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Smoking and lung cancer: current trends in Austria

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Summary

Background—Despite a recent decline in smoking behavior in many European countries, lung cancer rates remain high, especially in Central and Eastern Europe. This paper aims to describe trends in smoking behavior and lung cancer incidence and mortality, including histopathological classification of lung cancer, in a Central European country: Austria.

Methods—Using data from the Austrian Central Cancer Registry, we calculated age-standardized incidence, histopathology-specific incidence, and age-standardized and birth cohort-specific mortality rates for all lung cancer cases in Austria. Using national survey data, we estimated prevalence of smoking in the Austrian population. Our analysis covers the time period from 1970 to 2009.

Results—In 2009, lung cancer incidence rates were 41.3/100,000 and 18.5/100,000 and mortality rates were 36.3/100,000 and 14.5/100,000, for males and females, respectively. Male lung cancer rates declined but increased steadily in females over the past three decades. In 2009,

Conflicts of Interest

The authors do not have any conflicts of interest to disclose.

the most common histological type is adenocarcinoma, which reflects a shift from predominantly squamous cell carcinoma and large cell carcinoma in the mid 1980s. In 2009, 27 % of men and 19 % of women were smokers, which represent a rise of smoking rates in women, especially in younger women, and a decline in the men.

Conclusions—While in Austrian men the lung cancer rates, in accordance with their decreasing prevalence of smoking, declined over the past 30 years, the increasing smoking prevalence and lung cancer rates in women remain a public health concern. Antismoking laws and public health initiatives to curtail smoking habits are needed in Austria, especially targeting younger women.

Keywords

Lung cancer; Smoking; Austria; Public health

Introduction

Lung cancer is a major cause of morbidity and mortality worldwide [1]. In males, lung cancer is the most commonly diagnosed cancer and the number one cause of cancer-related death in the world; in females, it is the fourth most commonly diagnosed cancer and the second leading cause of death [1]. The primary cause of lung cancer is cigarette smoke (both active and passive inhalation), which accounts for 80–90 % of the worldwide cancer burden [2]. Occupational and environmental exposures such as indoor air pollution, asbestos, arsenic, and ionizing radiation are also major contributors to the burden of disease, accounting for about 10–20 % of newly diagnosed cases [3]. The vast majority of lung cancers are squamous cell carcinomas, small cell carcinomas, and adenocarcinomas; but trends vary according to type and gender [2]. Historically, squamous cell carcinomas were the most common histopathology and the most highly associated with smoking, however in recent years trends have shifted towards adenocarcinoma as being the most common type and there is evidence of a strengthening relationship of smoking as a risk factor for this type [2].

Recent declines in smoking prevalence have produced beneficial changes in lung cancer incidence and mortality rates, especially in developed nations such as the USA and many countries in Western Europe. However, rates remain high in many countries, particularly in Central and Eastern Europe, where smoking laws have been implemented late, and female smoking popularity is still on the rise. In 2007, in Austria, lung cancer accounted for 6.8 % of total deaths in males and 3 % of total deaths in females [4]. Previous reports described the lung cancer burden in Austria in 1986 [5], 2004 [6], 2001 [7], and 2004 [8]. In the present paper, we provide an update on lung cancer trends in Austria, including temporal trends of lung cancer mortality, overall lung cancer incidence, and lung cancer incidence by major histology classification from the years 1970–2009. We also updated smoking prevalence with estimates from 1972 to 2007. This is the first paper to present trends in Austrian lung cancer by major histology type.

Materials and methods

Lung cancer incidence and mortality data were obtained from the central registry maintained by Statistics Austria for the years 1970–2009 based on codes from the International Classification of Diseases (ICD) versions 9 (ICD9–162) and 10 (ICD10–33, -34). Mortality data were available for the years 1970–2009 while incidence data were only available for the years 1983–2007. Major histology of tumor type was available in incidence data only. For histology classification, all tumors were classified into five categories based on International Classification of Diseases for Oncology version 3 (ICD-O3) codes, per WHO category

conventions [9]: squamous cell carcinoma (SQC) including papillary carcinoma (8050–8078, 8083–8084); adenocarcinoma (ADC), including bronchio-alveolar carcinoma (8140, 8211, 8230–8231, 8250–8260, 8323, 8480–8490, 8550–8551, 8570–8574, 8576); large-cell carcinoma (LCC), including giant cell, clear cell, and large cell undifferentiated carcinoma (8010–8012, 8014–8031, 8035, 8310); small-cell carcinoma (SCC), including neuroendocrine carcinomas (8041–8045, 8246); and other (all remaining morphology codes). This last category includes other specified carcinomas such as adenoid cystic (8200), mucoepidermoid (8430) and adenosquamous (8560); non small cell lung cancer (NSCLC) not otherwise characterized as ADC or SQC (8046); carcinoid tumors (8240–8245); sarcomas (8800–8811, 8830, 8840–8921, 8990–8991, 9040–9044, 9120–9133, 9150, 9540–9581); other specified malignant neoplasms, and tumors of unspecified morphology (8000–8004). Age-adjusted rates of mortality and incidence were calculated using the direct method and the WHO world standard population. Birth cohort effects were described by plotting age-specific mortality rates for each 5-year age group according to birth year. Year of birth was obtained by subtracting the age at death from the year of death.

Data on smoking prevalence for the years 1972, 1979, 1986, 1991, and 1997 were obtained via microcensus survey data through the Austrian Central Statistical Office. The census surveys [10–14] were conducted via in-person interviews in a representative sample of households targeting about 1 % of all (noninstitutionalized) Austrians, and the average sample size was 60,000 respondents. These surveys included questions about whether or not respondents were never smokers, occasional smokers, or regular smokers, and for regular smokers, how many cigarettes were consumed per day (1–10, 11–20, 21–40, and 41 +). Response to the smoking questions was non-compulsory and nonresponse rates for these questions ranged from 1–5 % depending on the year. The microcensus was repeated in 1999, but the questions asked, and the order in which they were asked were not compatible with previous years (which had been consistent) [10, 15], as such the 1999 survey data were not considered in the present analysis. Calculated prevalence rates from the microcensus surveys reflect respondents who were occasional or regular smokers of any type of cigarette (manufactured or hand rolled). Smoking data for the year 2007 are from the Health Information Survey [10, 16], conducted by Statistics Austria from March 2006 to February 2007. The results of this survey include a representative sample of 15,474 Austrians (including those living in institutions) with an overall response rate of 63 %. This survey consisted of in-house interviews conducted in 32 geographic regions of Austria chosen based on national census response. The survey included a detailed section on smoking behaviors and exposures including past smoking habits, current smoking (in cigarettes per day), and environmental tobacco smoke exposure. Prevalence rates from the Health Information Survey reflect smokers of at least one cigarette (manufactured or hand rolled) daily.

We used SAS version 9.2 (SAS Institute, Cary NC, USA) for age-standardization and tabulations and Microsoft Excel 2010 for figures.

Results

Mortality

Age-standardized lung cancer mortality rates from 1970 to 2009 are shown in Fig. 1 for both sexes. In 2009, the mortality rate for males was 36.3 deaths per 100,000 person-years, reflecting a steady decline over the past three decades from its peak in 1973 at 58.5 deaths per 100,000 person-years. In contrast, the rates for females have been steadily increasing with a current rate of 14.5 deaths per 100,000 person-years reflecting a 123 % increase from the lowest rate in 1970 of 6.5 deaths per 100,000 person-years. The age-standardized lung cancer mortality based on 5-year birth cohorts is shown for men in Fig. 2 and for women in

Fig. 3. Men born before 1900 in age groups between 70 and 85 + at the time of their death experienced increases in lung cancer. For men in these age categories born after 1900, the figure reflects a levelling off in mortality. Mortality patterns in middle-aged men (40–59 years old at the time of death) are mostly stable rates for those born before 1949 and decreasing rates for those born since 1950. In women, the rates reflect steady lung cancer mortality in older age categories between 70 and 85 + over all birth years. In middle-aged women (40–59 years old at the time of death), the graph reflects sharply increasing lung cancer mortality rates for women born between 1920 and around 1950 and then a gradual decline for women born since 1950.

Incidence and histological subtypes

Age-standardized lung cancer incidence rates from 1983 to 2007 are shown in Fig. 1 for both sexes. Since lung cancer survival has not had any major improvement in the past 30 years [17], the slopes for incidence are more or less parallel and the gap reflects the 5-year survival rate (approximately 15 % in developed nations) and a 1–3 year time window for disease progression. For females, there is a divergence in this similar slope pattern around the year 2000, with a slightly higher incidence than mortality in the most recent decade (2000–2010).

Incidence rates are further divided by major histology classification in Fig. 4 (men) and Fig. 5 (women). In men, both SQC and LCC rates have declined dramatically over the past three decades. In 1983, SQC rate was 15.6 cases per 100,000 person-years. In 2007, this rate had decreased to 8.5 cases per 100,000 person-years. LCC was diagnosed at a rate of 15.2 cases per 100,000 person-years in 1983, but most recently in 2007 this diagnosis only accounted for 5.1 cases per 100,000 person-years. In a complementary fashion, ADC rates have increased, from 7 cases per 100,000 person-years in 1983 to 11.2 cases per 100,000 person-years in 2007. ADC surpassed SQC as the most common histology diagnosis in men in the mid 1990s. The “other” category has also increased, especially in the late 1980s and early 1990s. In females, the ADC subtype reflects the only substantial growth over the time period, increasing from 2.8 cases per 100,000 person-years in 1983 to 7 cases per 100,000 person-years in 2007. SQC, LCC, and SCC rates are low and remain low throughout the time period. Similarly to the men, the “other” category reflects a moderate increase from baseline, but still a very low rate throughout (from 0.2 cases per 100,000 to 1.5 cases per 100,000 over the entire follow-up period of 29 years).

Smoking

Overall prevalence of smoking by sex from the years 1972–2007 is presented in Fig. 1. Male smoking rates were highest at 45 % in 1972 and have been gradually decreasing over time, to 32 % in 2007. Female smoking rates rose steadily from 1972 when they were 13 % to 1997 at 21 % and have levelled off. The slight decrease to 19 % in 2006 could be caused by underestimation in 2006 due to restriction to daily smokers and/or a larger rate of nonresponders [18]. Smoking rates by sex and 5-year age group are provided in Table 1. In males, all age groups reflect the overall decrease in smoking prevalence displayed in Fig. 4. This is especially marked in older aged males (60 + years) whose smoking prevalence has decreased from 42 to 15 % or less over 34 years. In females, all age categories reflect the general increase in smoking habits until 1997 and a decline thereafter (probably an artefact). The rates remain low throughout the time period in the older aged women (60 + years) and are highest in young women.

Discussion

In this descriptive analysis of smoking and lung cancer trends in the Austrian population, we found that absolute rates of lung cancer incidence, mortality, and smoking are higher in Austrian men than in Austrian women. However, in terms of sex-specific trends, since the 1970s, incidence of and mortality from lung cancer is rising in Austrian women, while both have been on a steady decline for Austrian men. Nevertheless lung cancer remains the perfect indicator for “tobacco smoke load” [19]. Smoking population prevalence data indicate generally decreasing rates in men and generally increasing rates for women, in particular young women. Comparing the trends of incidence and mortality reveal little apparent improvement in 5-year survival rates, excepting among females, where the trends reflect a slightly higher incidence than mortality in the most recent decade (2000–2010). This divergence is not likely a sign of improved 5-year survival, but it may be evidence of advances in therapy regimens that may be lengthening the disease progression period. Our histopathological analysis, the first of its kind to be performed in Austria, supports a global trend of adenocarcinoma surpassing squamous cell carcinoma as the most prevalent subtype of lung cancer in both men and women.

Active smoking is by far the most important contributor to the lung cancer burden, accounting for 80 % of lung cancer deaths in men and 50 % of lung cancer deaths of women worldwide [20]. Other important etiologic factors include environmental and occupational exposures, passive smoking, other indoor and outdoor air pollution, and genetic factors. Smoking was more common among Austrian men than women around 1900, but the habit spread quickly among women after then, with especially rising rates in the 1940s and 1950s [5]. Lung cancer incidence and mortality is a serious concern, especially in the female Austrian population, as they remain on the rise. Male incidence and mortality, while still reflecting higher absolute rates than females, is slowly improving and the epidemic has likely peaked. Possible explanations for the decline in male rates include steady reductions in smoking prevalence throughout the last 30 years, improvements in workplace air quality, and reduced exposure to environmental tobacco smoke in the workplace, however the decline was much slower than in North America, Australia, or UK, related to poor tobacco legislation [21]. The most recent smoking data also indicate there may be a decline in female smoking prevalence, but because the 2006–2007 survey asked for daily smoking only, the resulting decline is likely to be overestimated and possibly an artefact.

ADC has replaced SQC as the most common histological type of lung cancer in Austria. This trend is common in the twentieth century, and has been detected in many other populations worldwide [22–24]. While a definitive reason for this shift is still unclear, a common hypothesis is the introduction of filtered cigarettes in the mid twentieth century [25]. Filtered cigarettes with less tar and nicotine are inhaled more deeply than nonfiltered cigarettes, which may allow the smoke and carcinogens to infiltrate the peripheral lung tissues where the majority of pulmonary adenocarcinomas normally arise [26]. While our smoking data do not specifically reflect trends in the type of cigarettes smoked, Austrian cigarette manufacturing data presented previously indicate a steeply declining trend in tar and condensate content from 1960 to 1981, as well as a shift from filtered cigarettes accounting for 9 % of the market in 1960 to 96 % of the market in 1981 [5]. The trends in female histological type and smoking also support this hypothesis as ADC is the only common type of cancer in the female population, which experienced a later increase in smoking prevalence correlating with the shift in cigarette manufacturing trends. Besides deeper inhalation of the smoke of low tar cigarettes with ventilated filters, also the smaller particles in side stream smoke (PAHs adsorbed on larger surface and penetrating deeper into the lung) and the nitrosamines in blended burley tobacco have been associated with the worldwide increase of ADC [27].

Trends noted in the histological subtype analysis may also be attributable to changing methods of diagnosis over the follow-up period. The “other” category increases in both males and females are likely due to improvements in tissue-specific diagnostic techniques. In addition, decreases in male LCC, especially from 1983 to 1995, may reflect a history of difficulty in distinguishing this type of cancer from poorly differentiated SQC and ADC prior to improvements in more modern diagnostic methods [28].

This study's strengths include 30 + years of follow-up using Austria's national cancer registry, which has been collecting and maintaining records of Austrian cancer since 1970. The nationalized health care system in Austria ensures complete coverage of cancer diagnoses in the population, and the corresponding smoking exposure data have been retrieved from nationally representative census surveys. Weaknesses include the ecologic design, which prevents individual-level correlations between exposure and disease, control for possible confounding factors, and reporting of specific smoking rates among the diseased. However, the smoking-lung cancer etiologic relationship has been firmly established since the 1950s [29, 30], so the smoking and lung cancer trend correlations may be more flexible to causal interpretation. For example, the smoking prevalence rates presented are population averages, and specific rates for those with lung cancer are expected to be much higher, but are not available using our data sources. Additional limitations include slight variations in the questionnaires used to characterize smoking habits, and less complete histological subtype information in the early reporting years.

Today, smoking remains popular in Austria, and smoking rates are higher than in many other European nations. Especially the rising smoking rates in 15-year-old children in the 1980s and 1990s and the decreasing age at initiation are reasons to worry about future development of lung cancer and other smoking-related disease [31]. Laws to restrict or ban smoking in public areas have been slow to implement and smoking in women, especially young women, is an epidemic that has been on the rise until very recently. This rise is reflected in a lagged increase in lung cancer incidence and mortality data which is likely to continue for the next 20 years or even longer, if progress of tobacco control stays poor. Antismoking laws and public health initiatives to elucidate the harmful effects of active and passive smoking and to further curtail smoking habits are needed in Austria, especially programs which target younger women.

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Fig. 1.
Age-adjusted lung cancer incidence (1983–2007), age-adjusted lung cancer mortality (1970–2009) and smoking prevalence (1972–2007), by sex

Fig. 2.
Male age-adjusted lung cancer mortality by 5-year birth cohort

Fig. 3.
Female age-adjusted lung cancer mortality by 5-year birth cohort

Fig. 4.
Male age-adjusted lung cancer incidence by histological type (1983–2007)

Fig. 5.
Female age-adjusted lung cancer incidence by histological type (1983–2007)

Table 1

Prevalence of smoking (in percent) by sex and age group for select survey years

Age	Males					Females				
	1972	1979	1986	1997	2006	1972	1979	1986	1997	2006
20-24	43	51	47	48	32	21	35	37	30	29
25-29	56	53	52	45	32	28	32	38	33	29
30-34	49	51	53	46	35	20	34	35	34	25
35-39	44	46	47	45	35	15	22	31	37	25
40-44	49	40	47	40	35	14	17	30	33	25
45-49	49	40	36	40	28	14	12	18	27	21
50-54	46	42	34	33	28	12	15	14	25	21
55-59	46	38	35	28	28	12	13	12	16	21
60-64	42	33	31	19	15	5	9	10	9	9
65-69	42	33	27	17	15	5	6	9	8	9
70-74	42	34	27	15	15	5	5	6	9	9
75+	42	25	22	11	6	5	2	3	4	2