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Original article

Time trends in tobacco-attributable cancer mortality in Poland — direct estimation method

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Introduction. Since the 20th century tobacco smoking has had an enormous impact on morbidity and mortality in the adult population, and it remains the greatest single preventable health risk factor worldwide. Cancer is the second leading cause of death in Poland, with lung cancer as the primary cause of cancer-related death in Polish men and women. Given these statistics, this manuscript aims to estimate tobacco-attributable cancer mortality in Poland.
Material and methods. Data on cancer mortality come from the WHO Mortality Statistics database. Data on smoking prevalence in Poland come from standardized surveys based on nationally representative samples. Data on relative risks come from the Cancer Prevention Study II. Tobacco-attributable fractions were calculated using standard methodology for calculating population-based attributable fractions.
Results. In 2014, there were over 24 thousand tobacco-attributed cancer deaths in men. Lung cancer tops the list of ranked cancer types, with a tobacco-attributable fraction of 93%. Next is laryngeal (TAF = 90%), oropharyngeal (TAF = 86%) and esophageal (TAF = 80%) cancer. Overall, two-thirds of the considered cancer deaths were attributed to tobacco smoke (TAF = 75%). In 2014, there were over 7.5 thousand of cancer deaths related to smoking in women. Here, both laryngeal and lung cancer (both TAF = 76%) top the ranked list. Next are esophageal (TAF = 61%) and oropharyngeal (TAF = 51%) cancers, and when combined almost half of all considered cancer deaths were attributed to tobacco smoke (TAF = 44%).
Conclusions. Tobacco smoking and tobacco-attributable cancer mortality remain one of the greatest health burdens in Poles. Each year over 30 thousand Polish men and women die of cancer caused by smoking. All these deaths could be avoided.

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Key words: tobacco-attributable fraction, cancer, time trends, direct estimation method, tobacco-related cancer, cancer mortality, TAF, PAF

Introduction

Since the 20th century tobacco smoking has enormously impacted population morbidity and mortality, and it remains the largest single preventable health-related risk factor worldwide. Historically cancer mortality was linked to carcinogen exposure in tobacco smoke. In developed countries cancer mortality is most pronounced in older populations, especially those over 65 years of age. However, in Poland nearly 40% of cancer deaths occur prematurely, i.e. before the age of 65. This stands in contrast to populations of other European countries, such as Sweden or the UK, where cancer deaths before the age of 65 average 20% and 25%, respectively [1].

Cancer is the second most common cause of death in Polish men and women. Moreover, lung cancer, a disease almost exclusively caused by tobacco smoke in developed populations, has historically ranked as the leading cause of cancer deaths in men, and since 2007, in women as well. This

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manuscript aims to estimate tobacco-attributable cancer mortality in Poland. Knowing the magnitude of preventable cancer deaths will highlight arguments necessary for decision makers to adopt effective means of prevention, such as population wide smoking cessation support and other tobacco control measures.

Material and methods

Data on cancer mortality for the period between 1994 and 2014 come from the WHO Mortality Statistics database [2]. This source provided raw data in 5-year age groups, stratified by gender, on 10 cancer sites that have established etiology to tobacco smoke [3], including: malignant neoplasm of trachea, bronchus and lung (ICD10: C33–C34), further denoted in this manuscript as lung cancer; malignant neoplasm of larynx (ICD10: C32), denoted as laryngeal cancer; malignant neoplasms of lip, oral cavity, and pharynx (ICD10: C00-C14), denoted as cancer of the oropharynx; malignant neoplasm of esophagus (ICD10: C15), denoted as esophageal cancer; malignant neoplasm of bladder (ICD10: C67), denoted as bladder cancer; malignant neoplasm of kidney, renal pelvis, ureter and other and unspecified urinary organs (ICD10: C64–C66, C68), denoted as kidney cancer; malignant neoplasm of pancreas (ICD10: C25), denoted as pancreatic cancer; malignant neoplasm of stomach (ICD10: C16), denoted as stomach cancer; lymphoid leukemia, myeloid leukemia, monocytic leukemia, other leukemias of specified cell types and unspecified cell types (ICD10: C91–C95), denoted jointly as leukemia; malignant neoplasm of cervix uteri (ICD10: C53), denoted as cervical cancer. In addition to the 10 aforementioned cancer sites, we summed raw data from each cancer site to construct a combined category encompassing all tobacco-attributable cancers. Population data come from the Polish Central Statistical Office [4]. Data on smoking prevalence in Poland for years 1974, 1982, 1985–1988, 1990–1994 come from standardized surveys based on nationally representative samples in subjects aged 15 years and over [5]. Relative risks, by gender, and separately for current and former smokers, come from the Cancer Prevention Study II [6]. The relative risk for those who have never smoked is equal to 1.

The method applied in this manuscript assumes that there are no tobacco-attributed deaths before the age of 35, as these occur extremely rarely [6], and for the sake of clarity they were set to zero in this model. The analysis was performed in four age groups: 35–44 years, 45–64 years, 65 years and over (65+), and jointly for the entire analyzed population, aged 35 years and over (35+).

Tobacco-attributable fractions were calculated by gender in 5-year age groups according to the following formula, which is standard methodology for calculating population-based attributable fractions [7–10].

$$TAF = \frac{\sum_{i=1}^{k} P_i(R_i - 1)}{\sum_{i=1}^{k} P_i(R_i - 1) + 1}$$

P_i denotes smoking prevalence in a particular category of exposure (for never smokers i = 0) and RR_i denotes relative risk for a particular category of exposure.

Application of the above formula returns a percentage of mortality that can be attributed to particular risk factors, such as tobacco smoking in this case. The returned percentage is used to obtain absolute numbers of smoking-attributable cancer deaths and for calculating age-standardized mortality rates attributed to smoking (rates were standardized to the world standard population). The model assumes a 20-year latency period between exposure to tobacco smoke and cancer death [6, 11].

For cancer sites not taken into account in this manuscript, there is no sufficient evidence correlating their etiology to tobacco smoke. While many studies describe an association between liver cancer, colorectal cancer, breast cancer, endometrial cancer, prostate cancer and tobacco smoke, the results remain inconclusive [3].

Results

Figure 1 presents trends in tobacco-attributable cancer mortality in Poland between the years 1994–2014 using three different measures: absolute number of deaths, age-standardized rates, and percentage of smoking-related cancer deaths among all analyzed cancer data. In men, the absolute number of tobacco-attributable cancer deaths remains relatively stable. In 2014, over 24 thousand of cancer deaths related to smoking were reported in men, constituting 75% of all cancer mortality[1]. Mortality rates experienced significant decline over the 20 years of observation from 106.5/100,000 in 1994 to 77.2/100,000 in 2014. In women there has been observed increase in all three measures. In 2014, there were over 7.5 thousand cancer deaths related to smoking in women, which constitutes 44% of all cancer mortality. Absolute numbers of tobacco-attributable cancer deaths more than doubled between 1994 (3678) and 2014 (7652), and mortality rates rose from 12.6/100,000 in 1994 to 19.6/100,000 in 2014. The fraction of tobacco-attributable cancers (of all types) also increased from 31% in 1994 to 44%, 20 years later.

Figure 2 presents time trends of tobacco-attributable cancer mortality rates compared to trends in cancers not attributed to tobacco use. In men, there is a wide gap between mortality rates attributed and not attributed to smoking. While tobacco-attributable cancer mortality rates

[1] Every time authors refer to „all cancer mortality", that means all 10 cancer categories with established etiology to tobacco that were analyzed in this manuscript.

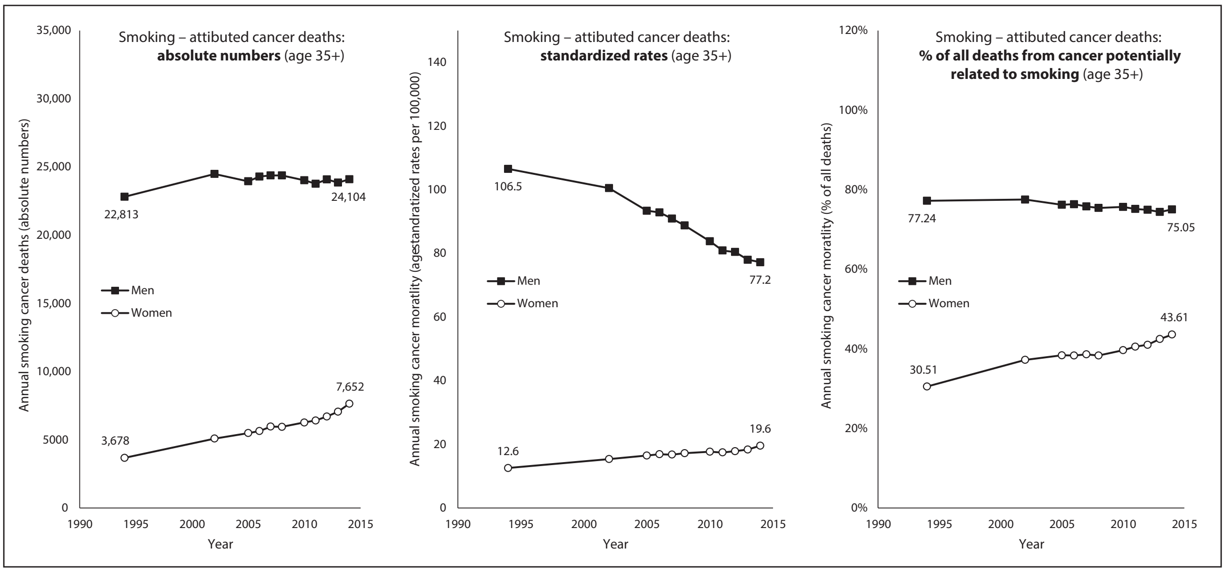

Figure 1. Poland 1994–2014: Tobacco-attributable cancer mortality

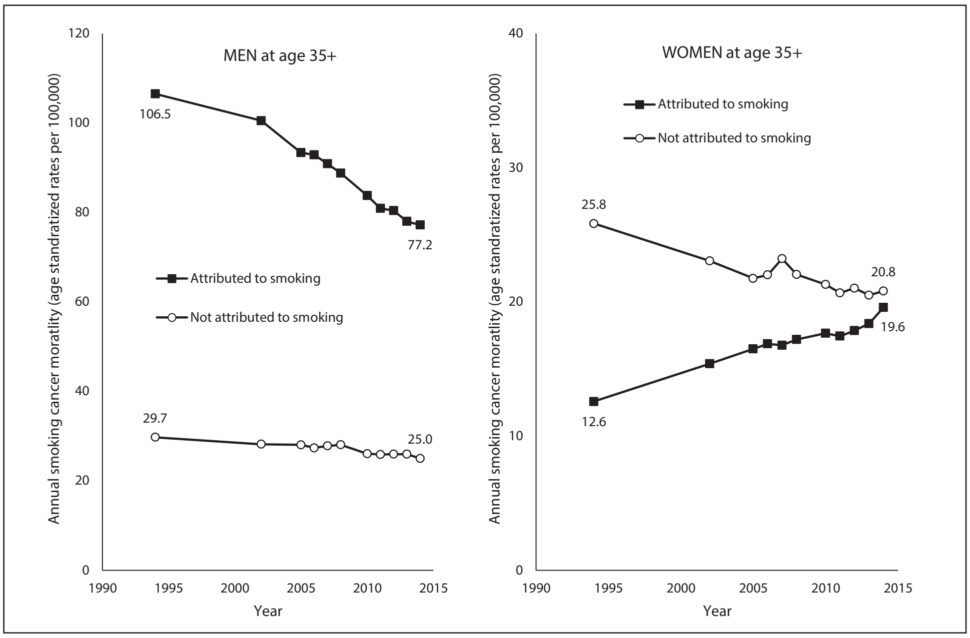

Figure 2. Poland 1994–2014: Cancer mortality rates attributed and not attributed to smoking

declined for the 20-year period of observation, rates of mortality in cancers not attributable to tobacco remained stable or decreased slightly. In 2014, death rates not attributed to tobacco were three times lower than those attributed to tobacco, at 25/100,000 and 77.2/100,000, respectively. In women the picture looks considerably different. While cancer mortality rates not attributed to tobacco are historically higher than those attributed to smoking, they converged in 2014. We observed an increase in tobacco-attributable cancer mortality rates from 12.6/100,000 in 1994 to 19.6/100,000 in 2014. Overall cancer mortality rates not attributed to tobacco dropped from 25.8/100,000 in 1994 to 20.8/100,000 in 2014.

Figure 3 presents a ranked list of tobacco-attributable fractions (TAF) of cancer mortality in Poland in 2014. In men, lung cancer tops this ranked list, with a tobacco-attributable fraction of 93%. Next are laryngeal (TAF = 90%), oropharyngeal (TAF = 86%) and esophageal (TAF = 80%) cancer, while the lowest tobacco-attributable fraction was observed in leukemia (TAF = 34%). When considered together, two--thirds of all cancer deaths are attributed to tobacco smoke (TAF = 75%). In women, laryngeal and lung cancer (both TAF = 76%) share the top position in the ranked list, followed by esophageal (TAF = 61%) and oropharyngeal (TAF = 51%) cancer. The lowest tobacco-attributable fractions were observed for kidney cancer (TAF = 7%) and leukemia (TAF = 5%),

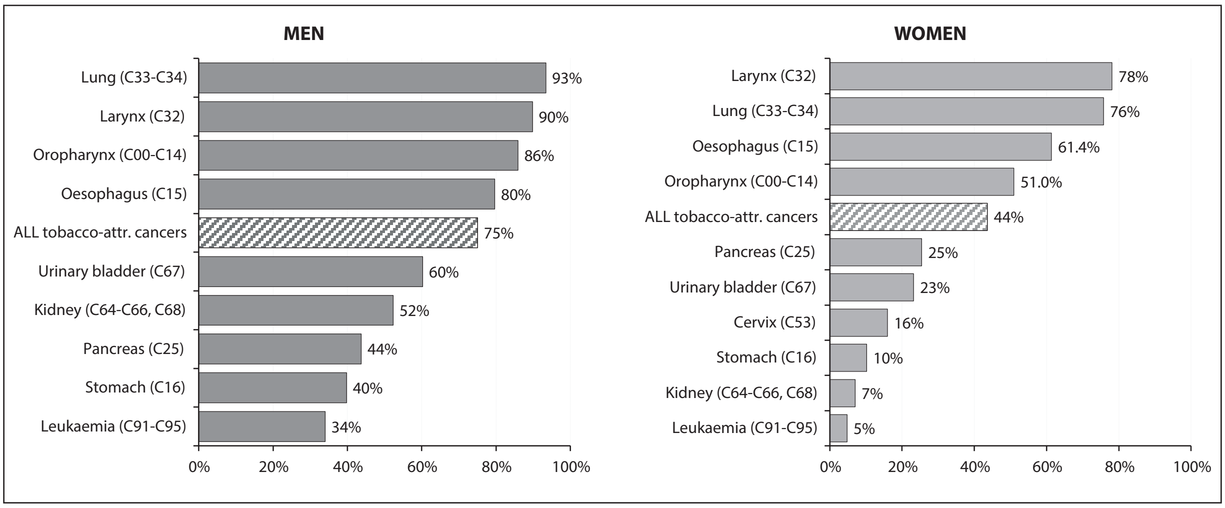

Figure 3. Tobacco-attributable fraction (TAF) of cancer mortality in Poland in 2014, by gender, age 35 years and over

and almost half of all considered cancer deaths were attributed to tobacco smoke (TAF = 44%).

Figure 4 presents a ranked list of tobacco-attributable age-standardized cancer mortality rates per 100,000 person/year in Poland in 2014. In both men and women lung cancer mortality rates dominate the lists with 47.2/100,000 in men, and 14.3/100,000 in women. The next highest rates are eight to nine times lower, with oropharyngeal cancer at 5.9/100,000 in men, and pancreatic cancer at 1.6/100,000 in women.

Additional material (Annex 1) includes 44 graphs with tobacco-attributable cancer mortality trends, over time, for the 10 cancer sites/groups analyzed, and for all cancers combined across four age groups. For males, there is a generally observable pattern of decline in tobacco-attributable cancer mortality rates across all cancer sites/groups, with the exception of oropharyngeal cancer, where an increase is observed among middle-aged adults (45–64 years) and adults over the age of 65 years. For women, a general increase or plateau in tobacco-attributable cancer mortality rates across all cancer sites/groups is observed, with the exception of the youngest age group (35–44 years) where we observed decreasing mortality rates.

Discussion

Tobacco smoking is one of the best documented risk factors for cancer in both men and women [12]. Since establishing the etiological association between exposure to tobacco smoke and mortality [13, 14], estimating the death toll of tobacco use has been plagued by controversies regarding limitations of quantitative methods, and results of such analyses constantly face criticism by various entities, including the tobacco industry [15].

One limitation of methods aiming to estimate tobacco--attributable mortality lies is defining smokers as current, former, and never smokers [12, 15, 16], which significantly

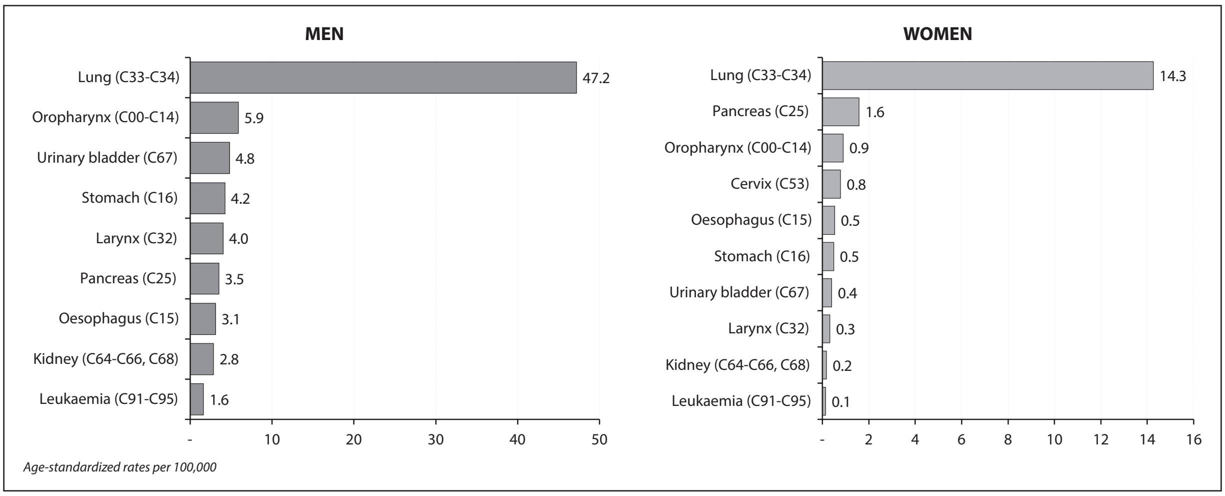

Figure 4. Tobacco-attributable cancer mortality rates in Poland in 2014, by gender, age 35 years and over

impacts downstream results [15, 17]. Defining smokers as a homogeneous group without accounting for the number of cigarettes smoked, age at which smoking began, length of exposure, and other variables that may impact risk, can lead to considerable differences in estimation results [15].

Newly emerging evidence, such as the recent finding of a causal relationship between tobacco smoking and breast cancer risk, must also be considered when analyzing tobacco-attributable cancer mortality rates [18, 19]. Although relative risk for breast cancer was not included in CPS-II, the most current and comprehensive set of relative risks for tobacco-attributable diseases, future data sets will likely include breast cancer, given the strength of the newest data.

As indicated by the results of this analysis, the greatest tobacco-attributable fractions of mortality rates are found in lung and laryngeal cancer, followed by cancer of oropharynx and esophagus. It should be noted that each of these sites is also etiologically related to alcohol consumption, and this method of analysis precludes separation of tobacco effects from effects of alcohol carcinogens. Moreover, these two behaviors, tobacco smoking and alcohol drinking, often occur together, and alcohol can alter the chemical properties of tobacco smoke carcinogens, enabling them to more easily penetrate cells and damage DNA. Therefore, the risk of tobacco related cancer deaths is likely elevated when alcohol is consumed.

In Poland, 75% of cancer deaths in men, and 44% in women, are caused by tobacco smoking. These figures translate to over 24 thousand men, and over 7.5 thousand women, who die prematurely due to tobacco use. This loss of human capital seems particularly immense given that it can be fully avoided by cessation of tobacco smoking.

Reducing prevalence of tobacco smoking will limit both morbidity and mortality from cancer attributable to tobacco smoke, as well as many other chronic conditions that are related to smoking, such as chronic obstructive pulmonary disease and cardiovascular diseases, which are the leading cause of death in Poland. Data suggest that nearly half of daily smokers, who took up smoking early in life, will die prematurely due to tobacco-attributable diseases [12].

Despite enormous efforts of medical professionals and the research community, the treatment of cancer remains a significant clinical challenge. However, one certain way to reduce the risk of death from lung cancer and other tobacco-attributable cancers is strict avoidance of smoking or quitting before the age of 35. To achieve this, health competences must be improved among both general population and physicians. Moreover, giving up smoking at any stage of cancer remains the most effective secondary and tertiary prevention [20].

Taking up smoking should be unattractive, difficult and costly, whereas help in quitting smoking should be made broadly available, affordable, and provided by the national health care system. Tailored interventions in tobacco control should be a priority of a country that loses tens of thousands of their citizens every year to the deadly habit of tobacco smoking.

Conclusions

Tobacco smoking and tobacco-attributable cancer mortality remains one of the most significant health burdens in the Polish population. Annually, more than 30 thousand Polish men and women die from cancer caused by smoking. All of these deaths are avoidable, though eliminating tobacco-associated cancer is not possible without eliminating tobacco use. Intensifying the Polish government's efforts in tobacco control policy, especially improvement in treatment of tobacco dependence syndrome and increasing expenditures on health interventions directed at reducing harm caused by tobacco, should be the main focus of health decision makers in years to come.

Conflict of interest: none declared

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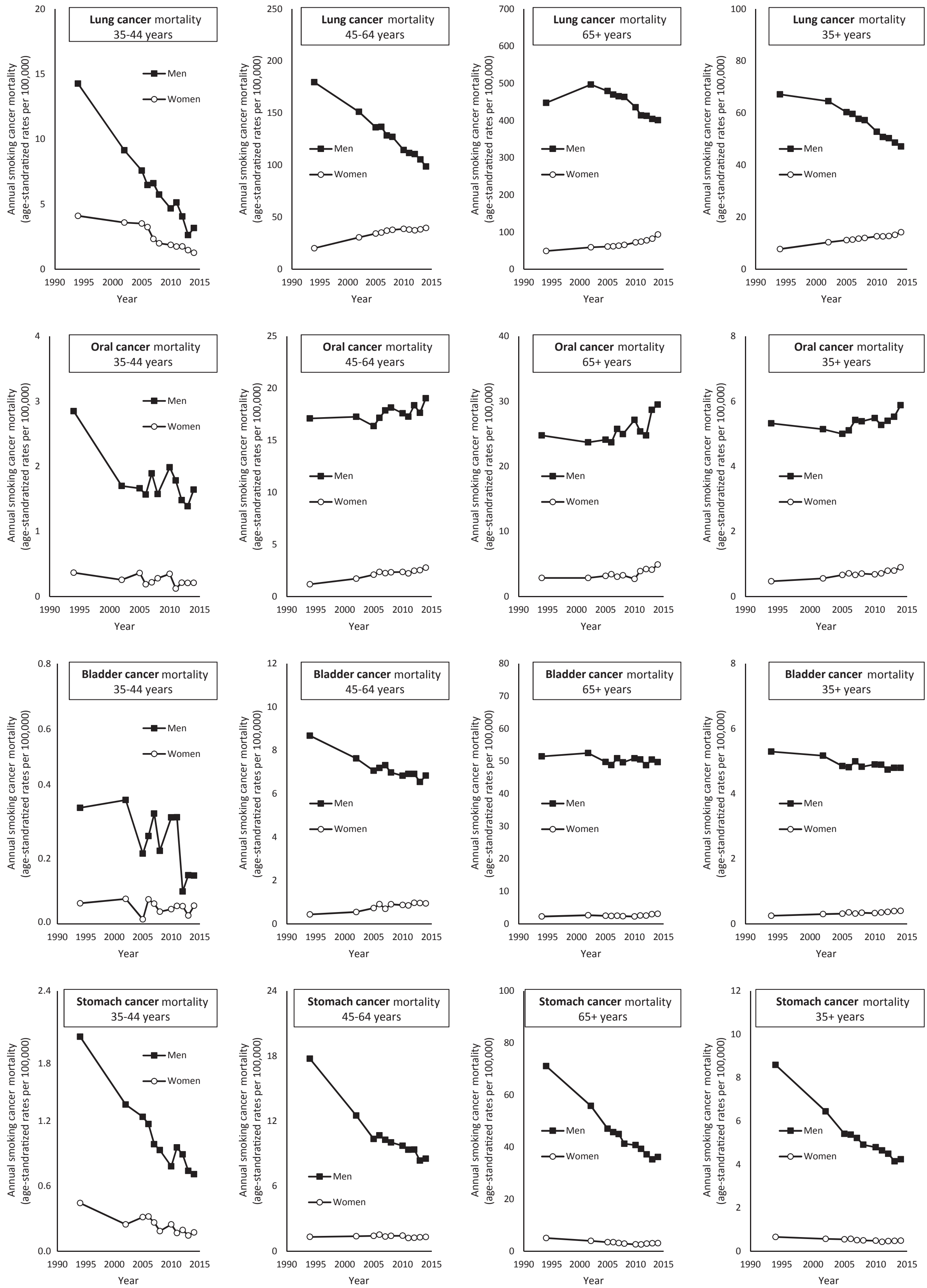
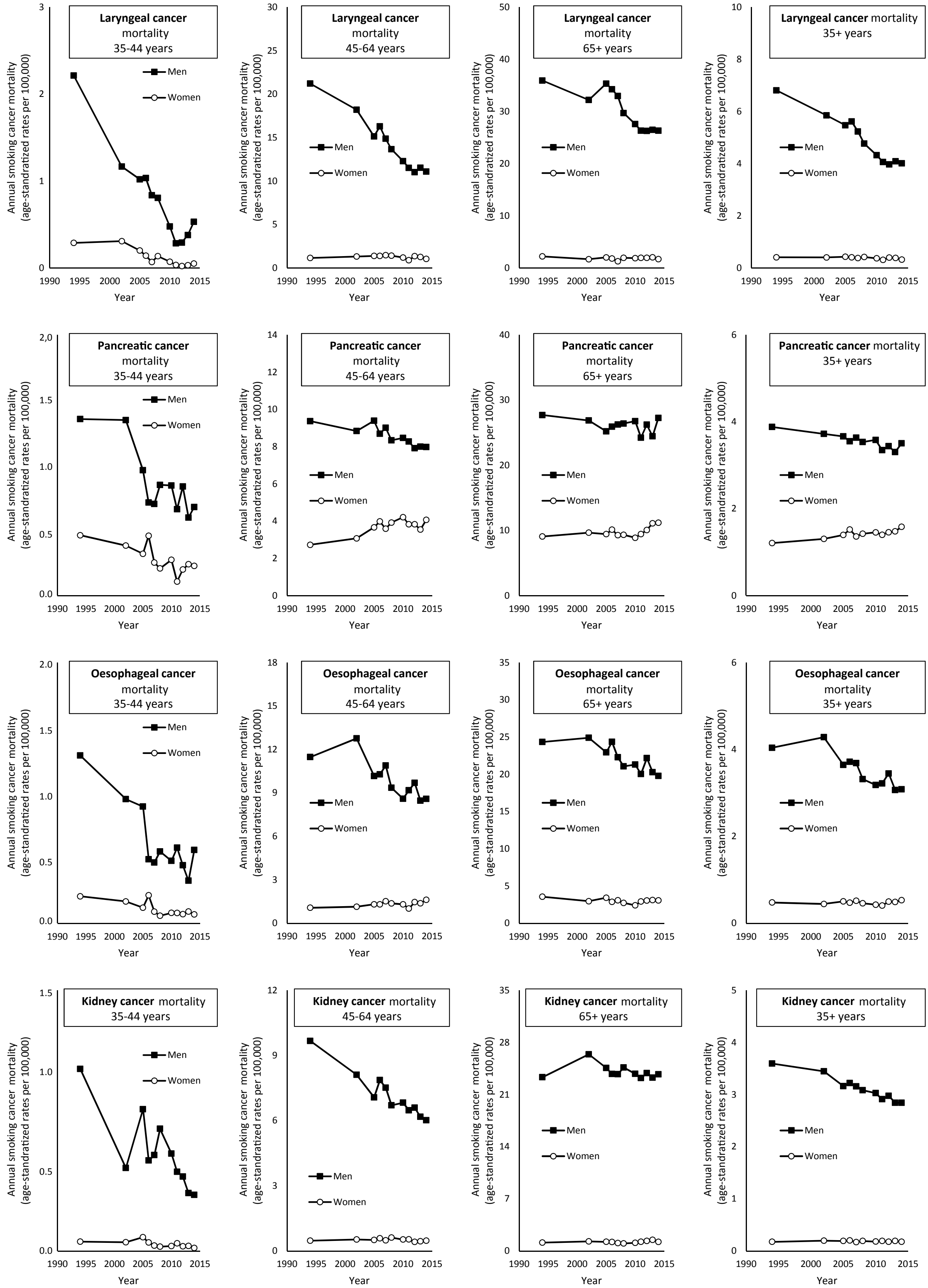
Annex 1

Poland 1994–2014: Tobacco-attributable cancer mortality rates in age groups: 35–44, 45–64, 65+, 35+



Poland 1994–2014: Tobacco-attributable cancer mortality rates in age groups: 35–44, 45–64, 65+, 35+



Poland 1994–2014: Tobacco-attributable cancer mortality rates in age groups: 35–44, 45–64, 65+, 35+