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THE REGIONAL VARIATION IN TOBACCO SMOKING-ATTRIBUTABLE MORTALITY IN POLAND, 2006-2010*

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ABSTRACT

STUDY OBJECTIVE. To explain the regional variation in smoking-attributable mortality in Poland by selected environmental characteristics.

MATERIAL AND METHODS. On the basis of the simplified Peto method, standardized smoking-attributable death rates were estimated by applying data on overall mortality and mortality due to malignant neoplasms of trachea, bronchus and lung for the years 2006-2010 obtained from the Central Statistical Office. The correlation between smoking-attributable mortality (SAM) and selected regional characteristics was estimated in two models of linear regression (for men and women). The characteristics of 379 NUTS-4 regions for the years 2006-2010 were derived from the CSO and other public data sources.

RESULTS. In both absolute and relative terms, the male and female SAM appeared to be higher in the northern and western regions of Poland. For both men and women, the linear regression confirmed the significant positive correlation between the level of SAM and poverty, hazardous working conditions, crime level, low level of settlement, low proportion of persons in agriculture and of University graduates. Additional variables correlating with the male SAM pointed to unemployment, proportion employed in services, mortality due to intentional self-harm and electoral turnout.

CONCLUSION. At the NUTS-4 level, the territorial variation in male and female SAM can be partially explained by the variation in regional characteristics indicating unfavourable economic and social conditions.

Key words*: tobacco, smoking-attributable mortality, smoking-attributable death rates, regional variation*

INTRODUCTION

Tobacco consumption is recognized as one of the most important determinants of mortality worldwide (1,2). Over the last two decades, an impressive decline in the prevalence of cigarette smoking has been registered in Poland for men, but not for women (3). Together with advantageous changes in diet, alcohol consumption and physical activity, the decrease in the use of tobacco contributes to the so-called health miracle on the Vistula river (*Cud zdrowotny nad Wisłą*), a term coined to illustrate an immediate recovery in life expectancy noted after the fall of communism (4).

In this context the large and persisting spatial differences in tobacco consumption in Poland are a disturbing phenomenon. Statistics on sales of cigarettes and other tobacco products reveal that from the late 1950s to the late 1980s, the consumption of tobacco was higher in the largest cities than in other urban and rural areas, and higher in the northern and western regions than in other parts of the country (5,6). More recent surveys show that in the 1990s and 2000s, the inhabitants of Poland's largest cities limited their tobacco consumption and, like their rural counterparts, smoked less than the inhabitants of small and medium urban areas (7). However, the territorial variation in smoking prevalence rates persisted (7,8,9): men and women living in northern and western regions have been consuming tobacco more frequently than inhabitants of other regions of Poland. Consequently, standardized death rates due to diseases associated with smoking have been higher in large cities and the northern and western regions for at least three decades

now (10,11). Also, recent estimates by Muszyńska et al. (12) proved that smoking contributed to the divergence between regions in all-cause mortality between 1991-1993 and 2008-2010 for men, but not for women.

In this study, we aim to achieve a better understanding of the factors underlying the spatial variation in smoking-attributable mortality (SAM) in Poland, by relating it to regional socio-economic, cultural and environmental characteristics at the NUTS-4 level. Spatial differences in regional characteristics have been identified as factors determining the variation of cause-specific mortality associated with smoking within many countries (cf. 13,14), including Poland (10).

MATERIAL AND METHODS

Death counts by age, sex and place of residence at the NUTS-4 level (379 regions, *powiat*), due to all causes and malignant neoplasms of trachea, bronchus and lung (ICD-10 codes: C33, C34) for the years 2006-2010 were obtained from the Central Statistical Office of Poland. The crude death rates were calculated on the basis of mid-year population counts based on the population register.

Like other authors (cf. 15,16), we rely on regional estimates of smoking-attributable mortality as an indicator of accumulated smoking in study populations, because the use of tobacco leads to development not only of malignant neoplasms of the lower respiratory tract, but also neoplasms and diseases of other organs, including organs of the digestive tract, circulatory system, urinary system etc. SAM at ages 35-80+ for 2006-2010 was estimated as presented in *Muszyńska* et al. (12). In brief, we applied *Levin's* (17) formula for the fraction of deaths attributable to any particular hazardous agent. The proportion of population exposed to smoking in each region was derived with the use of rates of registered deaths due to malignant neoplasms of lung, and the respective death rates for smokers and non-smokers from the second American Cancer Prevention Study (18). The relative risks of death due to smoking were obtained by dividing the all-cause death rates for smokers by the all-cause death rates for non-smokers in the second Cancer Prevention Study. We used the simplified indirect *Peto-Lopez* method (19) because due to the high percentage of deaths from ill-defined causes in Poland the original *Peto* method is not recommended. We also adjusted the relative risks with the use of a second-level polynomial as proposed by *Janssen* and *Spriensma* (16) and reduced them by 30% to obtain conservative estimates as suggested by *Ezzati and Lopez* (15). The smoking-attributable death rates were derived by multiplying all-cause mortality rates by smoking-attributable fractions, and standardized using the Polish population as of January 1st 2000 (20). We

calculated the mean and coefficient of variation (CV) for age-standardized values of SAM in NUTS-4 regions. All these calculations were done in the R program.

Two linear regression models (for men and women) were estimated, with the standardized smoking-attributable death rates per 10,000 population as dependent variable. We selected the following independent variables: characteristics of local labour markets and economies (rate of unemployment, average gross income, share of labour force in agriculture and services, percentage of persons receiving benefits for the poor, and the number of hazards in the work environment per employee), indicators of the health care system (number of medical doctors and hospital beds per 10,000 population), emission of particulates polluting the air (per 1 km2), characteristics approximating the integrity of social and community networks (proportion of persons living in the same place since birth, crime level (number of crimes per 1,000 population), death rate due to intentional self-harm, turnout at political elections), proportion of inhabitants of urban areas and proportion of university graduates. Independent variables for the years 2006-2010 were obtained online from the Central Statistical Office (21) and the Regional Statistical Offices. The data on electoral turnouts in the 2005 and 2010 presidential elections (both rounds) were available online at the National Electoral Commission's website and the standardized death rates due to intentional self-harm (all ages) for the years 2008-2010 were derived from *Wojtyniak* et al. (22). Regression models proved to be well-specified (Ramsey test), distribution of residuals was random (Jarque-Bera test) and the test (Box-Cox) for omitted variables was rejected. No interacting variables appeared to be statistically significant. These calculations were done in the Stata/SE 13 program.
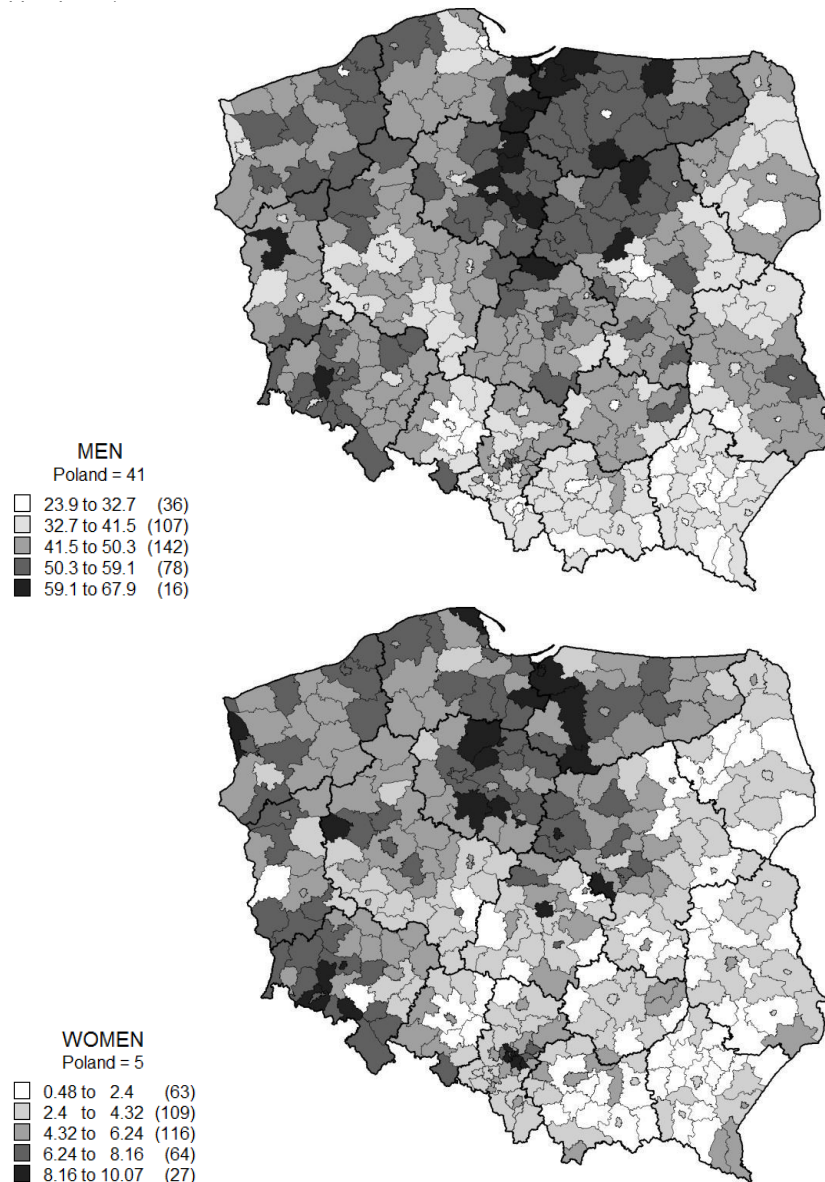
RESULTS

In the period 2006-2010, SAM equalled 41 per 10,000 male population and 5 per 10,000 female population. Regional variation, however, appeared to be higher for women than for men (Tab. I). For both sexes, elevated mortality due to the use of tobacco was observed in selected NUTS-4 regions in northern and north-western Poland (Fig. 1). Conversely to what the results on tobacco sales in the period 1958-1988 might suggest, large cities of Poznań, Kraków, Warszawa and Wrocław were not characterized by elevated male death rates due to smoking. Female SAM in the above-listed cities remained high, though not the highest in Poland. In relative terms, SAM constituted a large part of the overall mortality for men, but not for women (Tab. I).

In the regression models for male and female SAM, several independent variables turned out to be statisti-

Table I. Mean, range and coefficient of variation for all-cause and smoking-attributable death rates by sex and NUTS-4 regions, 2006-2010

	Men			Women		
	Mean	Range	CV	Mean	Range	CV
Age standardized death rates per 10,000 population						
All-cause	133	98-166	10	44	31-58	10
Smoking-attributable	44	24-68	19	5	0-10	46
as % of overall mortality						
Smoking-attributable	33	21-43	21-43	10	1-20	1-19

MEN
Poland = 41

☐ 23.9 to 32.7 (36)
☐ 32.7 to 41.5 (107)
▨ 41.5 to 50.3 (142)
▨ 50.3 to 59.1 (78)
■ 59.1 to 67.9 (16)

WOMEN
Poland = 5

☐ 0.48 to 2.4 (63)
☐ 2.4 to 4.32 (109)
▨ 4.32 to 6.24 (116)
▨ 6.24 to 8.16 (64)
■ 8.16 to 10.07 (27)

Source: own calculations on the basis of CSO data.

Fig. 1. Age-standardized smoking-attributable death rates (per 10,000 population) for men (upper panel) and women (lower panel) in NUTS-4 regions, Poland 2006-2010

cally significant and together they explained more than 40% of the variance in the dependent variable (Tab. II). In the model for men, such unfavourable characteristics as the unemployment rate, the percentage of persons receiving benefits for the poor, mortality due to intentional self-harm and the level of criminality correlated positively with the SAM. A negative correlation was observed between the SAM and the proportions of persons employed in agriculture and in services, the number of hazards in the work environment per employee, the proportion of persons living in the same place since birth, the electoral turnout, and the proportion of university graduates. In the model for women, fewer variables appeared to be statistically significant. A positive correlation with female SAM was observed for the percentage of persons receiving benefits for the poor

Table II. Results of linear regressions with the smoking-attributable death rates (per 10,000 population) as dependent variable by sex, N=379, Poland 2006-2010

Explanatory variables	Men		Women	
	B[1]	SE	B[1]	SE
unemployment rate for men	**0.344****	0.165	not included	
unemployment rate for women	not included		0.010	0.036
proportion in agriculture	**-13.478*****	4.232	**-4.292*****	1.018
proportion in services	**-18.702*****	6.411	1.545	1.588
number of hazards due to work environment	**-32.738*****	10.316	**-4.992***	2.569
average gross income per capita	0.002	0.001	0.000	0.000
proportion of persons with benefits for the poor	**41.807*****	12.665	**9.229*****	3.417
number of medical doctors	0.001	0.000	**0.000*****	0.000
number of beds at hospitals	-0.025	0.017	-0.000	0.000
emission of air pollutant	-0.125	0.148	-0.169	0.037
SDR due to self-harm for men	**3.393*****	1.065	not included	
SDR due to self-harm for women	not included		0.224	0.138
number of crimes	**0.166*****	0.046	**0.047*****	0.012
proportion in the same place since birth	**-14.834****	5.959	**-5.431*****	1.480
electoral turnouts	**-28.462*****	10.187	-1.843	2.532
proportion in urban areas	4.185	2.827	0.608	0.0696
proportion with University degree	**-51.062*****	16.049	**-15.708*****	4.059
constant	**66.138*****	6.675	**7.973*****	1.657
F-statistics	19.87		21.84	
Prob. > F	0.000		0.000	
Adjusted R-squared	0.428		0.453	

[1] *** p<0.01, ** p<0.05, * p<0.1

and criminality levels, whereas a negative correlation, for the proportion of persons employed in agriculture, the number of hazards at work, the proportion of persons living in the same place since birth and the proportion of university diploma holders. The variables concerning the health care system and environmental pollution did not appear to be statistically significant in either model.

DISCUSSION

In the existing literature, a large number of factors have been identified as determinants of tobacco consumption and mortality associated with smoking (cf. 23,24). In our model for SAM, the following unfavourable economic regional conditions appeared to be significant: unemployment (only for men), poverty and low share of university graduates. Although no conclusions should be drawn at the individual level, these results remain in line with other studies showing that smoking prevalence in Poland is negatively related to socio-economic status (7,9,10). The SAM level appeared to be significantly lower in regions where the share of persons employed in agriculture and services is high, or rather where the share of persons employed in industry is low, as another study proved that smoking prevalence rates are the most elevated among construction and industry employees (7). A significant negative association between SAM and number of hazards at work cannot be interpreted unequivocally; this result

may indicate the prevalence of precautionary measures adopted by the labour force at work and, subsequently, in private life too.

As for social conditions, the level of SAM correlates with, on the one hand, a relatively high level of criminality and high male mortality due to self-harm, and on the other, with low turnout at public elections and a low proportion of persons living in the same place since birth. At the territorial level, the observed regional variation of SAM coincides with other differences between the regions of Poland, especially between the northern and western regions (the so-called Recovered Territories, *Ziemie Odzyskane*) and the rest of country. The Recovered Territories were incorporated into the Polish state only after WW2 and populated with Polish nationals originating from the eastern part of pre-war Poland. The consequences of this resettlement may be observed even now: in the Recovered Territories the population is on average younger (25) and more mobile (11), nuptiality is distinctly lower and extra-marital and teenage fertility higher (11,26). Also, in these regions, the percentage of adult persons abusing alcohol is higher and average alcohol consumption is more elevated (8,27), which is important as the combination of tobacco and alcohol has a synergistic effect detrimental to health. These observations, together with the results of our study, point to low integrity of social networks in the Recovered Territories, which may translate into low social control and social support from families, friends and local communities. A study conducted at

individual level revealed that a high level of stress and frustration remains the most important factor underlying the consumption of tobacco in Poland (27), and we presume that during stressful life events the propensity to start and/or maintain abusive behaviours, such as tobacco smoking, may increase among individuals not receiving adequate social support.

The main limitation of this study is the use of current regional characteristics for explaining the current variation in SAM in Poland. Although this approach has been widely applied in other studies of all-cause and neoplasm mortality, we acknowledge that the current regional pattern of mortality depends to a large extent on health behaviours that took place in the past. The development of neoplasms and other fatal diseases results from long-term, regular use of, or exposition to, nicotine (28), and in developed countries there is a 30-year time lag between the increase in cigarette consumption and the number of deaths due to lung cancer (29). However, a study by Doll et al. (30) proved that cessation of smoking has an almost immediate effect, decreasing death risk due to neoplasm of lung. There is also a growing body of research proving that recent bans on smoking in public places in several countries have resulted in significant reductions in hospital admissions for ischaemic heart diseases, cerebrovascular diseases and asthma.

In this study the use of characteristics of social and economic conditions in the past was not possible, as statistics from the communist period are either unreliable or – in the case of statistics on unemployment or income – do not exist at all. Moreover, the reform of 1999 fundamentally changed the administrative division of Poland, which makes analysis that uses data gathered both before and after 1999 impossible. However, the regional variation of certain independent variables that turned out to be statistically significant in our study has not changed much in recent years. These are: unemployment rates since 1990 (31), male mortality due to intentional self-harm since 1999 (22), share of persons living in the same place since birth since the 1950s (32), and electoral turnout since 1989 (33). Due to the lack of reliable data, our analysis also lacked regional prevalence rates for smoking, which could approximate social tolerance towards the consumption of tobacco. Indeed, local differences in attitudes towards tobacco may contribute to the persistence, spread or cessation of its use. Recent changes in smoking prevalence rates in Poland, especially their decrease in the largest cities and regions inhabited by university graduates, suggest that certain vanguard groups are adopting behaviours advantageous to health. Further studies should show whether the smoking prevalence rates fall in other regions and for other social groups as well.

CONCLUSIONS

Male and female smoking-attributable mortality is higher in northern and western regions of Poland than in its other parts. At the NUTS-4 level, the territorial variation in male and female SAM can be partially explained by the variation in regional characteristics indicating unfavourable economic and social conditions.

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