regression Program (Version 4.1.1.3) was used to analyze trends and APC values (National Cancer Institute, Statistical Research and Applications Branch, 2014).

Results

As presented in Table 1, the incidence of lung cancer for men was observed to be decreasing in urban (APC = −3.9% [95% CI: −5.5; −2.3]) and rural areas (APC = −2.3% [95% CI: −3.1, −1.5]) from 1999–2010. Tables 3 and 4 present that the level of incidence for men was higher in rural than in urban areas. The urban/rural ratio for ASR was, on average, 0.82 [95% CI: 0.70; 0.97]; the urban-rural difference was −13.1 [95% CI: −24.1; −2.1].

For women, an increase in the incidence of lung cancer was reported in urban areas, on average by 0.4% per year [95% CI: −2.0; 2.8]. In rural areas, the average annual growth was 3.9% [95% CI: 0.9; 7.1) (Table 2). The level of incidence for women was higher in urban than in rural areas. The urban/rural ratio for ASR was on average 1.48 [95% CI: 1.04; 2.13] (Table 3); the urban-rural difference was 4.7 [95% CI: 0.5; 8.9] (Table 4).

Table 1. Rates of incidence, mortality, and PYLL of lung cancer and their trends from 1999–2010 in the urban and rural areas in the Świętokrzyskie Province

	MEN					
	URBAN			RURAL		
RATE OF INCIDENCE PER 105 POPULATION						
	1999	2010	%Change	1999	2010	%Change
CR[a]	92.6	75.0	–19.0	115.9	105.9	–8.6
APC 95% CI	1999–2010: –0.9 (–2.4;0.6)			1999–2010: –1.2* (–1.8;–0.5)		
ASR[b]	74.3	42.4	–42.9	80.7	67.2	–16.7
APC 95% CI	1999–2010: –3.9* (–5.5;–2.3)			1999–2010: –2.3* (–3.1;–1.5)		
RATE OF MORTALITY PER 10^5 POPULATION						
	1999	2010	%Change	1999	2010	%Change
CR[a]	70.9	84.1	+18.6	103.4	104.1	+0.7
APC 95% CI	1999–2010: +1.1 (–0.4;2.6)			1999–2010: +0.1 (–0.8;1.1)		
ASR[b]	56.1	47.8	–14.8	71.0	66.6	–6.2
APC 95% CI	1999–2010: –2.0* (–3.6;–0.3)			1999–2010: –1.0 (–2.1;0.2)		
RATE OF POTENTIAL YEARS OF LIFE LOST PER 10^5 POPULATION						
	1999	2010	%Change	1999	2010	%Change
CR[a]	593.3	507.1	–14.5	625.3	561.6	–10.2
APC 95% CI	1999–2010: –2.1* (–3.3;–0.9)			1999–2010: –0.8 (–2.4;0.8)		
ASR[b]	460.2	299.2	–35.0	533.9	380.8	–28.7
APC 95% CI	1999–2010: –4.8* (–6.2;–3.4)			1999–2010: –3.1* (–4.6;–1.5)		

%Change – decrease or increase of rate from 1999 to 2010 in percent (of observed values)
* – the APC is statistically significant (of trend values)
[a] – crude rate; [b] – age standardized rate

Table 2. Rates of incidence, mortality, and PYLL of lung cancer and their trends from 1999–2010 in the urban and rural areas of the Świętokrzyskie Province

	WOMEN					
	URBAN			RURAL		
RATE OF INCIDENCE PER 10^5 POPULATION						
	1999	2010	%Change	1999	2010	%Change
CR[a]	20.8	33.3	+60.1	13.6	18.7	+37.5
APC 95% CI	1999–2010: +3.2* (1.0;5.6)			1999–2010: +2.4* (0.2;4.7)		
ASR[b]	13.0	14.9	+14.6	6.8	9.6	+41.2
APC 95% CI	1999–2010: +0.4 (–2.0;2.8)			1999–2010: +3.9* (0.9;7.1)		

RATE OF MORTALITY PER 10^5 POPULATION						
	1999	2010	%Change	1999	2010	%Change
CR[a]	14.1	30.7	+117.7	10.8	15.3	+41.7
APC 95% CI	1999–2010: +5.2* (2.6;7.9)			1999–2010: +4.2* (1.4;7.1)		
ASR[b]	8.4	14.1	+67.9	5.6	8.3	+48.2
APC 95% CI	1999–2010: +2.5 (–0.2;5.2)			1999–2010: +5.3* (1.9;8.9)		
RATE OF POTENTIAL YEARS OF LIFE LOST PER 10^5 POPULATION						
	1999	2010	%Change	1999	2010	%Change
CR[a]	113.8	201.7	+77.2	63.3	102.9	+62.6
APC 95% CI	1999–2010: +5.4* (2.9;7.9)			1999–2010: +6.6* (1.7;11.6)		
ASR[b]	86.1	103.0	+19.6	49.9	69.0	+38.3
APC 95% CI	1999–2010: +2.2 (–0.0;4.4)			1999–2010: +4.9 (–0.1;10.2)		

%Change – decrease or increase of rate from 1999 to 2010 in percent (of observed values)
* – the APC is statistically significant (of trend values)
[a] – crude rate; [b] – age standardized rate

Table 3. Urban/rural ratio of lung cancer incidence. Mortality and PYLL rates from 1999–2010 in the Świętokrzyskie Province

	MEN			WOMEN		
	1999	2010	1999–2010ˆ	1999	2010	1999–2010ˆ
URBAN/RURAL RATIO OF INCIDENCE RATES						
CR[a] 95% CI	0.80* (0.68;0.93)	0.71* (0.60;0.84)	0.81* (0.69;0.95)	1.53* (1.05;2.22)	1.78* (1.31;2.43)	1.47* (1.06;2.04)
ASR[b] 95% CI	0.92 (0.79;1.08)	0.63* (0.53;0.75)	0.82* (0.70;0.97)	1.91* (1.27;2.88)	1.55* (1.10;2.18)	1.48* (1.04;2.13)
URBAN/RURAL RATIO OF MORTALITY RATES						
CR[a] 95% CI	0.69* (0.58;0.81)	0.81* (0.69;0.95)	0.82* (0.69;0.97)	1.31 (0.85;2.01)	2.01* (1.44;2.81)	1.58* (1.10;2.26)
ASR[b] 95% CI	0.79* (0.66;0.94)	0.72* (0.60;0.85)	0.84 (0.71;1.00)	1.50 (0.93;2.41)	1.70* (1.18;2.45)	1.54* (1.04;2.28)
URBAN/RURAL RATIO OF PYLL RATES						
CR[a] 95% CI	0.95 (0.89;1.01)	0.90* (0.84;0.97)	~	1.80* (1.50;2.15)	1.96* (1.70;2.26)	~
ASR[b] 95% CI	0.86* (0.81;0.92)	0.79* (0.73;0.84)	~	1.73* (1.46;2.05)	1.4* (1.30;1.71)	~

ˆ – the annual average for 1999–2010; * statistical significance
[a] – crude rate; [b] – age standardized rate

Table 4. Urban-rural difference of lung cancer incidence. Mortality and PYLL rates from 1999–2010 in the Świętokrzyskie Province

	MEN			WOMEN		
	1999	2010	1999–2010^	1999	2010	1999–2010^
URBAN-RURAL DIFFERENCE OF INCIDENCE RATES						
CR[a] 95% CI	–23.3* (–39.2;–7.4)	–30.9* (–45.7;–16.1)	–21.1* (–36.7;–5.5)	7.2* (0.9;13.5)	14.6* (6.7;22.5)	8.5* (1.2;15.8)
ASR[b] 95% CI	–6.4 (–18.6;5.8)	–24.8* (–34.1;–15.5)	–13.1* (–24.1;–2.1)	6.2* (2.3;10.1)	5.3* (1.3;9.3)	4.7* (0.5;8.9)
URBAN-RURAL DIFFERENCE OF MORTALITY RATES						
CR[a] 95% CI	–32.5* (–46.9;–18.1)	–20.0* (–35.2;–4.8)	–18.2* (–33.2;–3.2)	3.3 (–2.1;8.7)	15.4* (7.9;22.9)	8.3* (1.7;14.9)
ASR[b] 95% CI	–14.9* (–25.8;–4.0)	–18.8* (–28.4;–9.2)	–10.7* (–21.2;–0.2)	2.8 (–0.5;6.1)	5.8* (1.9;9.7)	4.2* (0.4;8.0)
URBAN-RURAL DIFFERENCE OF PYLL RATES						
CR[a] 95% CI	–32.0 (–72.1;8.1)	–54.4* (–92.6;–16.4)	~	50.5* (35.2;65.8)	98.8* (78.1;119.5)	~
ASR[b] 95% CI	–73.7* (–104.5;–42.9)	–81.6* (–104.7;–58.5)	~	36.2* (25.0;47.4)	34.0* (22.8;45.2)	~

^ – the annual average for 1999–2010; * statistical significance
[a] – crude rate; [b] – age standardized rate

Figures 1 and 2 present trends of inequality in the incidence of lung cancer between urban and rural areas for men and women. In 2010, as opposed to 1999, a 287.5% increase in inequality was reported for men, while for women there was a 14.5% decrease.

In the Świętokrzyskie Province, a systematic decline in mortality among men was observed both in urban and rural areas. The average annual decrease was up to 2.0% [95% CI: −3.6, −0.3] in urban areas and 1.0% [95% CI: −2.1, 0.2] in rural areas. The opposite trend was observed for crude rates (Table 1). In the analyzed period, the incidence rate was, on average, 16% lower in urban areas than in rural areas (urban-rural difference was 10.7 deaths/10^5 men – the difference was statistically significant) (Tables 3 and 4).

Amongst women, there was a systematic increase in mortality rates both in urban areas and (APC = +2.5% [95% CI: −0.2, 5.2]) in rural areas (APC = +5.3% [95% CI: 1,9; 8,9]) (Table 2). The mortality rate was on average 54% higher in urban areas than in rural areas (urban-rural difference

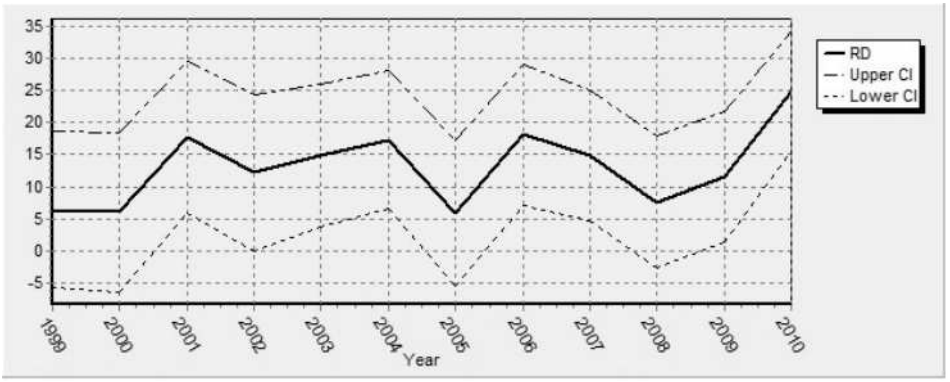

Figure 1. Trends of rate difference of age-standardised incidence rates among men in Świętokrzyskie, years 1999-2010

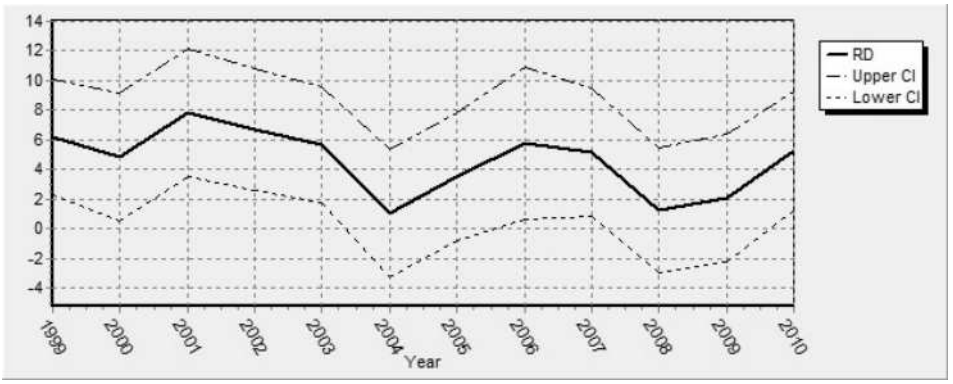

Figure 2. Trends of rate difference of age-standardised incidence rates among women in Świętokrzyskie, years 1999-2010

was equal to 4.2 deaths/10^5 women). These differences were statistically significant (Tables 3 and 4).

Figures 3 and 4 illustrate trends of inequality in lung cancer mortality for both sexes, again presenting both urban and rural areas. In 2010, there was a 26.2% increase in inequality in the burden of mortality between men from urban and rural areas in relation to 1999, and a 107.1% increase was reported for women.

In 2010, the male population was characterized by a systematic decline in PYLL rate values in urban (APC = −4.8% [95% CI: −6.2; −3.4]) and rural areas (APC = −3.1% [95% CI: −4.6, −1.5]) (Table 1). Tables 3 and 4 illustrate that the level of PYLL for men was higher in rural than in urban

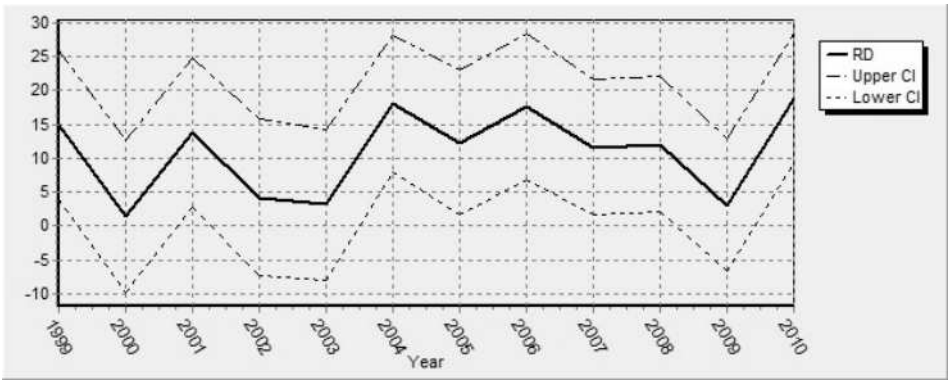

Figure 3. Trends of rate difference of age-standardised mortality rates among men in Świętokrzyskie, years 1999-2010

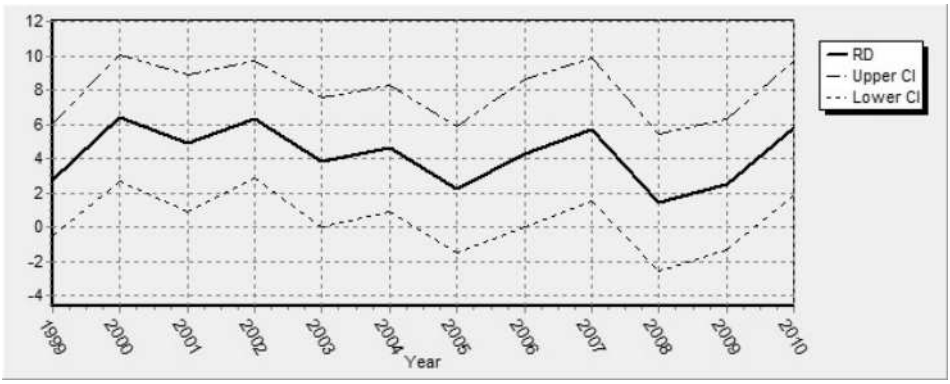

Figure 4. Trends of rate difference of age-standardised mortality rates among women in Świętokrzyskie, years 1999-2010

areas. The urban/rural ratio for ASR in 2010 amounted to 0.79 [95% CI: 0.73; 0.84]; the urban-rural difference was −81.6 [95% CI: −104.6, −58.5].

Amongst women, an unfavorable direction in the trend of PYLL rates was observed during the analyzed period. In urban areas, the average pace of growth was equal to 2.2% per year [95% CI: −0.0, 4.4], while in rural areas it was 4.9% per year [95% CI: −0.1, 10.2] (Table 2). In 2010, the level of PYLL amongst women was higher in urban than in rural areas. The urban/rural ratio for ASR was 1.49 [95% CI: 1.30; 1.71] (Table 3), and the urban-rural difference was 34.0 [95% CI: 22.8; 45.2] (Table 4).

Figures 5 and 6 present trends of inequality in premature mortality due to lung cancer between urban and rural areas amongst men and women.

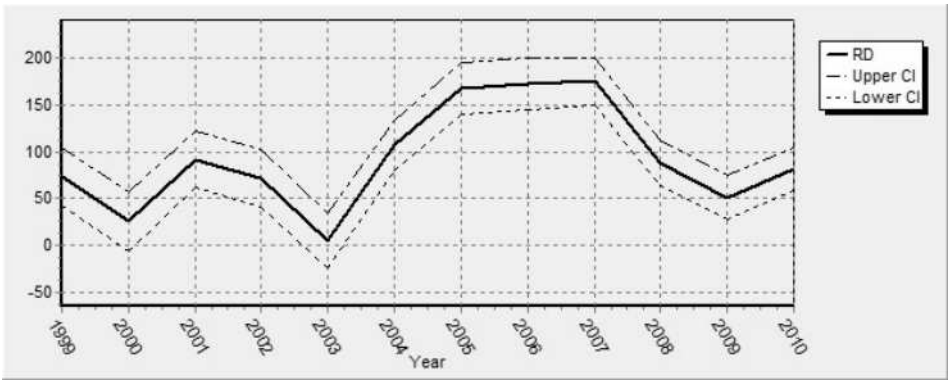

Figure 5. Trends of rate difference of age-standardised PYLL rates among men in Świętokrzyskie, years 1999-2010

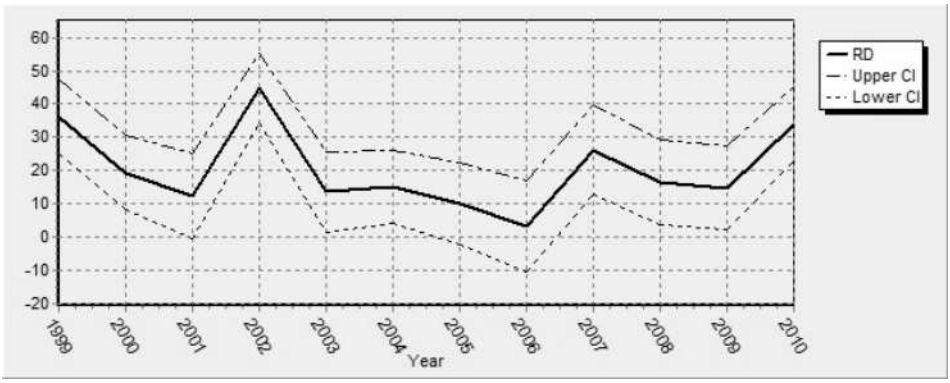

Figure 6. Trends of rate difference of age-standardised PYLL rates among women in Świętokrzyskie, years 1999-2010

In 2010, a 10.7% increase in inequality of premature mortality between urban and rural areas was noted for men, compared to 1999, while for women there was a decrease by 6.1%.

Discussion

At the beginning of the 20th century, lung cancers were very rare on the global scale. An increase in diagnosis of the disease was noted in 1930, and by the middle of the 90s it had already become a main cause of death among men. The number of cases peaked in 1960 amongst women (Alberg et al., 2003).

In Poland, between 1963 and 1990, a dynamic growth of both the incidence and the mortality rate in both sexes was observed. The rate of growth of the lung cancer threat was assumed to be the highest in the world (La Vecchia et al., 2010; Szczuka et al., 2008; Zatoński et al., 1990a). However, the last decades have been characterized by positive changes amongst men in the case of smoking, which have influenced decreasing trends in the incidences as well as mortality rates of lung cancers during the last 15 years or so (Bielska-Lasota et al., 2012; Wojciechowska et al., 2014). Yet 1/5 of cancer incidences and 1/3 of cancer deaths are still observed among men. Contrary to positive changes observed amongst men, recent years have shown an adverse trend concerning lung cancer in women. Increases in both number of deaths and mortality rates have been noted (Bielska-Lasota et al., 2012).

In 2010, lung cancer in men was in first place in the structure of incidence and mortality due to cancers in all provinces. Concerning incidence, the Świętokrzyskie Province was in 9th place (21%), while for mortality it was in 2nd place (34%). In the female population, lung cancers were in 4th place in the incidence structure of cancers and accounted for 7%, which placed the Świętokrzyskie Province 14th among the provinces. In the structure of cancer mortality, lung cancers were the third leading cause of death in women and accounted for 12% of all cancer mortalities (Wojciechowska et al., 2012).

On the global scale, a decrease in the incidence of lung cancers affecting men has been being observed since 1980 in the USA, Canada, Australia, and New Zealand. However, increases in incidence rates amongst women have been noted in the most developed regions of the world (Youlden et al., 2008). An analysis of trends of incidences in Europe during the years 1994–2006 demonstrated a decreasing trend amongst men, with the exception of Spain and France. The annual percentage change in individual countries amounted to: 3.4% in Finland, 1.0% in Denmark, 3.7% in the Netherlands, 2.2% in Germany, 1.3% in Austria, 3.0% in Italy, 2.0% in Slovenia, 2.4% in the Czech Republic, 1.9% in Lithuania and 3.7% in Poland. Amongst women, an opposite trend was registered (Karim-Kos et al., 2008).

On a world-wide scale, increases in lung cancer mortality rates were observed in both sexes between 1980 and 2005 in China, Romania, Israel, and South Korea, while a decrease amongst men and increase amongst women was observed in Australia, France, Germany, Greece, Hungary, Ireland, Italy, the Netherlands, New Zealand, Spain, Sweden and Poland. Decreases in the mortality rates of both sexes were recorded in Hong Kong, Japan, Rus-

sia, Singapore and Great Britain, and a decrease among men was recorded in Canada, Denmark and the USA (Youlden et al., 2008). Similar trends among both sexes were observed in Europe in the years 1994–2005 (Karim-Kos et al., 2008; La Vecchia et al., 2010). In the years 2005–2010, male lung cancer mortality declined in Austria, Finland, the Netherlands, Switzerland, the UK, and Sweden as well as in most other northern and western European countries and in several central and eastern countries. Only in Portugal and Romania did lung cancer mortality increase during recent years of the period analyzed. Overall, lung cancer mortality in women increased in the years 2005–2010 in most European countries, the highest rises being in Hungary, France and Spain. In contrast, in the Netherlands, the UK and Sweden, female lung cancer mortality levelled off in the last few years of the period analyzed (Bosetti et al., 2013).

Poland was one of the countries characterized by the slowest pace of decrease in male mortality rate and rapid growth of female mortality rate in northern Central Europe (Karim-Kos et al., 2008).

Moreover, studies conducted in the years 2002–2011 in the Podkarpackie Province showed an increase in both incidence of and mortality due to lung cancer in women, while for men a declining trend was reported (Grądalska-Lampart et al., 2015). In the Lodz Province in the years 1999–2001, mortality among men grew rapidly, and after 2001 a decrease in mortality at a rate of 2% per year was observed. For women, a disturbing growth trend at the rate of 3.7% per year was noted between 1999 and 2008 (Pikala et al., 2013).

The results of our research for the Świętokrzyskie Province in the years 1999–2010, both in urban as well as in rural areas amongst both sexes, by and large duplicate the standards of trends in the incidences and mortality rates introduced in the international arena.

In Poland, from the middle 60s until the end of the 80s, the premature mortality rate of men systematically grew; however, amongst women it kept a steady level. After 1991, it was noted that the trend of premature mortality amongst both sexes slowed and then decreased (Zatoński, 1996). In spite of these changes, in the years 1995–2007, Poland was still characterized as having one of the highest levels of premature mortality within the European Union (EU), and the pace of positive changes concerning the PYLL rate was among the slowest in the EU countries (European Commission, DG Employment, Social Affairs and Equal Opportunities, 2010). In the years 2002–2008, the Polish PYLL rate, because of lung cancers amongst men, reduced itself by 0.8% annually, whereas after 2008 a more robust fall of 3.2% annually was noted. However, in the period from 2002 until 2011, a negative

trend appeared amongst women, where the average annual growth was at the level of 2.7% (Krzyżak et al., 2013). The analysis of the premature mortality rate performed in the years 1999–2010 in the Świętokrzyskie Province showed that the PYLL rate decreased at an annual pace of 0.75% amongst men and grew amongst women. The average annual increment of the rate amounted to 6.2% (Góźdź et al., 2013).

The results of our research confirmed that the changes observed for both sexes, in both the urban and rural areas included in the study, corresponded both with changes recorded at the national level and with those presented by Góźdź et al. (2013) in the Świętokrzyskie Province. The level of the burden of malignant lung tumours is also leading to significant geographic diversity, both within continents as well as individual countries.

In Poland, regional diversification of health conditions affecting the population has also been noticeable for years (Bielska-Lasota et al., 2012; Maniecka-Bryła et al., 2012). In the case of cancers, it has been persistent for three decades (Wojciechowska et al., 2014). One of the crucial elements that has influenced the existence of these differences is the degree of urbanization present in specific regions. In Poland, research concerning cancer-threat inequalities between urban and rural areas had already been initiated by the 1960s. A considerable portion of cancerous locations, including those where lung cancers were most prominent, demonstrated geographical organization from east to west, with lower mortality rates in the eastern part of the country and with the highest level of mortality in the west, demonstrating a higher level of urbanization (Zatoński et al., 1990b). In the years 1970–1974, lung cancer appeared more often among residents of urban environments. The urban/rural ratio amongst men amounted to 1.56, while it amounted to 1.60 amongst women during that time period. The mortality rates for both sexes were also higher in urban than in rural areas (Staszewski, 1979). Interestingly, while the results of our research also showed a higher lung cancer burden amongst women in urban areas, in rural areas a higher burden was observed amongst men. Between 1980–1986, the highest level of mortality amongst men in Poland was noted in the Opolskie Province (Szczygielski, 1990). Currently, results of a few research efforts led in Poland as well as throughout the world are pointing at further sustaining differences between urban and rural districts when it comes to lung cancer risk (Maniecka-Bryła et al., 2012; Schouten et al., 1996; Smailyte et al., 2008).

We could assume that elements of lifestyle and environmental factors, such as frequency of smoking and drinking alcohol, diet, sexual and reproductive behaviours, carcinogens present in one's place of employment,

place of residence, or the natural environment, in which important differences are still maintained between residents of urban and rural areas, are the main causes for the particular geographical distribution of cancers. Lung cancer is a cancer for which, to a considerable degree, the threat posed by a particular territorial location depends on the appearance of its main risk factor – the spread in the prevalence of smoking (Główny Urząd Statystyczny, 2011; Zatoński et al., 1990b). In the years 1950–1980, the sale of tobacco and tobacco products was higher in major urban environments than in their rural surroundings and in northern and western regions of the country, which had an impact on the territorial location of regions with the highest lung cancer burdens during this period (Didkowska et al., 1999, World Health Organization, 2009). Results of the PONS study (Polish-Norwegian Study of Chronic Diseases) showed significant behavioral differences concerning male smoking that were dependent on place of residence. On the other hand, slight but statistically significant differences were found between women living in urban and rural areas when it came to former smokers, never smokers and ever smokers. Females from urban areas tended to be ever smokers (47.5%) and former smokers more often (32.2%) than females from rural areas (41.0% and 25.8%, respectively). Moreover, women living in rural areas were statistically more often never smokers (59.0%) than those living in urban areas (52.5%), which would seem to confirm a higher burden of lung cancer in women in urban areas (Przewoźniak et al., 2011). The results of the conducted analysis of the burden of lung cancers in the Świętokrzyskie Province show that they are still a relevant health, social and economic problem, with a diversified threat scale between urban and rural areas. This situation calls for intensified involvement of various institutions from the scope of health care, whose actions should be directed at the specificity of health needs in the scope of oncology both for residents of urban and rural surroundings, in order to equalize the inequalities appearing among them. Therefore, a systematic monitoring of the epidemiological situation of cancers based on Cancer Health Indicators (CHI) is essential (Micheli et al., 2003). Such monitoring would allow for identification of actual needs of local environments, which would coincide with creating regional maps (Rozporządzenie Ministra Zdrowia z dnia 26 marca 2015 r. w sprawie zakresu treści map potrzeb zdrowotnych, 2015) of health needs, as tools increasing the effectiveness of managerial processes in the health care system and simultaneously enabling the evaluation and alteration of existing interventions.

Conclusions

The comparative analysis of the burden of lung cancers in the Świętokrzyskie Province showed great diversity between urban and rural environments. The incidence level, mortality rate, and premature mortality of men living in the rural environment was higher than in the urban areas. However, amongst women, the highest level of the discussed indicators was noted in the urban environment.

Amongst men, incidence, mortality rate, and premature mortality due to lung cancers dropped during the years included in this study, but in the rural surroundings the pace of the fall was slower than in the urban areas. Amongst women, a negative trend concerning all indicators of lung cancer burden appeared, of which the rate of growth was over twice as high in the rural areas as in the urban surroundings.

The presented epidemiological situation showed that we should still intensify action in the area of primary and secondary prevention of cancers.

The differentiation of lung cancer burden is largely dependent on exposure to risk factors associated with rapidly changing lifestyles of the inhabitants of the province, which are different in the urban and rural areas. Implementation of programs promoting healthy lifestyles, taking into account the specifics of rural and urban areas separately, could contribute to the reduction of adverse differences in the burden of lung cancer among the inhabitants of the Świętokrzyskie Province.

REFERENCES

Alberg, A. J., & Samet, J. M. (2003). Epidemiology of Lung Cancer. *Chest*, 123(1), 21S–49S.

Bielska-Lasota, M., Car, J., & Rzepczak-Zacharek, E. (2012). Obciążenie nowotworami złośliwymi w Polsce na tle krajów Unii Europejskiej. In B. Wojtyniak, P. Goryński, & B. Moskalewicz (Eds.), *Sytuacja zdrowotna ludności Polski i jej uwarunkowania* (pp. 153–171). Warszawa, Polska: Narodowy Instytut Zdrowia Publicznego – Państwowy Zakład Higieny.

Bosetti, C., Bertuccio, P., Malvezzi, M., Levi, F., Chatenoud, L., Negri, E., & La Vecchia, C. (2013). Cancer mortality in Europe, 2005–2009, and an overview of trends since 1980. *Annals of Oncology*, 6. DOI:10.1093/annonc/mdt301

Breen, N., Scott, S., Percy-Laurry, A., Lewis D., & Glasgow R. (2014). Health disparities calculator: a methodologically rigorous tool for analyzing inequalities in population health. *American Journal of Public Health*, 104(9), 1589–1591.

Didkowska, J., Wojciechowska, U., & Zatoński, W. (1999). Spożycie tytoniu w Polsce w latach 1923–1995. In: W. Zatoński, & K. Przewoźniak (Eds.), *Palenie tytoniu w Polsce: postawy, następstwa zdrowotne i profilaktyka* (pp. 111–126). Warszawa, Polska: Centrum Onkologii – Instytut im. M. Skłodowskiej-Curie.

Esteve, J., Benhamou, E., & Raymond, L. (1994). *Statistical methods in cancer research. Volume 4. Descriptive epidemiology.* Paris, France: ADAGP.

European Commission, DG Employment, Social Affairs and Equal Opportunities (2010). *Health trends in the UE.* The London School of Economics and Political Science.

Ferlay, J., Soerjomataram, I., Ervik, M., Dikshit, R., Eser, S., Mathers, C., Rebelo, et al. (2013). GLOBOCAN 2012 v1.0, Cancer Incidence and Mortality Worldwide: IARC Cancer Base No. 11. Lyon, France: International Agency for Research on Cancer. Retrieved from http://globocan.iarc.fr

Główny Urząd Statystyczny. (2011). *Stan zdrowia ludności Polski w 2009 r.* Warszawa, Polska: GUS. Retrieved from http://stat.gov.pl/obszary-tematyczne/zdrowie/zdrowie/stan-zdrowia-ludnosci-polski-w-2009-r,6,5.html

Główny Urząd Statystyczny. (2015). *Baza danych demograficznych.* Retrieved from http://demografia.stat.gov.pl/bazademografia/Tables.aspx

Grądalska-Lampart, M., Karczmarek-Borowska, B., & Radziszewska, A. U. (2015). Lung cancer in Podkarpackie region in the years 2002–2011. *Pneumonologia i Alergologia Polska*, 83(2), 109–119.

Góźdź, S., Krzyżak, M., Maślach, M., Kołpak, M., Wróbel, M., & Bielska-Lasota, M. (2013). Premature mortality due to cancer in świętokrzyskie province (Poland) in 1999–2010. *Przegląd Epidemiologiczny*, 67(3), 477–482.

Harper, S., & Lynch, J. (2005). *Methods for Measuring Cancer Disparities: Using Data Relevant to Healthy People 2010 Cancer-Related Objectives* (NIH Publication No. 05–5777). NCI Cancer Surveillance Monograph Series, Number 6. Bethesda, MD: National Cancer Institute.

Harper, S., & Lynch, J. (2007). *Selected Comparisons of Measures of Health Disparities: A Review Using Databases Relevant to Healthy People 2010 Cancer-Related Objectives* (NIH Publication No. 07–6281). NCI Cancer Surveillance Monograph Series, Number 7. Bethesda, MD: National Cancer Institute.

Karim-Kos, H. E., de Vries, E., Soerjomataram, I., Lemmens, V., Siesling, S., & Coebergh, J. W. (2008). Recent trends in Europe: A combined approach of incidence, survival or mortality for 17 cancer sites since the 1990s. *European Journal of Cancer*, 44(10), 1345–1389.

Kim, H. J., Fay, M. P., Feuer, E. J., & Midthune, D. N. (2000). Permutation tests for joinpoint regression with applications to cancer rates. *Statics in Medicine*, 19(3), 335–351 (correction: 2001; 20(4), 655).

Krzyżak, M., Maślach, D., Skrodzka, M., Florczyk, K., Szpak, A., Pędziński, B., Sowa, P., & Szpak, A. (2013). Joinpoint Regression analysis of Potential

Years of Life Lost Due to Main Causes of Death in Poland, Years 2002–2011. *Studies in Logic, Grammar and Rhetoric. Logical, Statistical and Computer Methods in Medicine*, 35(48), 157–167.

La Vecchia, C., Bosetti, C., Lucchini, F., Bertuccio, P., Negri, E., Boyle, P., & Levi, F. (2010). Cancer mortality in Europe, 2000–2004, and an overview of trends since 1975. *Annals of Oncology*, 21(6), 1323–1360.

Lipowicz, A. (2015). Disparities in health status between rural and urban adult males in Lower Silesia, Poland. *Anthropologischer Anzeiger*, 72(1), 13–25.

Maniecka-Bryła, I., Pikala, M., & Bryła, M. (2012). Health inequalities among rural and urban inhabitants of Łódz Province, Poland. *Annals of Agricultural and Environmental Medicine*, 19(4), 723–731.

Micheli, A., Capocaccia, R., Martinez, C., Mugno, E., Coebergh, J. W., Baili, P., Verdecchia, A., et al. (2003). Cancer control in Europe. A proposed set of European Cancer Health Indicators. *European Journal of Public Health*, 13(3), 116–119.

National Health Programme for the years 2007–2015. (2007). Annex to the Resolution of the Council of Ministers No 90/2007 of 15 May 2007. Retrieved from http://www.mz.gov.pl/_data/assets/pdf_file/0003/15843/1943_001pop.pdf

National Cancer Institute, Division of Cancer Control and Population Sciences, Surveillance Research Program and Applied Research Program (2013). Health Disparities Calculator (Version 1.2.4).

National Cancer Institute, Statistical Research and Applications Branch. (2014). Joinpoint Regression Program (Version 4.1.1.3).

Pikala, M., Maniecka-Bryła, I., & Bryła, M. (2013). Trendy umieralności z powodu najczęstszych przyczyn zgonów w województwie łódzkim w latach 1999–2008 – analiza joinpoint regression. *Hygeia Public Health*, 48(1), 28–34.

Przewoźniak, K., Łobaszewski, J., Cedzyńska, M., Wojtyła, A., Paprzycki, P., Mańczuk, M., & Zatoński, W. A. (2011). Cigarette smoking among a sample of PONS Study. *Annals of Agricultural and Environmental Medicine*, 18(2), 215–220.

Romeder, J., & McWhinnie, J. (1977). Potential Years of Life Lost Between Ages 1 and 70: An Indicator of Premature Mortality for Health Planning. *International Journal of Epidemiology*, 6(2), 143–151.

Rozporządzenie Ministra Zdrowia z dnia 26 marca 2015 r. w sprawie zakresu treści map potrzeb zdrowotnych. (2015). Dz. U. 2015, item. 458. Retrieved from http://isap.sejm.gov.pl/DetailsServlet?id=WDU20150000458

Schouten, L. J., Meijer, H., Hauveneers, J. A., & Kiemeney, L. A. (1996). Urban-Rural Differences in Cancer Incidence in The Netherlands, 1989–1991. *International Journal of Epidemiology*, 25(4), 729–736.

Szczygielski, K. (1990). Cancer mortality in Opole voivodship in the years 1980–1986. In L. Mazurkiewicz, & A. Wróbel (Eds.), *Spatial problems of health Conference Papers 9* (pp. 141–164). Warszawa, Poland: Institute of Geography and Spatial Organization Polish Academy of Sciences.

Smailyte, G., & Kurtinaitis, J. (2008). Cancer mortality differences among urban and rural residents in Lithuania. *BMC Public Health*, 8(56). DOI:10.1186/1471-2458-8-56

Staszewski, J. (1979). Regionalne różnice umieralności na nowotwory złośliwe w Polsce w latach 1970–1974. Instytut Onkologii. Retrieved from http://legacy.library.ucsf.edu/tid/zhn42a99

Szczuka, I., & Roszkowski-Śliż, K. (2008). Rak płuca w Polsce w latach 1970–2004. *Pneumonologia i Alergologia Polska*, 76(1), 19–28.

Ustawa z dnia 29 sierpnia 2003 r. o urzędowych nazwach miejscowości i obiektów Fizjograficznych. (2003). Dz. U. 2003, vol. 166, item. 1612. Retrieved from http://isap.sejm.gov.pl/DetailsServlet?id=WDU20031661612

Whitehead, M., & Dahlgren, G. (2007). *Concepts and principles for tackling social inequities in health: levelling up part 1*. Copenhagen, WHO Regional Office for Europe. Retrieved from http://www.euro.who.int/__data/assets/pdf_file/0010/74737/E89383.pdf

Wojciechowska, U., Didkowska, J., & Zatoński, W. (2012). *Nowotwory złośliwe w Polsce w 2010 roku*. Warszawa, Polska: Centrum Onkologii, Instytut im. M. Skłodowskiej-Curie. Retrieved from http://onkologia.org.pl/wp-content/uploads/Nowotwory_2010.pdf

Wojciechowska, U., Didkowska, J., & Zatoński, W. (2014). *Nowotwory złośliwe w Polsce w 2012 roku*. Warszawa, Polska: Centrum Onkologii, Instytut im. M. Skłodowskiej-Curie. Retrieved from http://onkologia.org.pl/wp-content/uploads/Rok2012.pdf

World Health Organization. (2009). *The current status of the tobacco epidemic in Poland*. Copenhagen, WHO Regional Office for Europe. Retrieved from http://www.euro.who.int/__data/assets/pdf_file/0006/68064/E92470.pdf

World Health Organization. (2004). *International Statistical Classification of Diseases and Health Related Problems: tenth revision* (2nd Ed.). Geneva: WHO.

World Health Organization Regional Office for Europe. (2012). *Social inequalities in health in Poland*. Retrieved from http://www.euro.who.int/__data/assets/pdf_file/0008/177875/E96720.pdf

Youlden, D. R., Cramb, S. M., & Baade, P. D. (2008). The International Epidemiology of Lung Cancer. Geographical Distribution and Secular Trends. *Journal of Thoracic Oncology*, 3(8), 819–831.

Zatoński, W. (1996). *Evaluation of health in Poland Since 1988*. Warszawa, Polska: Centrum Onkologii, Instytut im. M. Skłodowskiej-Curie.

Zatoński, W., & Tyczyński, J. (1990a). *Nowotwory złośliwe w Polsce w 1990 roku*. Warszawa, Polska: Centrum Onkologii, Instytut im. M. Skłodowskiej-Curie. Retrieved from http://onkologia.org.pl/wp-content/uploads/90.pdf

Zatoński, W., & Tyczyński, J. (1990b). Geography of cancer mortality in Poland. In L. Mazurkiewicz, & A. Wróbel (Eds.), *Spatial problems of health Conference Papers 9* (pp. 119–140). Warszawa, Poland: Institute of Geography and Spatial Organization Polish Academy of Sciences.