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Sex-specific trends in smoking prevalence within seven years in different Austrian populations: results of a time series cross-sectional survey

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ABSTRACT

Objectives: It was the aim to examine trends over time in smoking status in men and women, and in subgroups in Austria, a country with poor smoking regulation policies.

Design and Participants: Series of two cross-sectional surveys (Austrian health interview survey 2007 and 2014), each with more than 15.000 participants of the general population, aged ≥15 years.

Outcome measures: Prevalence of self-reported daily smoking; Odds ratios for daily smoking in sub-groups as results of logistic regression models, adjusted for socio-demographic variables (age, education, employment status, land of birth, urbanisation, and family status), and health related factors (presence of a chronic disease);

Results: Prevalence of daily cigarette smoking was 26.0% for men in both years, and 19.1% and 22.0% in women in the years 2007 and 2014, respectively. Smoking prevalence increased especially in female patients with diabetes mellitus by 67% (P=0.005), with obesity by 26% (P=0.010), and with hypertension by 27% (P=0.010). Smoking prevalence increased furthermore significantly in unemployed men as well as in women ≥30 years, in women with lower education and in women with a migration background. In the adjusted analysis in women in 2014 there was a higher chance of smoking (OR 1.22, 95% CI 1.12 to 1.32) compared to 2007. Furthermore, for women being affected by a chronic disease there was a higher risk of smoking compared to women with no chronic disease (OR 1.15, 95% CI 1.06 to 1.25).

Conclusions In contrast to other countries, there is a remarkable increase in smoking prevalence in women in Austria, especially in those with chronic diseases, higher age, lower education, and migration background. Better tobacco control and regulatory implications as well as greater public health efforts and clinical efforts are needed to address and reduce high tobacco use in all subjects but particularly in most vulnerable patients.

Strengths and limitations of this study

- The results are based on a series of two cross-sectional surveys with representative sample sizes of more than 15.000 subjects in both surveys.
- The seven years between the two surveys allow to analyse trends in smoking prevalence during a time period, where most countries, in opposite to Austria, made huge efforts in tobacco control.
- The survey are population-based, which allow the analysis of health persons in parallel with patients with chronic diseases.
- All data are self-reported with according potential limitations due to this fact.

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INTRODUCTION

Smoking is the most important and largest avoidable risk factor for ill health and premature mortality.[1-3] Smoking shortens life expectancy by approximately a decade. Risk of death is about 3fold higher in smokers compared to non-smokers.[4] The biggest problem is an increase in cardiovascular disease but there is also a rise of many cancers and respiratory problems due to the negative effects of smoking.[1]

In industrialised countries, smoking peaked ten years later in women compared to men but comparable consumption patterns are now seen in both sexes in most countries. Risk of total mortality in smoking women increased over time almost threefold paralleling the increase in men. There is evidence of gender differences regarding prevalence of smoking, the development of complications and temporal trends. In most countries smoking prevalence is still higher in men except in Sweden and Iceland.[1]

In many countries smoking rates decreased since 2000, by about 25% on average, with most prominent decrease in Northern European countries.[1] Analysis with data from 181 countries showed an average decline of smoking prevalence between 1980 and 2012 from 41.2% to 31.1% in men and from 10.6% to 6.2% in women. Only few countries including Austria increased their smoking prevalence and Austrian women even had the third highest absolute prevalence among the investigated countries.[5]

Advertising bans, restriction in public spaces and restaurants, awareness campaigns and higher taxation are all anti-tobacco policies of governments aiming to work against the rise of smoking-related diseases,[6] and declined smoking prevalence may be attributed to lack of policies in one or more of those areas. Unfortunately Austria is among the countries with poor

smoking regulation policy.[7] Since 2007 Austria has consistently had the lowest score in the Tobacco Control Scale of the European Cancer Leagues,[8] and does not fulfil its legal obligations under the WHO Framework Convention, already ratified in 2005.[9 10]

In front of this background, it was the aim of this study to examine in more detail smoking status and the relation to chronic diseases in men and women and monitor trends over time in Austria. Additionally, we aimed to evaluate the smoking status in different subgroups according to socio-demographic and health parameters and to assess if the association between those parameter with smoking status differed over time or according to sex.

METHODS

Datasets

The databases for the analysis were two existing waves of the Austrian Health Interview Survey (AT-HIS) 2007[11] and 2014[12], a repeatedly performed representative population-based survey in subjects aged 15 years and older, carried out by Statistics Austria on behalf of the Austrian Ministry of Health. The questionnaires used for the AT-HIS was designed based on the European Health Interview Survey (E-HIS) which is regularly conducted in the countries of the European Union (EU)[13 14] and has been adapted for Austria by an expert panel. For the AT-HIS, the sample was stratified by 32 geographic regions, with the same number of subjects being included from each region (higher number for the three regions in Vienna). To balance possible distortions through the geographic stratification of the sample, the data were weighted using the number of people living in each region, age in five-year groups, and sex as weight factors in 2007, and geographic region, age, sex, family situation, migration background, and education level as weight factors in 2014. Missing values were imputated

according to established imputation guidelines based on fundamental analyses of the non-responses.

For the AT-HIS 2007, subjects were interviewed face-to-face using CAPI (computer assisted personal interviewing) between March 2006 and March 2007 by 137 trained interviewers. The gross sample size comprised 25,130 people. 9,656 subjects were excluded due to different reasons: 5,709 subjects refused or broke up the interview, 3,308 were excluded due to difficulties in contacting them or because of deficiency regarding the command of the German language, and for 639 cases there was an insufficiency in data quality. The data of a total of 15,474 subjects were eligible for analysis, representing a response rate of 63.1%. The ATHIS 2014 was carried out from October 2013 to June 2015 via computer assisted telephone interviewing (CATI). The survey comprised a gross sample size of 38,768 subjects. Of those, 21,343 subjects initially already refused to participate. Another 1,594 subjects who initially declared their interest to participate could not be reached any more or refused the telephone interview. 25 subjects broke off the interview, and the data of 35 subjects was insufficient. Thus, a net sample of 15,771 subjects was included in the survey, yielding in a response rate of 40.7%. To increase response rate, subjects were repeatedly reminded and handed out a gift voucher as incentive.

Variables

Daily cigarette smoking was given in the AT-HIS 2007, if subjects answered “Yes” to the question “Have you smoked yet in your live more than 100 cigarettes, cigars, pipes or other tobacco products?”, and answered “Yes daily” to the question “Do you smoke currently?”, and answered with “Cigarettes from cigarette boxes” to the question “Which of the following tobacco products do you smoke daily?”. Daily cigarette smoking in the AT-HIS 2014 was given, if subjects answered “Yes, daily” to the question “Do you smoke?” and “cigarettes” to

the question “Which of the following tobacco products do you use most frequently?”. Furthermore, in the survey 2014 the number of cigarettes smoked per day and the age of beginning with smoking was analysed in those who indicated to smoke cigarettes daily.

For socio-demographic variables age was used in three categories: 15-29 years, 30-64 years, and 65 years and older. Highest education level was categorised as primary education (school until the age of 15 years), secondary education (education up to the Austrian school leaving exam “Matura” at the age of 18 or 19 years, or apprenticeship), and tertiary education (university, or university of applied sciences, or further vocational education after the “Matura”). Employment status was coded in three categories as gainfully employed (including self-employed), unemployed or not gainfully employed (retirement, in formal education, housewives and househusbands, subjects in maternity or paternity leave, and persons in military service). Birthland was coded in three categories: Austria, EU and non-EU. In the survey 2007, the variable birthland EU-states comprised the 27 states in the EU of the year 2006 except Austria as well as the 4 states of the European Free Trade Association, and in the survey 2014 the 28 European states in the EU of the year 2014 except Austria. Urbanisation was coded as living in the Austrian capital Vienna, the only Austrian big city with about two million inhabitants, or in any other Austrian federal state (in which no city has more than 300,000 inhabitants). Family status was coded with two categories in relationship or not in relationship, whereas in relationship also includes being married. Being affected by at least one chronic disease was evaluated with the question “Do you have a chronic health problem?”. Furthermore, specific chronic diseases were evaluated and asked, if subjects were affected by the respective chronic health problem within the last 12 months. For this analysis the following chronic health problems were used: diabetes mellitus, hypertension, chronic obstructive pulmonary disease (COPD), stroke, and myocardial infarction. Additionally, body mass index (BMI) was calculated as kg/m² with self-reported data on body weight and body height, and a BMI ≥ 30 kg/m² classified as obesity.

Statistical analysis

For statistical analyses SPSS 24 was used. Bivariate analyses were undertaken by means of cross-tabs, and group differences assessed with the Pearson's Chi²-test. To test for the interaction between the year of evaluation and socio-demographic factors or health factors or the interaction between sex and socio-demographic or health factors on the probability for daily smoking, we performed binary logistic regression analysed. Daily cigarette smoking was defined as the dependent variable, all socio-demographic and health factors as independent variables and additionally the product between year of evaluation or sex with the respective socio-demographic or health factor also as independent variable. The P-value for this product in the fully adjusted model is presented as indicator whether there is a significant interaction effect on smoking status or not (for interaction between year and the respective factor in tables 2a and 2b, and for the interaction between sex and the respective factor in the text). The estimates of the logistic regression model with all mutually adjusted socio-demographic and health variables on the probability of daily smoking is presented as odds ratio (OR) and 95% confidence interval (95% CI) in table 4.

Ethical considerations

The secondary analysis of the AT-HIS databases which were used for this study was approved by the Ethics Committee of the Medical University Vienna: (EK # 770/2011 for the AT-HIS 2007 and EK # 2211/2015 for the AT-HIS 2014).

RESULTS

Prevalence of daily cigarette smoking was 26.0% in men in both years, 2007 and 2014. In women there was a significant increase in smoking prevalence from 19.1% in 2007 to 22.0% in 2014 (P<0.001). In the survey 2014, men reported a mean age of starting smoking of 17.7

(SD: 4.8) years, and women of 18.8 (SD: 6.2) years (P<0.001). Mean number of cigarettes was reported in the survey 2014 at 17.3 (SD: 9.2) in men, and 13.6 (SD: 6.8) in women (P<0.001).

Table 1 shows socio-demographic and health characteristics of male and female participants in both surveys. In men there was a significant difference in age group categories (higher age in 2014), in educational level (higher education in 2014), in employment status (less gainfully employed in 2014), in birthland (more migrants from the EU and less from non-EU countries in 2014), higher prevalence of obesity, hypertension, and myocardial infarction in 2014 compared to 2007. In women, there were significant differences in educational level (higher education in 2014), employment status (more gainfully employed, more unemployed, but less not gainfully employed 2014), in birthland (more migrants from the EU and less from non-EU countries in 2014), a lower prevalence of diabetes mellitus, but a higher prevalence of hypertension, and myocardial infarction in 2014 compared to 2007.

In table 2 the prevalence of daily cigarette smoking in different subgroups is indicated for men (table 2a) and women (table 2b). In men, prevalence of smoking was particularly high in people aged 15-29 years, in men with no tertiary education, in unemployed men, in men living in Vienna, in those not being in relationship, and in subjects with no chronic disease. In men, there was a significant interaction between the year of evaluation and the employment status on the probability of daily cigarette smoking. In 2014, unemployed men smoked even more than unemployed men in 2007. In women, prevalence of smoking was particularly high in the age groups 15-29, as well as in those aged 30-64 years, in women with primary and secondary education, in unemployed women, in those with a migration background (especially from non-EU countries), in the year 2014 in those from Vienna (which was not the case in 2007), in women with no relationship in 2014 (again, not the case in 2007), and in

2007 in women with no chronic disease (not in 2014). In women, there was a significant interaction between the year of evaluation with the following three parameters on the probability of daily cigarette smoking: age, education level, and birthland. Compared to 2007, in 2014 the proportion of smoking women was higher in older age groups (30-64, and particularly 65+ years), and similar in younger women. Compared to 2007, in 2014 women with lower education smoked more and with higher education less often. And, compared to 2007, the increase in smoking prevalence in women with migration background was much higher than the increase in women born in Austria.

In both years, there was a significant interaction between sex and age on the probability of daily cigarette smoking (P<0.001): While in men there was a clear gradual decrease in smoking prevalence with higher age groups, this was not so much pronounced in women. Especially in 2014, smoking prevalence in women was similar in the age groups 15-29 years and 30-64 years (prevalence in subgroups shown in tables 2a and 2b). In 2007, there was additionally a significant interaction between sex and educational level (P=0.021) and sex and urbanisation (P=0.002) on the probability of daily smoking. While in men smoking prevalence was similar high in those with primary and secondary education and low in those with tertiary education, in women smoking prevalence was highest in those with secondary education. In 2014, smoking prevalence in women was, like in men, highest in those with primary education. While in 2007 in men there was a clear higher smoking prevalence in city-dwellers, this was not the case in women. In 2014, however, female subjects living in the city had, even more pronounced than in men, a clearly higher smoking prevalence than those living in rural federal states. Furthermore, in 2014, there was a significant interaction between sex and birthland on the probability of daily smoking (P=0.006). The difference in smoking prevalence between those with a migration background and those born in Austria was slightly more pronounced in women than in men.

In table 3 smoking prevalence in men and women with certain health conditions are presented. Compared with the general population, smoking prevalence in patients with chronic diseases was lower, except in men and women with COPD (2007 and 2014), and in women after myocardial infarction (2007). In men with chronic diseases, there was no significant difference in smoking prevalence in the years 2014 and 2007. In women, however, in 2014 there was a significant higher smoking prevalence in those with any chronic diseases, those with diabetes mellitus, those with obesity, and those with hypertension, compared to 2007.

Table 4 shows the association between the year of evaluation, socio-demographic variables and health status with the chance of daily cigarette smoking in men and women. In this multivariate analysis, women had 22% higher odds for smoking in 2014 in comparison to 2007. Additionally, women had 15% higher odds of daily smoking when affected by chronic diseases compared to women without chronic diseases. Socio-demographic variables were associated with the odds of daily smoking in both sexes, in the multivariate analysis.

DISCUSSION

In this survey of trends of smoking in the Austrian population in the last decade, we found that prevalence of daily smoking increased in women to 22% in 2014 while it remained steadily high over time in men resulting in a small gender gap in Austria. This corresponds to one of the worst places worldwide with only Greece and Bulgaria having higher prevalence of smoking females.[5] As in all OECD countries except in Sweden and Iceland,[1] smoking prevalence in Austria is higher in males compared to females in Austria. Furthermore, 56% of the countries in the OECD had less than 20% of their adult population smoking daily in 2013.[1] Thus, smoking in Austria deserves special attention, and in fact, cardio-vascular

mortality in Austria did not decrease in the last decades that much as in other comparable countries, despite many advantages in other cardio-vascular risk factors, most probably due to the high smoking prevalence in Austria.[15]

Therefore, it was necessary to analyse in more detail the characteristics of the smoking subpopulation in Austria. Comparing now daily smokers in different subgroups of men indicated highest prevalence at young age, in migrants, in those with low education, unemployment, urbanisation (living in Vienna), single status and in the subgroup without a chronic disease. On the other hand, in women prevalence of smoking daily was particularly high at young and middle age, at low as well as at higher levels of education, in the unemployed subgroup, as well as in migrants, especially from non-EU countries. Only in 2014 also women with single status, those living in Vienna and the subgroup with chronic diseases showed high prevalence of smoking. We also found an increase in smoking rates in those with higher age, with lower education, and in those with origin from non-EU countries in 2014 compared to 2007, in women. In men, however, smoking prevalence in subgroups did not change, except that smoking was more common in unemployed men 2014 compared to 2007.

As smoking is a large avoidable risk factor for many chronic diseases, in particular cardiovascular disease, various cancers and respiratory diseases, but also metabolic diseases such as diabetes mellitus, we also evaluated the proportion of daily cigarette smokers in both sexes in different populations regarding health status and the changes over time. Due to the cross-sectional nature of the study, we certainly cannot conclude if smoking had contributed to the genesis of the respective chronic diseases. However, since smoking cessation is part of the recommended therapy and guidelines in many chronic diseases including diabetes mellitus, cardiovascular disease or COPD, a high smoking prevalence in those patients can be

interpreted in the way that smoking cessation was not very successful or was not given a high priority in the therapy of the chronic diseases.[16] Since we found higher increases in smoking prevalence in women with chronic diseases compared to men, we can assume that treatment according to guidelines, which includes smoking cessation, has worsened particularly in women. Less often treating according to guidelines in women compared to men has been shown also in other studies.[17-19]

The largest and most worrisome increase by almost 70% was present in women with diabetes mellitus. This is of particular concern as women with diabetes mellitus are already a very high risk population especially for myocardial infarction and stroke with greater relative risk than diabetic men.[20 21] Furthermore, smoking is a prominent risk factor both for development of insulin resistance and diabetes mellitus as well as for the progression of diabetic complications. Data from NHANES III showed that tobacco smoke exposure relates to the metabolic syndrome in adolescents.[22] Another recent meta-analysis showed a pooled adjusted relative risk of 55% for total mortality and of 49% for cardiovascular mortality associated with smoking in patients with diabetes mellitus.[23]

A special concern is also the high number of smoking women of reproductive age. Although we do not know if these women smoked during their potential pregnancies we can assume that at least some of them did. Smoking during pregnancy exposes the fetus to a high risk of health problems in utero and in later life further contributing to transgenerational programming of cardiometabolic risk.[24 25]

The high prevalence of smoking in patients with myocardial infarction or stroke in Austria is also alarming. Smokers lose approximately 10.3 years compared with 5.4 years of non-smokers up to 8 years after acute myocardial infarction, with women loosing almost two years

more than men.[26] Besides causal links of smoking to many chronic diseases, continued smoking also contributes to exacerbations of these chronic conditions. Thus, it is of utmost importance to support these patients to become tobacco-free. Special support may be necessary as stress related with chronic diseases may aggravate withdrawal symptoms in these patients.

It can therefore be expected that especially vulnerable groups with chronic diseases, metabolic disorders, lower socioeconomic status, migrants and females in general, which also often suffer from additional mental health problems, are particularly at risk of the sequelae of smoking and of lower success of cessation programmes. Some studies showed success of smoking cessation programmes in patients with acute and chronic diseases who might be particularly motivated to quit.[4] Anyway, greater potential harm from continued use is expected in patients with chronic diseases. Such studies highlight the importance of intensive guidance and advice to quit smoking in patients treated in hospital for diseases related to smoking and after discharge.[27]

Strengths of the study include the high sample size with more than 15.000 subjects in both surveys with relatively high response rates, and the population-based design, allowing to analyse healthy subjects in parallel with subjects with clinical conditions. A potential limitation is the fact that all factors analysed were self-reported. This might have led to underestimations of smoking prevalence as well as underestimation of the prevalence of chronic diseases. However, another Austrian study has shown that self-reported data on smoking are highly valid when compared with objectively verified data on smoking e.g. with exhaled carbon monoxide.[28] This might be due to the fact that in Austria, compared with other countries, smoking and reporting to do so is not associated with social stigma, as result of the lacking smoking regulation policy. A further limitation is the fact, that the methods applied in

the two waves of the AT-HIS differed (CAPI in 2007 and CATI in 2014) which limits the possibility to compare the two surveys.

In summary, better tobacco control and regulatory implications as well as greater public health and clinical efforts are highly needed to address and reduce high tobacco use and exposition to environmental smoke. This is of particular importance in most vulnerable patients coping with chronic conditions and continued smoking. Intensified tobacco control efforts are needed in countries like Austria where the percentage of smokers is consistently high in men or even increasing in women. Inclusion of a female perspective in smoking prevention and cessation policies appears crucial to antagonise the current trend and to protect the most vulnerable group of young women. Such policies could contribute to better health related quality of life of the population and to cost reductions in the health care system.

Author's contribution

TED, HB, and AKW designed the manuscript and the analyses jointly. TED made the statistical analyses. TED and AKW drafted different parts of the manuscript. All authors have commented on the manuscript draft and read and approved the final version of the manuscript.

Patient consent for publication

Not required.

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Table 1: Characteristics and change of characteristics in male and female participants

	Men			Women		
	2007	2014	P*	2007	2014	P*
	N=7453	N=7670		N=8021	N=8100	
Age			0.010			0.790
15-29	23.3	22.5		21.0	20.6	
30-64	59.8	58.8		56.1	56.3	
65+	16.9	18.8		22.9	23.1	
Education level			<0.001			<0.001
Primary	20.1	17.2		33.5	27.0	
Secondary	70.4	69.0		57.2	59.8	
Tertiary	9.6	13.7		9.2	13.1	
Employment status			<0.001			<0.001
Gainfully employed	61.8	59.3		44.1	45.7	
Unemployed	4.3	6.3		2.7	4.0	
Not gainfully employed	33.9	34.4		53.2	50.3	
Birthland			<0.001			<0.001
Austria	83.9	84.0		84.4	81.8	
EU	4.8	9.1		6.2	12.1	
Non-EU	11.2	6.9		9.4	6.1	
Urbanisation			0.350			0.492
Vienna	19.9	20.5		20.7	21.1	
Other federal States	80.1	79.5		79.3	78.9	
Family status			0.765			0.132
In relationship	69.9	70.1		62.1	60.9	

Not in relationship	30.1	29.9		37.9	39.1	
Health status			0.215			0.110
At least one chronic disease	34.2	33.2		39.8	38.6	
No chronic disease	65.8	66.8		60.2	61.4	
Prevalence of diabetes mellitus	5.2	5.4	0.480	5.9	4.5	<0.001
Prevalence of obesity	12.0	15.6	<0.001	12.7	13.2	0.375
Prevalence of hypertension	17.6	20.5	<0.001	20.1	21.7	0.014
Prevalence of COPD	3.5	4.0	0.148	4.2	4.4	0.492
Prevalence of MI	0.6	1.4	<0.001	0.4	0.6	0.036
Prevalence of stroke	0.8	0.8	0.765	0.8	0.8	0.885
Daily cigarette smoking	26.0	26.0	0.998	19.1	22.0	<0.001

*P-value as results of Chi² test between 2007 and 2014

Table 2a: Prevalence of smoking in male subpopulations 2007 and 2014

	2007		2014		Interaction year*factor on daily smoking
	%Smokers	P*	%Smokers	P*	P**
Age		<0.001		<0.001	0.807
15-29	31.2		31.9		
30-64	28.9		29.2		
65+	8.3		8.6		
Education level		<0.001		<0.001	0.719
Primary	27.3		29.1		
Secondary	27.4		27.6		
Tertiary	12.6		13.7		
Employment status		<0.001		<0.001	0.002
Gainfully employed	30.7		29.5		
Unemployed	43.6		57.1		
Not gainfully employed	15.2		14.1		
Country of birth		<0.001		<0.001	0.246
Austria	24.3		24.5		
EU	23.0		30.6		
Non-EU	39.6		38.0		
Urbanisation		0.008		<0.001	0.149
Vienna	28.7		32.9		
Other federal states	25.3		24.2		

Family status		<0.001		<0.001	0.917
In relationship	24.0		23.6		
Not in relationship	30.6		31.5		
Health status		<0.001		0.006	0.647
At least one chronic disease	23.1		24.0		
No chronic disease	27.5		27.0		

*P-value as results of Chi² test between 2007 and 2014

**P-value as result of binary logistic regression analyses for the interaction between year of evaluation and the respective socio-demographic or health variable on the odds of daily smoking (dependent variable), adjusted for all socio-demographic and health variables and the year of evaluation

Table 2b: Prevalence of smoking in female subpopulations 2007 and 2014

	2007		2014		Interaction year*factor on daily smoking
	%Smokers	P*	%Smokers	P*	P**
Age		<0.001		<0.001	0.004
15-29	28.4		27.8		
30-64	21.9		26.3		
65+	3.9		6.2		
Education level		<0.001		<0.001	<0.001
Primary	17.2		24.4		
Secondary	21.4		23.4		
Tertiary	12.2		10.4		
Employment status		<0.001		<0.001	0.997
Gainfully employed	25.6		28.6		
Unemployed	42.1		45.4		
Not gainfully employed	12.6		14.0		
Country of birth		<0.001		<0.001	0.016
Austria	18.7		20.5		
EU	16.6		26.1		
Non-EU	25.0		32.8		
Urbanisation		0.599		<0.001	0.514
Vienna	19.6		31.5		
Other federal states	19.1		19.4		

Family status		0.160		<0.001	0.290
In relationship	18.6		20.6		
Not in relationship	19.9		24.1		
Health status		0.001		0.357	0.662
At least one chronic disease	17.4		21.4		
No chronic disease	20.3		22.3		

*P-value as results of Chi² test between 2007 and 2014

**P-value as result of binary logistic regression analyses for the interaction between year of evaluation and the respective socio-demographic or health variable on the odds of daily smoking (dependent variable), adjusted for all socio-demographic and health variables and the year of evaluation

Table 3: Proportion of daily cigarette smokers in men and women of different populations and changes over time

	Men				Women			
	2007	2014	Change	P*	2007	2014	Change	P*
General population	26.0	26.0	±0%	0.998	19.1	22.0	+15%	<0.001
People with at least one chronic disease	23.1	24.0	+4%	0.433	17.4	21.4	+23%	<0.001
Diabetes mellitus	14.5	17.7	+22%	0.219	9.9	16.4	+67%	0.005
Obesity (BMI≥30 kg/m²)	23.2	24.7	+6%	0.405	17.1	21.6	+26%	0.010
Hypertension	17.5	20.1	+15%	0.082	11.2	14.2	+27%	0.010
COPD	31.6	28.2	-11%	0.382	24.9	25.7	+3%	0.814
Myocardial infarction	8.9	20.0	+125%	0.094	20.0	14.3	-29%	0.506
Stroke	10.2	17.5	+72%	0.245	9.1	20.0	+120%	0.076

*P-value as results of Chi² test between 2007 and 2014

Table 4: Association of socio-demographic and health variables on the chance of daily cigarette smoking. Results of multivariate logistic regression model based on both surveys2007 and 2014; each included variable is mutually adjusted for all other variables.

		Men		Women	
		OR	(95% CI)	OR	(95% CI)
Year	2007	1		1	
	2014	1.04	(0.97 to 1.13)	1.22	(1.12 to 1.32)
Age	15-29	2.51	(2.09 to 3.01)	6.10	(5.11 to 7.28)
	30-64	2.50	(2.11 to 2.96)	5.17	(4.35 to 6.14)
	65+	1		1	
Education level	Primary	3.02	(2.54 to 3.59)	3.82	(3.21 to 4.55)
	Secondary	2.81	(2.42 to 3.26)	3.02	(2.58 to 3.55)
	Tertiary	1		1	
Employment status	Gainfully employed	1		1	
	Unemployed	1.93	(1.73 to 2.16)	1.84	(1.67 to 2-02)
	Not gainfully employed	3.70	(3.11 to 4.39)	2.87	(2.37 to 3.47)
Birthland	Austria	1		1	
	EU	1.25	(1.08 to 1.46)	1.26	(1.10 to 1-45)
	Non-EU	1.52	(1.34 to 1.73)	1.12	(0.97 to 1-30)
Urbanisation	Vienna	1.28	(1.16 to 1.40)	1.50	(1.36 to 1.65)
	Other federal States	1		1	
Family status	In relationship	1		1	
	Not in relationship	1.38	(1.26 to 1.52)	1.33	(1.22 to 1.45)

Health status	At least one chronic disease	1.04	(0.96 to 1.13)	1.15	(1.06 to 1.25)
	No chronic disease	1		1	

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

"Sex-specific trends in smoking prevalence within seven years in different Austrian populations: results of a time series cross-sectional survey"

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1; 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	*6-8*
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	5-6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	5

		(*e*) Describe any sensitivity analyses	n.a.
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	18, Table 1
		(b) Indicate number of participants with missing data for each variable of interest	n.a.
Outcome data	15*	Report numbers of outcome events or summary measures	18, Table 1
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	18-26, Tables 1-4
		(*b*) Report category boundaries when continuous variables were categorized	n.a.
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n.a.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-10; 20-23, Table 2
Discussion			
Key results	18	Summarise key results with reference to study objectives	11-12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14-15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	11-14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	3

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Sex-specific trends in smoking prevalence over seven years in different Austrian populations: results of a time-series cross-sectional analysis

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Sex-specific trends in smoking prevalence over seven years in different Austrian populations: results of a time-series cross-sectional analysis

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ABSTRACT

Objectives: Aim of this study was to examine trends over time in smoking status in men and women, and in subgroups, in Austria, a country with poor smoking regulation policies.

Design and participants: Two cross-sectional surveys (Austrian Health Interview Surveys for 2007 and 2014), each with more than 15,000 participants from the general population, aged ≥15 years.

Outcome measures: Prevalence of self-reported daily smoking. Odds ratios for daily smoking in subgroups, presented as results of logistic regression models, adjusted for socio-demographic variables and presence of chronic diseases.

Results: Prevalence of daily cigarette smoking was 26.0% for men in both years, and increased from 19.1% to 22.0% (P<0.001) in women from 2007 to 2014. Smoking prevalence increased especially in female patients with diabetes mellitus (from 9.9% to 16.4%, P=0.005), obesity (from 17.1% to 21.6%, P=0.010), and hypertension (from 11.2% to 14.2%, P=0.010). Smoking prevalence increased significantly in unemployed men (from 43.6% to 57.1%, P<0.001). In women, smoking prevalence increased in those aged 30 to 64 years (from 21.9% to 26.3%, P<0.001) and 65+ (from 3.9% to 6.2%, P=0.002), with primary (from 17.2% to 24.4%, P<0.001) and secondary education (from 21.4% to 23.4%, P=0.021), and with a European (from 16.6% to 26.1%, P<0.001) and non-European migration background (from 25.0% to 32.8%, P=0.003). In the adjusted analysis for women in 2014, there was a higher likelihood of smoking (OR 1.22, 95% CI 1.12 to 1.32, P<0.001) compared to 2007, and for those affected by a chronic disease (OR 1.15, 95% CI 1.06 to 1.25, P=0.002).

Conclusions There has been a remarkable increase in smoking prevalence over the 7 year period in women in Austria, especially for those with chronic diseases, higher age, lower education, and a migration background. Better political and clinical efforts are needed to reduce the high tobacco use in Austria.

Strengths and limitations of this study

- The results are based on two cross-sectional surveys with representative sample sizes of more than 15,000 subjects in each survey.
- The seven years between the two surveys allowed us to analyse the trends in smoking prevalence over this time period, during which time most countries, in opposite to Austria, have made huge efforts in tobacco control.
- The surveys were population-based, and thus allowed the analysis of healthy persons in parallel with patients with chronic diseases.
- Potential limitations can be ascribed to the fact that all the data are self-reported, and that there were slightly different methods applied in the two national surveys.

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

INTRODUCTION

Smoking is the most important and largest avoidable risk factor for ill health and premature mortality.[1-3] Smoking also shortens life expectancy by approximately a decade. Risk of death is about threefold higher in smokers compared to non-smokers.[4] The biggest problems associated with smoking include cardiovascular diseases, cancers, and respiratory problems.[1]

In industrialised countries, smoking peaked ten years later in women compared to men but comparable consumption patterns are now seen in both sexes in most countries. Between 2000 and 2013, risk of total mortality in women that smoke increased almost threefold paralleling the increase in men. There is also evidence of gender differences regarding the prevalence of smoking, and in the development of complications and temporal trends. In most countries, smoking prevalence is still higher in men, except in Sweden and Iceland.[1]

In many countries, smoking rates have decreased since 2000, by about 25% on average, with the most prominent decrease in Northern European countries.[1] Analysis of data from 181 countries showed an average decline of smoking prevalence between 1980 and 2012 of 41.2% to 31.1% in men and 10.6% to 6.2% in women. Only a few countries, including Austria, increased their smoking prevalence, and Austrian women had the third highest absolute prevalence among the investigated countries. In conclusion, the authors urged that intensified efforts and policies were required in all countries to control tobacco use, especially in those with a high smoking prevalence.[5]

Advertising bans, restrictions in public spaces and restaurants, awareness campaigns and higher taxation are all anti-tobacco policies aimed at addressing the rise of smoking-related

diseases.[6] A failure to decrease smoking prevalence may be attributed to a lack of policies in one or more of these areas. Unfortunately, Austria is among the countries with poor smoking regulation policies.[7] Since 2007, Austria has consistently had the lowest score in the Tobacco Control Scale of the Association of European Cancer Leagues,[8] and does not fulfil its legal obligations under the WHO Framework Convention, which was ratified in 2005.[9 10]

According to the European Tobacco Control Report of the WHO European Region, since joining this network in 2005, up until 2017, Austria has had very high and stable scores in monitoring tobacco use, and in enforcing bans on tobacco advertising, promotion and sponsorship. Austria has also had high and stable scores in offering people to help quitting tobacco use and treating dependence (with free quit lines and medication for smoking cessation, for which, however, patients have to pay out of their own pocket). With regard to warnings on cigarette packages about the dangers of tobacco, and in raising tobacco taxes, Austria has also scored quite highly, and in both measures, scores increased between 2015 and 2017. Austria has, however, scored poorly in terms of warning people about the dangers of tobacco use through anti-tobacco campaigns. Only between 2015 and 2017 did Austria introduce national campaigns conducted with characteristics appropriate to WHO standards. The worst scores Austria received were in terms of protecting people from second-hand tobacco smoke.[7] In fact, it was not until November 2019 that Austria introduced smoking bans in restaurants, cafés, and bars.

Against this background, it was the aim of this study to examine the prevalence of daily smoking and the relation to chronic diseases in men and women, and to monitor trends over time in Austria. In addition, we aimed to evaluate the prevalence of daily smoking in different subgroups, according to socio-demographic parameters and the occurrence of certain chronic

diseases, and to assess if the association between these parameters with smoking status differed over time.

METHODS

Datasets

The databases used for the analysis were the two existing waves of the Austrian Health Interview Survey (AT-HIS) for 2007[11] and 2014[12].The AT-HIS is a representative population-based survey that is conducted at regular intervals in Austria, in subjects aged 15 years and older, carried out by Statistik Austria on behalf of the Austrian Ministry of Health. The questionnaires used for the AT-HIS were designed based on the European Health Interview Survey (E-HIS), which is regularly conducted in the countries of the European Union (EU)[13] [14], and was adapted for Austria by an expert panel. For the AT-HIS, the sample is stratified into 32 geographic regions, with the same number of subjects in each region (there is a higher number for the three regions in Vienna). To balance the possible distortion brought about by the geographic stratification of the sample, the data have been weighted using the number of people living in each region, with the age in five-year groups, and sex as the weighting factors in 2007, and geographic region, age, sex, family situation, migration background, and education level as the weighting factors in 2014. Missing values have been imputed after fundamental analyses of the non-responses, based on sex, age, education, and living region. There are, however, very few missing variables, and none in the case of the used variables regarding smoking.[11 12]

For the AT-HIS 2007, subjects were interviewed face-to-face using computer-assisted personal interviewing (CAPI) between March 2006 and March 2007 by 137 trained

interviewers. The initial sample comprised 25,130 addresses of the central population register, of which 621 addresses had to be excluded due to the fact that the target person had moved, had already died, or the address did not exist anymore. The remaining 24,509 persons were the gross sample size, which was the basis for calculating the response rate. Of this total, 9,656 subjects were excluded for different reasons: 5,709 subjects refused or terminated the interview; 3,308 were excluded due to difficulties in contacting them or because of deficiency regarding their command of the German language; and 639 cases were excluded due to unsatisfactory data quality. The data of a total of 15,474 subjects were eligible for analysis, representing a response rate of 63.1%. The AT-HIS 2014 was carried out from October 2013 to June 2015 via computer-assisted telephone interviewing (CATI). The survey comprised a gross sample size of 38,768 subjects from the central population register. Of this total, 21,343 subjects initially refused to participate; another 1,594 subjects who initially declared their interest to participate could no longer be reached, or refused the telephone interview; 25 subjects terminated the interview; and 35 subjects were excluded due to unsatisfactory data quality. Thus, a net sample of 15,771 subjects was included in the survey, yielding a response rate of 40.7%. The flow chart for the recruitment processes in both surveys is depicted in Figure 1. To increase the response rate, subjects were repeatedly reminded and given a gift voucher as incentive.

Variables

Daily cigarette smoking was indicated in the AT-HIS 2007 if subjects answered “Yes” to the question “Have you smoked yet in your life more than 100 cigarettes, cigars, pipes or other tobacco products?”, answered “Yes daily” to the question “Do you smoke currently?”, and answered with “Cigarettes from cigarette boxes” to the question “Which of the following tobacco products do you smoke daily?”. Daily cigarette smoking was indicated in the AT-HIS 2014, if subjects answered “Yes, daily” to the question “Do you smoke?” and “Cigarettes” to

the question "Which of the following tobacco products do you use most frequently?" Furthermore, in the 2014 survey, the number of cigarettes smoked per day and the age of starting smoking were recorded for those who indicated that they smoked cigarettes daily. For the socio-demographic variables, age was recorded in three categories: 15-29 years, 30-64 years, and 65 years and older. Highest education level was categorised as primary education (school until the age of 15 years), secondary education (education up to the Austrian school leaving exam "Matura" at the age of 18 or 19 years, or apprenticeship), and tertiary education (university, or university of applied sciences, or further vocational education after the "Matura"). Employment status was recorded in three categories as gainfully employed (including self-employed), unemployed or not gainfully employed (retirement, in formal education, housewives and househusbands, subjects in maternity or paternity leave, and persons in military service). Land of birth was recorded in three categories: Austria, EU and non-EU. In the 2007 survey, the land of birth variable of EU states comprised the 27 states in the EU for the year 2006, except Austria, as well as the four states of the European Free Trade Association. In the 2014 survey, the land of birth variable of EU states comprised the 28 European states in the EU for the year 2014, except Austria. Urbanisation was recorded as living in the Austrian capital Vienna (the only Austrian city with a population approaching two million inhabitants) or in any other Austrian federal state (in which no city has more than 300,000 inhabitants). Family status was recorded with two categories of in a relationship or not in a relationship, with in a relationship also including being married. Being affected by at least one chronic disease was recorded with the question "Do you have a chronic health problem?" Furthermore, the specific chronic diseases were recorded and the participants were asked if they had been affected by the respective chronic health problem within the last 12 months. For this analysis, the following chronic health problems were considered: diabetes mellitus, hypertension, chronic obstructive pulmonary disease (COPD), stroke, and

myocardial infarction. In addition, body mass index (BMI) was calculated as kg/m² from self-reported data on body weight and body height, and a BMI ≥ 30 kg/m² was classified as obese.

Statistical analyses

IBM SPSS 24 was used for the statistical analyses. All the analyses were carried out with the weighted data, as described in the dataset description. Bivariate analyses were undertaken by means of cross-tabulations, and group differences were assessed with Pearson's Chi-squared tests. To test for the interaction between the year of evaluation and socio-demographic factors or health factors on the likelihood of daily smoking, we performed binary logistic regression analyses. The reason for testing the interaction was that, if there a significant interaction was found, we could assume that there was a difference in the association between the respective tested factors with daily smoking in the respective year. If we found a significant interaction, we demonstrated the prevalence of daily smoking in the respective subgroup, stratified by the year of the survey. Daily cigarette smoking was defined as the dependent variable, and all the socio-demographic and health factors were defined as the independent variables. In addition, the product between the year of evaluation with the respective socio-demographic or health factor was also defined as an independent variable. For every possible interaction, a separate regression analysis was conducted, adjusted for all the other mentioned variables. The P-value for this product in the fully adjusted model was considered as an indicator of whether there was a significant interaction effect on smoking status or not. The estimates of the logistic regression models with all the mutually adjusted socio-demographic and health variables on the likelihood of daily smoking are presented as odds ratio (OR) and 95% confidence interval (95% CI).

Ethical considerations

The secondary analysis of the AT-HIS databases which were used for this study was approved by the Ethics Committee of the Medical University Vienna: (EK # 770/2011 for the AT-HIS 2007 and EK # 2211/2015 for the AT-HIS 2014).

Patient and public involvement

There was no patient involvement in this study.

RESULTS

Prevalence of daily smoking

Prevalence of daily cigarette smoking in Austria was 26.0% in men in both, 2007 and 2014. In women, there was a significant increase in smoking prevalence from 19.1% in 2007 to 22.0% in 2014 (P<0.001). In the 2014 survey, men reported a mean age of starting smoking of 17.7 (SD: 4.8) years, and women reported a mean age of 18.8 (SD: 6.2) years (P<0.001). The mean number of cigarettes smoked per day was reported in the 2014 survey as 17.3 (SD: 9.2) for men, and 13.6 (SD: 6.8) for women (P<0.001).

Sample characteristics

As shown in Table 1, for men, there were significant differences in age group categories (higher age in 2014), education level (higher education in 2014), employment status (fewer gainfully employed in 2014), and land of birth (more migrants from the EU and fewer from non-EU countries in 2014), and a higher prevalence of obesity, hypertension, and myocardial infarction in 2014 compared to 2007. In women, there were significant differences in education level (higher education in 2014), employment status (more gainfully employed, more unemployed, but fewer not gainfully employed in 2014) and, land of birth (more

migrants from the EU and fewer from non-EU countries in 2014), and a lower prevalence of diabetes mellitus, but a higher prevalence of hypertension, and myocardial infarction in 2014 compared to 2007.

Prevalence and trends of daily smoking in various subgroups

According to Table 2, for men, the prevalence of smoking was particularly high in people aged 15-29 years, in those with no tertiary education, in the unemployed, in those living in Vienna, in those not in a relationship, and in subjects with no chronic disease. For men, there was a significant interaction between the year of evaluation and the employment status on the likelihood of daily cigarette smoking. In 2014, unemployed men smoked even more than unemployed men in 2007. According to Table 3, in women, the prevalence of smoking was particularly high in the 15-29 age group, as well as in those aged 30-64 years, in those with primary and secondary education, in the unemployed, in those with a migration background (especially from non-EU countries), in those from Vienna in the year 2014 (which was not the case in 2007), in those not in a relationship in 2014 (again, not the case in 2007), and in those with no chronic disease in 2007 (not in 2014). For women, there was a significant interaction between the year of evaluation with the following three parameters on the likelihood of daily cigarette smoking: age, education level, and land of birth. Compared to 2007, in 2014, the proportion of women who smoked was higher in the older age groups (30-64, and particularly 65+ years), but almost equal in younger women. Compared to 2007, in 2014, women with a lower education level smoked more, and those with a higher education level smoked less often. Furthermore, compared to 2007, the increase in smoking prevalence in women with a migration background was much higher than the increase in women born in Austria.

Smoking prevalence and chronic diseases The smoking prevalence in men and women with certain health conditions is presented in Table 4. Compared with the general population, the

smoking prevalence in patients with chronic diseases was lower, except for men and women with COPD (2007 and 2014), and in women after myocardial infarction (2007). In men with chronic diseases, there was no significant difference in smoking prevalence in the years 2014 and 2007. In women, however, in 2014, there was a significantly higher smoking prevalence in those with any chronic disease, in those with diabetes mellitus, in those with obesity, and in those with hypertension, compared to 2007.

Factors associated with daily smoking – multivariate analysis

Table 5 shows the association between the year of evaluation, the socio-demographic variables and the health status with the likelihood of daily cigarette smoking in men and women. From this multivariate analysis, it can be seen that women had a 22% higher likelihood of smoking in 2014 compared to 2007. In addition, women had a 15% higher likelihood of daily smoking when affected by chronic diseases compared to women without chronic diseases. Socio-demographic variables were significantly associated with the odds of daily smoking in both sexes, in the multivariate analysis.

DISCUSSION

Main findings in comparison to other countries

In this survey of the trends in smoking in the Austrian population over seven years, we found that the prevalence of daily smoking increased in women from 19.1% in 2007 to 22% in 2014, while it remained steadily high over time in men at 26.0%, indicating a small gender gap in Austria. These findings are in line with Austrian sales data that show stable numbers of sold cigarettes at 4.3 to 5 cigarettes per person per day, but clearly increasing levels for tobacco for roll-your-own cigarettes, pipes, chewing tobacco, and other tobacco products between the years 2009 and 2014. In addition, sales data point towards equalisation of sales habits between men and women. [15] The female level recorded in our analysis corresponds to one of

the highest figures worldwide, with only Greece and Bulgaria having a higher prevalence of smoking in women.[5] As in all Organisation for Economic Co-operation and Development (OECD) countries, except for Sweden and Iceland,[1] smoking prevalence in Austria is higher in males than females. Furthermore, 56% of the countries in the OECD had less than 20% of their adult population smoking daily in 2013.[1] Thus, smoking in Austria deserves special attention. In fact, cardio-vascular mortality in Austria, as an example of the consequences of a high smoking prevalence, has not decreased over the last decades by as much as other comparable countries. Since smoking prevalence in these countries decreased, showing an opposite trend to Austria, smoking has been discussed as a responsible factor for these different developments.[16]

Smoking prevalence in different subgroups

Comparing daily smokers in the different subgroups of men indicates the highest prevalence at a young age, in migrants, in those with a low education level, in the unemployed, those living in Vienna, in those of a single status and in those without a chronic disease. On the other hand, in women, the prevalence of daily smoking was relatively high for the young and middle aged, for those with low as well as higher levels of education, for the unemployed, as well as migrants, especially those from non-EU countries. In 2014 only, there was a high prevalence of smoking in women with a single status, in those living in Vienna and in those with chronic diseases. We also found an increase in the smoking rates in women in those of a higher age, in those with a lower education level, and in those with an origin of non-EU countries in 2014, compared to 2007. In men, however, smoking prevalence in the subgroups did not substantially change, except that smoking was more common in unemployed men in 2014, compared to 2007. These subgroups with a relatively high smoking prevalence should be regarded as important target groups for smoking cessation and smoking prevention programmes.

Between the two surveys, there were changes in the population, which can be seen in Table 1. These changes might have contributed to the changes in smoking prevalence. In particular, the Austrian population became older between 2007 and 2014, and there was a higher proportion of people with a higher education level, which should have resulted in a lower total prevalence of smoking, because, as we also could see in our results, people with a higher education level and older persons generally smoke less. However, we also saw an increase in smoking prevalence in middle-aged and older women, and in women with secondary education. Furthermore, there was an increase in migrants from other European countries and an increase of smoking prevalence in female migrants from EU and non-EU countries. The combination of these factors could have contributed to the increase in total smoking prevalence in women.

Smoking and chronic diseases

Smoking is an avoidable risk factor for many chronic diseases, in particular cardiovascular disease, various cancers and respiratory diseases, but also metabolic diseases such as diabetes mellitus. Smoking also causes adverse outcomes in these diseases, such as complications, acute and unstable episodes, co-morbidity, a higher mortality, and a worse quality of life. Therefore, we also evaluated in particular the proportion of daily cigarette smokers in both sexes in subjects with chronic diseases, and the changes over time. Due to the cross-sectional nature of the study, we cannot conclude if smoking contributed to the genesis of the respective chronic diseases. However, since smoking cessation is part of the recommended therapy and guidelines in many chronic diseases, including diabetes mellitus,[17 18] cardiovascular disease,[19] and COPD,[20] a high smoking prevalence in these patients can be interpreted as smoking cessation not being very successful, or smoking cessation not being given a high priority in chronic disease therapy. Since we found higher increases in smoking

prevalence in women with chronic diseases compared to men, we can assume that treatment according to guidelines, which includes smoking cessation, has worsened, particularly in women. Less often treating according to guidelines, in women compared to men has also been reported in other studies.[21-23]

The largest and most worrisome increase in smoking of 67% was found in women with diabetes mellitus. This is of particular concern as women with diabetes mellitus are already a very high risk population, especially for myocardial infarction and stroke, with a greater relative risk than diabetic men.[24 25] Furthermore, smoking is a prominent risk factor for both development of insulin resistance and diabetes mellitus, as well as for the progression of diabetic complications. Data from the Third National Health and Nutrition Examination Survey (NHANES III) showed that tobacco smoke exposure is related to the metabolic syndrome in adolescents.[26] Another recent meta-analysis showed a pooled adjusted relative risk of 55% for total mortality and 49% for cardiovascular mortality associated with smoking in patients with diabetes mellitus.[27]

A special concern is the high number of women of reproductive age that smoke. Although we do not know if these women smoked during their potential pregnancies, we can assume that at least some of them did. Smoking during pregnancy exposes the foetus to a high risk of health problems in utero and in later life, further contributing to the transgenerational programming of cardiometabolic risk.[28 29]

The high prevalence of smoking in patients with myocardial infarction or stroke in Austria is also alarming. According to an eight-year follow-up study in those suffering acute myocardial infarction, smokers lost 10.3 years of life due to premature death compared with 5.4 years for non-smokers. More years of life were lost among women that smoke than among men that

smoke.[30] In addition to the causal links of smoking to many chronic diseases, continued smoking also contributes to exacerbations of these chronic conditions. Thus, it is of the utmost importance to support these patients to become tobacco-free. Special support may be necessary as the stress related with chronic diseases may aggravate withdrawal symptoms in these patients.

It can therefore be expected that especially vulnerable groups with chronic diseases, metabolic disorders, lower socioeconomic status, migrants and females in general, which also often suffer from additional mental health problems, are particularly at risk of the sequelae of smoking and of the lower success of cessation programmes. However, some studies have reported success of smoking cessation programmes in patients with acute and chronic diseases who might be particularly motivated to quit.[4] Either way, greater potential harm from continued use can be expected in patients with chronic diseases. Such studies have highlighted the importance of intensive guidance and advice to help quit smoking in patients treated in hospital for diseases related to smoking and after discharge.[31]

Policy implications

Austria is notorious for its tardiness in introducing policies to reduce the harm associated with tobacco use,[8] especially when compared to other countries in the European WHO region.[7] Therefore, the existing high prevalence of smoking is no surprise. There was no improvement in the Austrian tobacco policies after Austria ratified the European WHO Framework Convention on Tobacco Control in the year 2005, up until the year 2015.[7] This suggests that the lack of enhancement in tobacco policies during the period between our two surveys resulted in an increase of the smoking prevalence in women, and a lack of a decrease of the smoking prevalence in men. Only in the years after the second survey did Austria make some improvements in tobacco policies, i.e., more prominent warnings on cigarette packages,

higher tobacco taxes between 2015 and 2017,[7] and the introduction of a total smoking ban in bars and restaurants in 2019. It will be interesting to see if these measures will result in changes in smoking prevalence in future health interview surveys. Nevertheless, there is still a need to improve the policies offering people help in smoking cessation, from which patients with chronic diseases will especially profit, and our results clearly show the need for this.

Strengths and limitations

The strengths of this study include the high sample size with more than 15,000 subjects in each survey, and the population-based design, allowing us to analyse healthy subjects in parallel with subjects with clinical conditions. Statistik Austria is the only organisation in Austria with access to the central population register, which allows them to draw samples from the universal population. Weighting the sample according to the age, sex, and geographic region (and additional socio-demographic variables for the 2014 survey) of the general population can yield representative samples. The fact that the trends of the self-reported smoking in our analysis are reflected in the sales data of tobacco products [15] also suggests that our findings are valid. A potential limitation is that all the factors analysed were self-reported. This might have led to underestimation of the smoking prevalence, as well as underestimation of the prevalence of chronic diseases. However, another Austrian study has shown that self-reported data on smoking are highly valid when compared with objectively verified data on smoking, e.g. exhaled carbon monoxide.[32] This might be due to the fact that, in Austria, compared with other countries, smoking and reporting of such is not associated with social stigma, as a result of the lack of smoking regulation policies. Although the total sample size in our study was large, the sample sizes in the subgroups (e.g. women with diabetes mellitus who smoke) were relatively small, yielding a limited power for the statistical analyses in the subgroups. A further limitation is the fact that the methods applied in the two AT-HIS surveys differed, i.e., CAPI in 2007 and CATI in 2014, with subsequent different

response rates, slightly different weighting factors, and minor differences in the wording regarding smoking habits, which limits the possibility of comparing the two surveys. In addition, the different response rates (63.1% vs. 40.7%) have to be taken into account. These differences reflect the different survey methods, where personal interviewing led to a higher response rate and telephone interviewing to a lower response rate. For Austrian surveys, a response rate of 40% for a non-mandatory survey is regarded as expected and a response rate of more than 60% as relatively high.[11 12]

Conclusions

In summary, better tobacco control and regulatory implications, as well as greater public health and clinical efforts, are urgently needed to address and reduce the high tobacco use and exposure to second-hand smoke in Austria. Examples of such policies to reduce smoking prevalence include creating smoke-free spaces, raising taxes, and educating people about the dangers of smoking. This is of particular importance in the most vulnerable patients coping with chronic conditions and continued smoking. Intensified tobacco control efforts are needed in countries such as Austria where the percentage of smokers is consistently high in men or even increasing in women. Inclusion of a female perspective in smoking prevention and cessation policies appears crucial to buck the current trend and to protect the most vulnerable group of young women. Such policies could contribute to a better health-related quality of life for the population, and to cost reductions in the health care system.

Authors' contributions

TED, HB, and AKW designed the manuscript and the analyses jointly. TED conducted the statistical analyses. TED and AKW drafted different parts of the manuscript. All authors have commented on the manuscript draft and read and approved the final version of the manuscript.

Patient consent for publication

Not required.

Competing interest

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Data sharing statement

Data can be obtained on request at Statistik Austria.

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Table 1: Characteristics and change of characteristics in the male and female participants

	Men			Women		
	2007	2014	P*	2007	2014	P*
	N=7,453	N=7,670		N=8,021	N=8,100	
Age			0.010			0.790
15-29	23.3	22.5		21.0	20.6	
30-64	59.8	58.8		56.1	56.3	
65+	16.9	18.8		22.9	23.1	
Education level			<0.001			<0.001
Primary	20.1	17.2		33.5	27.0	
Secondary	70.4	69.0		57.2	59.8	
Tertiary	9.6	13.7		9.2	13.1	
Employment status			<0.001			<0.001
Gainfully employed	61.8	59.3		44.1	45.7	
Unemployed	4.3	6.3		2.7	4.0	
Not gainfully employed	33.9	34.4		53.2	50.3	
Land of birth			<0.001			<0.001
Austria	83.9	84.0		84.4	81.8	
EU	4.8	9.1		6.2	12.1	
Non-EU	11.2	6.9		9.4	6.1	
Urbanisation			0.350			0.492
Vienna	19.9	20.5		20.7	21.1	
Other federal states	80.1	79.5		79.3	78.9	
Family status			0.765			0.132
In a relationship	69.9	70.1		62.1	60.9	

Not in a relationship	30.1	29.9		37.9	39.1	
Health status			0.215			0.110
At least one chronic disease	34.2	33.2		39.8	38.6	
No chronic disease	65.8	66.8		60.2	61.4	
Prevalence of diabetes mellitus	5.2	5.4	0.480	5.9	4.5	<0.001
Prevalence of obesity	12.0	15.6	<0.001	12.7	13.2	0.375
Prevalence of hypertension	17.6	20.5	<0.001	20.1	21.7	0.014
Prevalence of COPD	3.5	4.0	0.148	4.2	4.4	0.492
Prevalence of myocardial infarction	0.6	1.4	<0.001	0.4	0.6	0.036
Prevalence of stroke	0.8	0.8	0.765	0.8	0.8	0.885
Daily cigarette smoking	26.0	26.0	0.998	19.1	22.0	<0.001

*P-value as results of the Chi-squared test between 2007 and 2014

Table 2: Prevalence of smoking in the male subpopulations in 2007 and 2014

	2007		2014		Interaction year*factor on daily smoking
	%Smokers	P*	%Smokers	P*	P**
Age		<0.001		<0.001	0.807
15-29	31.2		31.9		
30-64	28.9		29.2		
65+	8.3		8.6		
Education level		<0.001		<0.001	0.719
Primary	27.3		29.1		
Secondary	27.4		27.6		
Tertiary	12.6		13.7		
Employment status		<0.001		<0.001	0.002
Gainfully employed	30.7		29.5		
Unemployed	43.6		57.1		
Not gainfully employed	15.2		14.1		
Land of birth		<0.001		<0.001	0.246
Austria	24.3		24.5		
EU	23.0		30.6		
Non-EU	39.6		38.0		
Urbanisation		0.008		<0.001	0.149
Vienna	28.7		32.9		
Other federal states	25.3		24.2		

Family status		<0.001	<0.001	0.917
In a relationship	24.0	23.6		
Not in a relationship	30.6	31.5		
Health status		<0.001	0.006	0.647
At least one chronic disease	23.1	24.0		
No chronic disease	27.5	27.0		

*P-value as results of the Chi-squared test: differences in smoking prevalence based on socio-demographic and health variables in the respective surveys, 2007 and 2014

**P-value as results of the binary logistic regression analyses for the interaction between year of evaluation and the respective socio-demographic or health variable on the likelihood of daily smoking (dependent variable), adjusted for all socio-demographic and health variables and the year of evaluation

Table 3: Prevalence of smoking in the female subpopulations in 2007 and 2014

	2007		2014		Interaction year*factor on daily smoking
	%Smokers	P*	%Smokers	P*	P**
Age		<0.001		<0.001	0.004
15-29	28.4		27.8		
30-64	21.9		26.3		
65+	3.9		6.2		
Education level		<0.001		<0.001	<0.001
Primary	17.2		24.4		
Secondary	21.4		23.4		
Tertiary	12.2		10.4		
Employment status		<0.001		<0.001	0.997
Gainfully employed	25.6		28.6		
Unemployed	42.1		45.4		
Not gainfully employed	12.6		14.0		
Land of birth		<0.001		<0.001	0.016
Austria	18.7		20.5		
EU	16.6		26.1		
Non-EU	25.0		32.8		
Urbanisation		0.599		<0.001	0.514
Vienna	19.6		31.5		
Other federal states	19.1		19.4		

Family status		0.160		<0.001	0.290
In a relationship	18.6		20.6		
Not in a relationship	19.9		24.1		
Health status		0.001		0.357	0.662
At least one chronic disease	17.4		21.4		
No chronic disease	20.3		22.3		

*P-value as results of the Chi-squared test: differences in smoking prevalence based on socio-demographic and health variables in the respective surveys, 2007 and 2014

**P-value as results of the binary logistic regression analyses for the interaction between year of evaluation and the respective socio-demographic or health variable on the likelihood of daily smoking (dependent variable), adjusted for all socio-demographic and health variables and the year of evaluation

Table 4: Proportion of daily cigarette smokers in men and women of the different populations, and changes over time

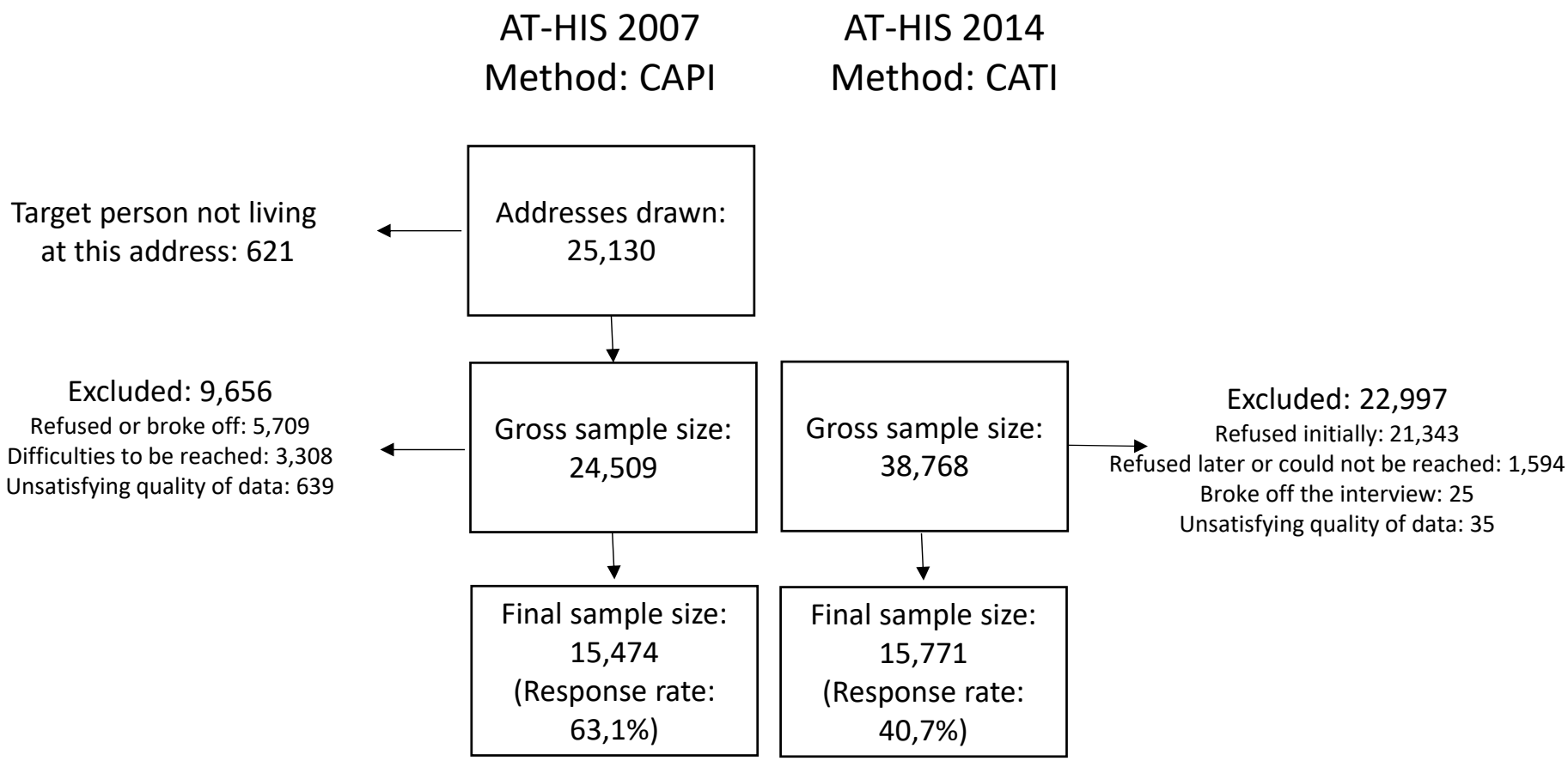
	Men				Women			
	2007	2014	Change	P*	2007	2014	Change	P*
General population	26.0	26.0	±0%	0.998	19.1	22.0	+15%	<0.001
People with at least one chronic disease	23.1	24.0	+4%	0.433	17.4	21.4	+23%	<0.001
Diabetes mellitus	14.5	17.7	+22%	0.219	9.9	16.4	+67%	0.005
Obesity (BMI≥30kg/m²)	23.2	24.7	+6%	0.405	17.1	21.6	+26%	0.010
Hypertension	17.5	20.1	+15%	0.082	11.2	14.2	+27%	0.010
COPD	31.6	28.2	-11%	0.382	24.9	25.7	+3%	0.814
Myocardial infarction	8.9	20.0	+125%	0.094	20.0	14.3	-29%	0.506
Stroke	10.2	17.5	+72%	0.245	9.1	20.0	+120%	0.076

*P-value as results of Chi-squared test between 2007 and 2014

Table 5: Association of socio-demographic and health variables on the likelihood of daily cigarette smoking. Results of multivariate logistic regression model based on both surveys in 2007 and 2014; each included variable is mutually adjusted for all the other variables.

		Men			Women		
		OR	(95% CI)	P	OR	(95% CI)	P
Year	2007	1			1		
	2014	1.04	(0.97 to 1.13)	0.269	1.22	(1.12 to 1.32)	<0.001
Age	15-29	2.51	(2.09 to 3.01)	<0.001	6.10	(5.11 to 7.28)	<0.001
	30-64	2.50	(2.11 to 2.96)	<0.001	5.17	(4.35 to 6.14)	<0.001
	65+	1			1		
Education level	Primary	3.02	(2.54 to 3.59)	<0.001	3.82	(3.21 to 4.55)	<0.001
	Secondary	2.81	(2.42 to 3.26)	<0.001	3.02	(2.58 to 3.55)	<0.001
	Tertiary	1			1		
Employment status	Gainfully employed	1			1		
	Unemployed	1.93	(1.73 to 2.16)	<0.001	1.84	(1.67 to 2.02)	<0.001
	Not gainfully employed	3.70	(3.11 to 4.39)	<0.001	2.87	(2.37 to 3.47)	<0.001
Land of birth	Austria	1			1		

	EU	1.25	(1.08 to 1.46)	0.003	1.26	(1.10 to 1.45)	0.001
	Non-EU	1.52	(1.34 to 1.73)	<0.001	1.12	(0.97 to 1.30)	0.115
Urbanisation	Vienna	1.28	(1.16 to 1.40)	<0.001	1.50	(1.36 to 1.65)	<0.001
	Other federal States	1			1		
Family status	In a relationship	1			1		
	Not in a relationship	1.38	(1.26 to 1.52)	<0.001	1.33	(1.22 to 1.45)	<0.001
Health status	At least one chronic disease	1.04	(0.96 to 1.13)	0.360	1.15	(1.06 to 1.25)	0.002
	No chronic disease	1			1		


AT-HIS 2007
Method: CAPI
AT-HIS 2014
Method: CATI
Addresses drawn: 25,130
Target person not living at this address: 621
Gross sample size: 24,509
Excluded: 9,656
Refused or broke off: 5,709
Difficulties to be reached: 3,308
Unsatisfying quality of data: 639
Gross sample size: 38,768
Excluded: 22,997
Refused initially: 21,343
Refused later or could not be reached: 1,594
Broke off the interview: 25
Unsatisfying quality of data: 35
Final sample size: 15,474 (Response rate: 63,1%)
Final sample size: 15,771 (Response rate: 40,7%)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

"Sex-specific trends in smoking prevalence within seven years in different Austrian populations: results of a time series cross-sectional survey"

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1; 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	*6-8*
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	5-6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	5

		(*e*) Describe any sensitivity analyses	n.a.
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	18, Table 1
		(b) Indicate number of participants with missing data for each variable of interest	n.a.
Outcome data	15*	Report numbers of outcome events or summary measures	18, Table 1
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	18-26, Tables 1-4
		(*b*) Report category boundaries when continuous variables were categorized	n.a.
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n.a.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-10; 20-23, Table 2
Discussion			
Key results	18	Summarise key results with reference to study objectives	11-12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14-15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	11-14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	3

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Sex-specific trends in smoking prevalence over seven years in different Austrian populations: results of a time-series cross-sectional analysis

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Sex-specific trends in smoking prevalence over seven years in different Austrian populations: results of a time-series cross-sectional analysis

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ABSTRACT

Objectives: Aim of this study was to examine trends over time in smoking status in men and women, and in subgroups, in Austria, a country with poor smoking regulation policies.

Design and participants: Two cross-sectional surveys (Austrian Health Interview Surveys for 2007 and 2014), each with more than 15,000 participants from the general population, aged ≥15 years.

Outcome measures: Prevalence of self-reported daily smoking. Odds ratios for daily smoking in subgroups, presented as results of logistic regression models, adjusted for socio-demographic variables and presence of chronic diseases.

Results: Prevalence of daily cigarette smoking was 26.0% for men in both years, and increased from 19.1% to 22.0% (P<0.001) in women from 2007 to 2014. Smoking prevalence increased especially in female patients with diabetes mellitus (from 9.9% to 16.4%, P=0.005), obesity (from 17.1% to 21.6%, P=0.010), and hypertension (from 11.2% to 14.2%, P=0.010). Smoking prevalence increased significantly in unemployed men (from 43.6% to 57.1%, P<0.001). In women, smoking prevalence increased in those aged 30 to 64 years (from 21.9% to 26.3%, P<0.001) and 65+ (from 3.9% to 6.2%, P=0.002), with primary (from 17.2% to 24.4%, P<0.001) and secondary education (from 21.4% to 23.4%, P=0.021), and with a European (from 16.6% to 26.1%, P<0.001) and non-European migration background (from 25.0% to 32.8%, P=0.003). In the adjusted analysis for women in 2014, there was a higher likelihood of smoking (OR 1.22, 95% CI 1.12 to 1.32, P<0.001) compared to 2007, and for those affected by a chronic disease (OR 1.15, 95% CI 1.06 to 1.25, P=0.002).

Conclusions There has been a remarkable increase in smoking prevalence over the 7 year period in women in Austria, especially for those with chronic diseases, higher age, lower education, and a migration background. Better political and clinical efforts are needed to reduce the high tobacco use in Austria.

Strengths and limitations of this study

- The results are based on two cross-sectional surveys with representative sample sizes of more than 15,000 subjects in each survey.
- The seven years between the two surveys allowed us to analyse the trends in smoking prevalence over this time period, during which time most countries, in opposite to Austria, have made huge efforts in tobacco control.
- The surveys were population-based, and thus allowed the analysis of healthy persons in parallel with patients with chronic diseases.
- Potential limitations can be ascribed to the fact that all the data are self-reported, and that there were slightly different methods applied in the two national surveys.

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INTRODUCTION

Smoking is the most important and largest avoidable risk factor for ill health and premature mortality.[1-3] Smoking also shortens life expectancy by approximately a decade. Risk of death is about threefold higher in smokers compared to non-smokers.[4] The biggest problems associated with smoking include cardiovascular diseases, cancers, and respiratory problems.[1]

In industrialised countries, smoking peaked ten years later in women compared to men but comparable consumption patterns are now seen in both sexes in most countries. Between 2000 and 2013, risk of total mortality in women that smoke increased almost threefold paralleling the increase in men. There is also evidence of gender differences regarding the prevalence of smoking, and in the development of complications and temporal trends. In most countries, smoking prevalence is still higher in men, except in Sweden and Iceland.[1]

In many countries, smoking rates have decreased since 2000, by about 25% on average, with the most prominent decrease in Northern European countries.[1] Analysis of data from 181 countries showed an average decline of smoking prevalence between 1980 and 2012 of 41.2% to 31.1% in men and 10.6% to 6.2% in women. Only a few countries, including Austria, increased their smoking prevalence, and Austrian women had the third highest absolute prevalence among the investigated countries. In conclusion, the authors urged that intensified efforts and policies were required in all countries to control tobacco use, especially in those with a high smoking prevalence.[5]

Advertising bans, restrictions in public spaces and restaurants, awareness campaigns and higher taxation are all anti-tobacco policies aimed at addressing the rise of smoking-related

diseases.[6] A failure to decrease smoking prevalence may be attributed to a lack of policies in one or more of these areas. Unfortunately, Austria is among the countries with poor smoking regulation policies.[7] Since 2007, Austria has consistently had the lowest score in the Tobacco Control Scale of the Association of European Cancer Leagues,[8] and does not fulfil its legal obligations under the WHO Framework Convention, which was ratified in 2005.[9 10]

According to the European Tobacco Control Report of the WHO European Region, since joining this network in 2005, up until 2017, Austria has had very high and stable scores in monitoring tobacco use, and in enforcing bans on tobacco advertising, promotion and sponsorship. Austria has also had high and stable scores in offering people to help quitting tobacco use and treating dependence (with free quit lines and medication for smoking cessation, for which, however, patients have to pay out of their own pocket). With regard to warnings on cigarette packages about the dangers of tobacco, and in raising tobacco taxes, Austria has also scored quite highly, and in both measures, scores increased between 2015 and 2017. Austria has, however, scored poorly in terms of warning people about the dangers of tobacco use through anti-tobacco campaigns. Only between 2015 and 2017 did Austria introduce national campaigns conducted with characteristics appropriate to WHO standards. The worst scores Austria received were in terms of protecting people from second-hand tobacco smoke.[7] In fact, it was not until November 2019 that Austria introduced smoking bans in restaurants, cafés, and bars.

Against this background, it was the aim of this study to examine the prevalence of daily smoking and the relation to chronic diseases in men and women, and to monitor trends over time in Austria. In addition, we aimed to evaluate the prevalence of daily smoking in different subgroups, according to socio-demographic parameters and the occurrence of certain chronic

diseases, and to assess if the association between these parameters with smoking status differed over time.

METHODS

Datasets

The databases used for the analysis were the two existing waves of the Austrian Health Interview Survey (AT-HIS) for 2007[11] and 2014[12].The AT-HIS is a representative population-based survey that is conducted at regular intervals in Austria, in subjects aged 15 years and older, carried out by Statistik Austria on behalf of the Austrian Ministry of Health. The questionnaires used for the AT-HIS were designed based on the European Health Interview Survey (E-HIS), which is regularly conducted in the countries of the European Union (EU)[13] [14], and was adapted for Austria by an expert panel. For the AT-HIS, the sample is stratified into 32 geographic regions, with the same number of subjects in each region (there is a higher number for the three regions in Vienna). To balance the possible distortion brought about by the geographic stratification of the sample, the data have been weighted using the number of people living in each region, with the age in five-year groups, and sex as the weighting factors in 2007, and geographic region, age, sex, family situation, migration background, and education level as the weighting factors in 2014. Missing values have been imputed after fundamental analyses of the non-responses, based on sex, age, education, and living region. There are, however, very few missing variables, and none in the case of the used variables regarding smoking.[11 12]

For the AT-HIS 2007, subjects were interviewed face-to-face using computer-assisted personal interviewing (CAPI) between March 2006 and March 2007 by 137 trained

interviewers. The initial sample comprised 25,130 addresses of the central population register, of which 621 addresses had to be excluded due to the fact that the target person had moved, had already died, or the address did not exist anymore. The remaining 24,509 persons were the gross sample size, which was the basis for calculating the response rate. Of this total, 9,656 subjects were excluded for different reasons: 5,709 subjects refused or terminated the interview; 3,308 were excluded due to difficulties in contacting them or because of deficiency regarding their command of the German language; and 639 cases were excluded due to unsatisfactory data quality. The data of a total of 15,474 subjects were eligible for analysis, representing a response rate of 63.1%. The AT-HIS 2014 was carried out from October 2013 to June 2015 via computer-assisted telephone interviewing (CATI). The survey comprised a gross sample size of 38,768 subjects from the central population register. Of this total, 21,343 subjects initially refused to participate; another 1,594 subjects who initially declared their interest to participate could no longer be reached, or refused the telephone interview; 25 subjects terminated the interview; and 35 subjects were excluded due to unsatisfactory data quality. Thus, a net sample of 15,771 subjects was included in the survey, yielding a response rate of 40.7%. The flow chart for the recruitment processes in both surveys is depicted in Figure 1. To increase the response rate, subjects were repeatedly reminded and given a gift voucher as incentive.

Variables

Daily cigarette smoking was indicated in the AT-HIS 2007 if subjects answered “Yes” to the question “Have you smoked yet in your life more than 100 cigarettes, cigars, pipes or other tobacco products?”, answered “Yes daily” to the question “Do you smoke currently?”, and answered with “Cigarettes from cigarette boxes” to the question “Which of the following tobacco products do you smoke daily?”. Daily cigarette smoking was indicated in the AT-HIS 2014, if subjects answered “Yes, daily” to the question “Do you smoke?” and “Cigarettes” to

the question "Which of the following tobacco products do you use most frequently?" Furthermore, in the 2014 survey, the number of cigarettes smoked per day and the age of starting smoking were recorded for those who indicated that they smoked cigarettes daily. For the socio-demographic variables, age was recorded in three categories: 15-29 years, 30-64 years, and 65 years and older. Highest education level was categorised as primary education (school until the age of 15 years), secondary education (education up to the Austrian school leaving exam "Matura" at the age of 18 or 19 years, or apprenticeship), and tertiary education (university, or university of applied sciences, or further vocational education after the "Matura"). Employment status was recorded in three categories as gainfully employed (including self-employed), unemployed or not gainfully employed (retirement, in formal education, housewives and househusbands, subjects in maternity or paternity leave, and persons in military service). Land of birth was recorded in three categories: Austria, EU and non-EU. In the 2007 survey, the land of birth variable of EU states comprised the 27 states in the EU for the year 2006, except Austria, as well as the four states of the European Free Trade Association. In the 2014 survey, the land of birth variable of EU states comprised the 28 European states in the EU for the year 2014, except Austria. Urbanisation was recorded as living in the Austrian capital Vienna (the only Austrian city with a population approaching two million inhabitants) or in any other Austrian federal state (in which no city has more than 300,000 inhabitants). Family status was recorded with two categories of in a relationship or not in a relationship, with in a relationship also including being married. Being affected by at least one chronic disease was recorded with the question "Do you have a chronic health problem?" Furthermore, the specific chronic diseases were recorded and the participants were asked if they had been affected by the respective chronic health problem within the last 12 months. For this analysis, the following chronic health problems were considered: diabetes mellitus, hypertension, chronic obstructive pulmonary disease (COPD), stroke, and

myocardial infarction. In addition, body mass index (BMI) was calculated as kg/m² from self-reported data on body weight and body height, and a BMI ≥ 30 kg/m² was classified as obese.

Statistical analyses

IBM SPSS 24 was used for the statistical analyses. All the analyses were carried out with the weighted data, as described in the dataset description. Bivariate analyses were undertaken by means of cross-tabulations, and group differences were assessed with Pearson's Chi-squared tests. To test for the interaction between the year of evaluation and socio-demographic factors or health factors on the likelihood of daily smoking, we performed binary logistic regression analyses. The reason for testing the interaction was that, if there a significant interaction was found, we could assume that there was a difference in the association between the respective tested factors with daily smoking in the respective year. If we found a significant interaction, we demonstrated the prevalence of daily smoking in the respective subgroup, stratified by the year of the survey. Daily cigarette smoking was defined as the dependent variable, and all the socio-demographic and health factors were defined as the independent variables. In addition, the product between the year of evaluation with the respective socio-demographic or health factor was also defined as an independent variable. For every possible interaction, a separate regression analysis was conducted, adjusted for all the other mentioned variables. The P-value for this product in the fully adjusted model was considered as an indicator of whether there was a significant interaction effect on smoking status or not. The estimates of the logistic regression models with all the mutually adjusted socio-demographic and health variables on the likelihood of daily smoking are presented as odds ratio (OR) and 95% confidence interval (95% CI).

Ethical considerations

The secondary analysis of the AT-HIS databases which were used for this study was approved by the Ethics Committee of the Medical University Vienna: (EK # 770/2011 for the AT-HIS 2007 and EK # 2211/2015 for the AT-HIS 2014).

Patient and public involvement

There was no patient involvement in this study.

RESULTS

Prevalence of daily smoking

Prevalence of daily cigarette smoking in Austria was 26.0% in men in both, 2007 and 2014. In women, there was a significant increase in smoking prevalence from 19.1% in 2007 to 22.0% in 2014 (P<0.001). In the 2014 survey, men reported a mean age of starting smoking of 17.7 (SD: 4.8) years, and women reported a mean age of 18.8 (SD: 6.2) years (P<0.001). The mean number of cigarettes smoked per day was reported in the 2014 survey as 17.3 (SD: 9.2) for men, and 13.6 (SD: 6.8) for women (P<0.001).

Sample characteristics

As shown in Table 1, for men, there were significant differences in age group categories (higher age in 2014), education level (higher education in 2014), employment status (fewer gainfully employed in 2014), and land of birth (more migrants from the EU and fewer from non-EU countries in 2014), and a higher prevalence of obesity, hypertension, and myocardial infarction in 2014 compared to 2007. In women, there were significant differences in education level (higher education in 2014), employment status (more gainfully employed, more unemployed, but fewer not gainfully employed in 2014) and, land of birth (more

migrants from the EU and fewer from non-EU countries in 2014), and a lower prevalence of diabetes mellitus, but a higher prevalence of hypertension, and myocardial infarction in 2014 compared to 2007.

Prevalence and trends of daily smoking in various subgroups

According to Table 2, for men, the prevalence of smoking was particularly high in people aged 15-29 years, in those with no tertiary education, in the unemployed, in those living in Vienna, in those not in a relationship, and in subjects with no chronic disease. For men, there was a significant interaction between the year of evaluation and the employment status on the likelihood of daily cigarette smoking. In 2014, unemployed men smoked even more than unemployed men in 2007. According to Table 3, in women, the prevalence of smoking was particularly high in the 15-29 age group, as well as in those aged 30-64 years, in those with primary and secondary education, in the unemployed, in those with a migration background (especially from non-EU countries), in those from Vienna in the year 2014 (which was not the case in 2007), in those not in a relationship in 2014 (again, not the case in 2007), and in those with no chronic disease in 2007 (not in 2014). For women, there was a significant interaction between the year of evaluation with the following three parameters on the likelihood of daily cigarette smoking: age, education level, and land of birth. Compared to 2007, in 2014, the proportion of women who smoked was higher in the older age groups (30-64, and particularly 65+ years), but almost equal in younger women. Compared to 2007, in 2014, women with a lower education level smoked more, and those with a higher education level smoked less often. Furthermore, compared to 2007, the increase in smoking prevalence in women with a migration background was much higher than the increase in women born in Austria.

Smoking prevalence and chronic diseases

The smoking prevalence in men and women with certain health conditions is presented in Table 4. Compared with the general population, the smoking prevalence in patients with chronic diseases was lower, except for men and women with COPD (2007 and 2014), and in women after myocardial infarction (2007). In men with chronic diseases, there was no significant difference in smoking prevalence in the years 2014 and 2007. In women, however, in 2014, there was a significantly higher smoking prevalence in those with any chronic disease, in those with diabetes mellitus, in those with obesity, and in those with hypertension, compared to 2007.

Factors associated with daily smoking – multivariate analysis

Table 5 shows the association between the year of evaluation, the socio-demographic variables and the health status with the likelihood of daily cigarette smoking in men and women. From this multivariate analysis, it can be seen that women had a 22% higher likelihood of smoking in 2014 compared to 2007. In addition, women had a 15% higher likelihood of daily smoking when affected by chronic diseases compared to women without chronic diseases. Socio-demographic variables were significantly associated with the odds of daily smoking in both sexes, in the multivariate analysis.

DISCUSSION

Main findings in comparison to other countries

In this survey of the trends in smoking in the Austrian population over seven years, we found that the prevalence of daily smoking increased in women from 19.1% in 2007 to 22% in 2014, while it remained steadily high over time in men at 26.0%, indicating a small gender gap in Austria. These findings are in line with Austrian sales data that show stable numbers of sold cigarettes at 4.3 to 5 cigarettes per person per day, but clearly increasing levels for tobacco for roll-your-own cigarettes, pipes, chewing tobacco, and other tobacco products between the

years 2009 and 2014. In addition, sales data point towards equalisation of sales habits between men and women. [15] The female level recorded in our analysis corresponds to one of the highest figures worldwide, with only Greece and Bulgaria having a higher prevalence of smoking in women.[5] As in all Organisation for Economic Co-operation and Development (OECD) countries, except for Sweden and Iceland,[1] smoking prevalence in Austria is higher in males than females. Furthermore, 56% of the countries in the OECD had less than 20% of their adult population smoking daily in 2013.[1] Thus, smoking in Austria deserves special attention. In fact, cardio-vascular mortality in Austria, as an example of the consequences of a high smoking prevalence, has not decreased over the last decades by as much as other comparable countries. Since smoking prevalence in these countries decreased, showing an opposite trend to Austria, smoking has been discussed as a responsible factor for these different developments.[16]

Smoking prevalence in different subgroups

Comparing daily smokers in the different subgroups of men indicates the highest prevalence at a young age, in migrants, in those with a low education level, in the unemployed, those living in Vienna, in those of a single status and in those without a chronic disease. On the other hand, in women, the prevalence of daily smoking was relatively high for the young and middle aged, for those with low as well as higher levels of education, for the unemployed, as well as migrants, especially those from non-EU countries. In 2014 only, there was a high prevalence of smoking in women with a single status, in those living in Vienna and in those with chronic diseases. We also found an increase in the smoking rates in women in those of a higher age, in those with a lower education level, and in those with an origin of non-EU countries in 2014, compared to 2007. In men, however, smoking prevalence in the subgroups did not substantially change, except that smoking was more common in unemployed men in 2014, compared to 2007. These subgroups with a relatively high smoking prevalence should

be regarded as important target groups for smoking cessation and smoking prevention programmes.

Between the two surveys, there were changes in the population, which can be seen in Table 1. These changes might have contributed to the changes in smoking prevalence. In particular, the Austrian population became older between 2007 and 2014, and there was a higher proportion of people with a higher education level, which should have resulted in a lower total prevalence of smoking, because, as we also could see in our results, people with a higher education level and older persons generally smoke less. However, we also saw an increase in smoking prevalence in middle-aged and older women, and in women with secondary education. Furthermore, there was an increase in migrants from other European countries and an increase of smoking prevalence in female migrants from EU and non-EU countries. The combination of these factors could have contributed to the increase in total smoking prevalence in women.

Smoking and chronic diseases

Smoking is an avoidable risk factor for many chronic diseases, in particular cardiovascular disease, various cancers and respiratory diseases, but also metabolic diseases such as diabetes mellitus. Smoking also causes adverse outcomes in these diseases, such as complications, acute and unstable episodes, co-morbidity, a higher mortality, and a worse quality of life. Therefore, we also evaluated in particular the proportion of daily cigarette smokers in both sexes in subjects with chronic diseases, and the changes over time. Due to the cross-sectional nature of the study, we cannot conclude if smoking contributed to the genesis of the respective chronic diseases. However, since smoking cessation is part of the recommended therapy and guidelines in many chronic diseases, including diabetes mellitus,[17 18] cardiovascular disease,[19] and COPD,[20] a high smoking prevalence in these patients can be

interpreted as smoking cessation not being very successful, or smoking cessation not being given a high priority in chronic disease therapy. Since we found higher increases in smoking prevalence in women with chronic diseases compared to men, we can assume that treatment according to guidelines, which includes smoking cessation, has worsened, particularly in women. Less often treating according to guidelines, in women compared to men has also been reported in other studies.[21 22]

The largest and most worrisome increase in smoking of 67% was found in women with diabetes mellitus. This is of particular concern as women with diabetes mellitus are already a very high risk population, especially for myocardial infarction and stroke, with a greater relative risk than diabetic men.[23 24] Furthermore, smoking is a prominent risk factor for both development of insulin resistance and diabetes mellitus, as well as for the progression of diabetic complications. Data from the Third National Health and Nutrition Examination Survey (NHANES III) showed that tobacco smoke exposure is related to the metabolic syndrome in adolescents.[25] Another recent meta-analysis showed a pooled adjusted relative risk of 55% for total mortality and 49% for cardiovascular mortality associated with smoking in patients with diabetes mellitus.[26]

A special concern is the high number of women of reproductive age that smoke. Although we do not know if these women smoked during their potential pregnancies, we can assume that at least some of them did. Smoking during pregnancy exposes the foetus to a high risk of health problems in utero and in later life, further contributing to the transgenerational programming of cardiometabolic risk.[27 28]

The high prevalence of smoking in patients with myocardial infarction or stroke in Austria is also alarming. According to an eight-year follow-up study in those suffering acute myocardial

infarction, smokers lost 10.3 years of life due to premature death compared with 5.4 years for non-smokers. More years of life were lost among women that smoke than among men that smoke.[29] In addition to the causal links of smoking to many chronic diseases, continued smoking also contributes to exacerbations of these chronic conditions. Thus, it is of the utmost importance to support these patients to become tobacco-free. Special support may be necessary as the stress related with chronic diseases may aggravate withdrawal symptoms in these patients.

It can therefore be expected that especially vulnerable groups with chronic diseases, metabolic disorders, lower socioeconomic status, migrants and females in general, which also often suffer from additional mental health problems, are particularly at risk of the sequelae of smoking and of the lower success of cessation programmes. However, some studies have reported success of smoking cessation programmes in patients with acute and chronic diseases who might be particularly motivated to quit.[4] Either way, greater potential harm from continued use can be expected in patients with chronic diseases. Such studies have highlighted the importance of intensive guidance and advice to help quit smoking in patients treated in hospital for diseases related to smoking and after discharge.[30]

Policy implications

Austria is notorious for its tardiness in introducing policies to reduce the harm associated with tobacco use,[8] especially when compared to other countries in the European WHO region.[7] Therefore, the existing high prevalence of smoking is no surprise. There was no improvement in the Austrian tobacco policies after Austria ratified the European WHO Framework Convention on Tobacco Control in the year 2005, up until the year 2015.[7] This suggests that the lack of enhancement in tobacco policies during the period between our two surveys resulted in an increase of the smoking prevalence in women, and a lack of a decrease of the

smoking prevalence in men. Only in the years after the second survey did Austria make some improvements in tobacco policies, i.e., more prominent warnings on cigarette packages, higher tobacco taxes between 2015 and 2017,[7] and the introduction of a total smoking ban in bars and restaurants in 2019. It will be interesting to see if these measures will result in changes in smoking prevalence in future health interview surveys. Nevertheless, there is still a need to improve the policies offering people help in smoking cessation, from which patients with chronic diseases will especially profit, and our results clearly show the need for this.

Strengths and limitations

The strengths of this study include the high sample size with more than 15,000 subjects in each survey, and the population-based design, allowing us to analyse healthy subjects in parallel with subjects with clinical conditions. Statistik Austria is the only organisation in Austria with access to the central population register, which allows them to draw samples from the universal population. Weighting the sample according to the age, sex, and geographic region (and additional socio-demographic variables for the 2014 survey) of the general population can yield representative samples. The fact that the trends of the self-reported smoking in our analysis are reflected in the sales data of tobacco products [15] also suggests that our findings are valid. A potential limitation is that all the factors analysed were self-reported. This might have led to underestimation of the smoking prevalence, as well as underestimation of the prevalence of chronic diseases. However, another Austrian study has shown that self-reported data on smoking are highly valid when compared with objectively verified data on smoking, e.g. exhaled carbon monoxide.[31] This might be due to the fact that, in Austria, compared with other countries, smoking and reporting of such is not associated with social stigma, as a result of the lack of smoking regulation policies. Although the total sample size in our study was large, the sample sizes in the subgroups (e.g. women with diabetes mellitus who smoke) were relatively small, yielding a limited power for the statistical

analyses in the subgroups. A further limitation is the fact that the methods applied in the two AT-HIS surveys differed, i.e., CAPI in 2007 and CATI in 2014, with subsequent different response rates, slightly different weighting factors, and minor differences in the wording regarding smoking habits, which limits the possibility of comparing the two surveys. In addition, the different response rates (63.1% vs. 40.7%) have to be taken into account. These differences reflect the different survey methods, where personal interviewing led to a higher response rate and telephone interviewing to a lower response rate. For Austrian surveys, a response rate of 40% for a non-mandatory survey is regarded as expected and a response rate of more than 60% as relatively high.[11 12] Furthermore, it could be hypothesised, that answers obtained with CATI or CAPI would differ, and that a face-to-face interview could yield more honest answers, compared to telephone interviewing, thus leading to higher prevalence rates of smoking. However, a study conducted in Bavaria, the German federal state next to Austria, compared the validity of a population-based CATI survey with the German National Health Examination Survey, a survey with face-to-face contact to the examiners. In this study, smoking prevalence obtained with CATI was indeed non-significantly slightly higher in the face-to-face survey compared to CATI (29.0 vs. 30.1%).[32] Similarly, in a Norwegian study, although with small sample sizes, there was no significant difference in smoking status when obtained with either CATI or CAPI, with a non-significantly higher smoking prevalence obtained with CAPI (31 vs. 39%).[33] If underreporting of smoking would be a higher problem in CATI than in CAPI, this would have led to an underestimation of the increased smoking prevalence in women found in our survey and to an actual increase in smoking status in men. When adding the 4% higher rates in CAPI derived from the Bavarian study, the prevalence of smoking in Austria would have increased from 26.0% to 27.0% in men and from 19.1% to 22.9% in women. And when adding the 26% higher rates in CAPI derived from the Norwegian study, the prevalence of smoking in Austria would have increased from 26.0% to

32.8% in men and from 19.1% to 27.7% in women. Therefore, the trends in smoking prevalence rates in our survey represent conservative estimates.

Conclusions

In summary, better tobacco control and regulatory implications, as well as greater public health and clinical efforts, are urgently needed to address and reduce the high tobacco use and exposure to second-hand smoke in Austria. Examples of such policies to reduce smoking prevalence include creating smoke-free spaces, raising taxes, and educating people about the dangers of smoking. This is of particular importance in the most vulnerable patients coping with chronic conditions and continued smoking. Intensified tobacco control efforts are needed in countries such as Austria where the percentage of smokers is consistently high in men or even increasing in women. Inclusion of a female perspective in smoking prevention and cessation policies appears crucial to buck the current trend and to protect the most vulnerable group of young women. Such policies could contribute to a better health-related quality of life for the population, and to cost reductions in the health care system.

Authors' contributions

TED, HB, and AKW designed the manuscript and the analyses jointly. TED conducted the statistical analyses. TED and AKW drafted different parts of the manuscript. All authors have commented on the manuscript draft and read and approved the final version of the manuscript.

Patient consent for publication

Not required.

Competing interest

None declared

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None

Data sharing statement

Data can be obtained on request at Statistik Austria.

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Table 1: Characteristics and change of characteristics in the male and female participants

	Men			Women		
	2007	2014	P*	2007	2014	P*
	N=7,453	N=7,670		N=8,021	N=8,100	
Age			0.010			0.790
15-29	23.3	22.5		21.0	20.6	
30-64	59.8	58.8		56.1	56.3	
65+	16.9	18.8		22.9	23.1	
Education level			<0.001			<0.001
Primary	20.1	17.2		33.5	27.0	
Secondary	70.4	69.0		57.2	59.8	
Tertiary	9.6	13.7		9.2	13.1	
Employment status			<0.001			<0.001
Gainfully employed	61.8	59.3		44.1	45.7	
Unemployed	4.3	6.3		2.7	4.0	
Not gainfully employed	33.9	34.4		53.2	50.3	
Land of birth			<0.001			<0.001
Austria	83.9	84.0		84.4	81.8	
EU	4.8	9.1		6.2	12.1	
Non-EU	11.2	6.9		9.4	6.1	
Urbanisation			0.350			0.492
Vienna	19.9	20.5		20.7	21.1	
Other federal states	80.1	79.5		79.3	78.9	
Family status			0.765			0.132
In a relationship	69.9	70.1		62.1	60.9	

Not in a relationship	30.1	29.9		37.9	39.1	
Health status			0.215			0.110
At least one chronic disease	34.2	33.2		39.8	38.6	
No chronic disease	65.8	66.8		60.2	61.4	
Prevalence of diabetes mellitus	5.2	5.4	0.480	5.9	4.5	<0.001
Prevalence of obesity	12.0	15.6	<0.001	12.7	13.2	0.375
Prevalence of hypertension	17.6	20.5	<0.001	20.1	21.7	0.014
Prevalence of COPD	3.5	4.0	0.148	4.2	4.4	0.492
Prevalence of myocardial infarction	0.6	1.4	<0.001	0.4	0.6	0.036
Prevalence of stroke	0.8	0.8	0.765	0.8	0.8	0.885
Daily cigarette smoking	26.0	26.0	0.998	19.1	22.0	<0.001

*P-value as results of the Chi-squared test between 2007 and 2014

Table 2: Prevalence of smoking in the male subpopulations in 2007 and 2014

	2007		2014		Interaction year*factor on daily smoking
	%Smokers	P*	%Smokers	P*	P**
Age		<0.001		<0.001	0.807
15-29	31.2		31.9		
30-64	28.9		29.2		
65+	8.3		8.6		
Education level		<0.001		<0.001	0.719
Primary	27.3		29.1		
Secondary	27.4		27.6		
Tertiary	12.6		13.7		
Employment status		<0.001		<0.001	0.002
Gainfully employed	30.7		29.5		
Unemployed	43.6		57.1		
Not gainfully employed	15.2		14.1		
Land of birth		<0.001		<0.001	0.246
Austria	24.3		24.5		
EU	23.0		30.6		
Non-EU	39.6		38.0		
Urbanisation		0.008		<0.001	0.149
Vienna	28.7		32.9		
Other federal states	25.3		24.2		

Family status		<0.001	<0.001	0.917
In a relationship	24.0	23.6		
Not in a relationship	30.6	31.5		
Health status		<0.001	0.006	0.647
At least one chronic disease	23.1	24.0		
No chronic disease	27.5	27.0		

*P-value as results of the Chi-squared test: differences in smoking prevalence based on socio-demographic and health variables in the respective surveys, 2007 and 2014

**P-value as results of the binary logistic regression analyses for the interaction between year of evaluation and the respective socio-demographic or health variable on the likelihood of daily smoking (dependent variable), adjusted for all socio-demographic and health variables and the year of evaluation

Table 3: Prevalence of smoking in the female subpopulations in 2007 and 2014

	2007		2014		Interaction year*factor on daily smoking
	%Smokers	P*	%Smokers	P*	P**
Age		<0.001		<0.001	0.004
15-29	28.4		27.8		
30-64	21.9		26.3		
65+	3.9		6.2		
Education level		<0.001		<0.001	<0.001
Primary	17.2		24.4		
Secondary	21.4		23.4		
Tertiary	12.2		10.4		
Employment status		<0.001		<0.001	0.997
Gainfully employed	25.6		28.6		
Unemployed	42.1		45.4		
Not gainfully employed	12.6		14.0		
Land of birth		<0.001		<0.001	0.016
Austria	18.7		20.5		
EU	16.6		26.1		
Non-EU	25.0		32.8		
Urbanisation		0.599		<0.001	0.514
Vienna	19.6		31.5		
Other federal states	19.1		19.4		

Family status		0.160		<0.001	0.290
In a relationship	18.6		20.6		
Not in a relationship	19.9		24.1		
Health status		0.001		0.357	0.662
At least one chronic disease	17.4		21.4		
No chronic disease	20.3		22.3		

*P-value as results of the Chi-squared test: differences in smoking prevalence based on socio-demographic and health variables in the respective surveys, 2007 and 2014

**P-value as results of the binary logistic regression analyses for the interaction between year of evaluation and the respective socio-demographic or health variable on the likelihood of daily smoking (dependent variable), adjusted for all socio-demographic and health variables and the year of evaluation

Table 4: Proportion of daily cigarette smokers in men and women of the different populations, and changes over time

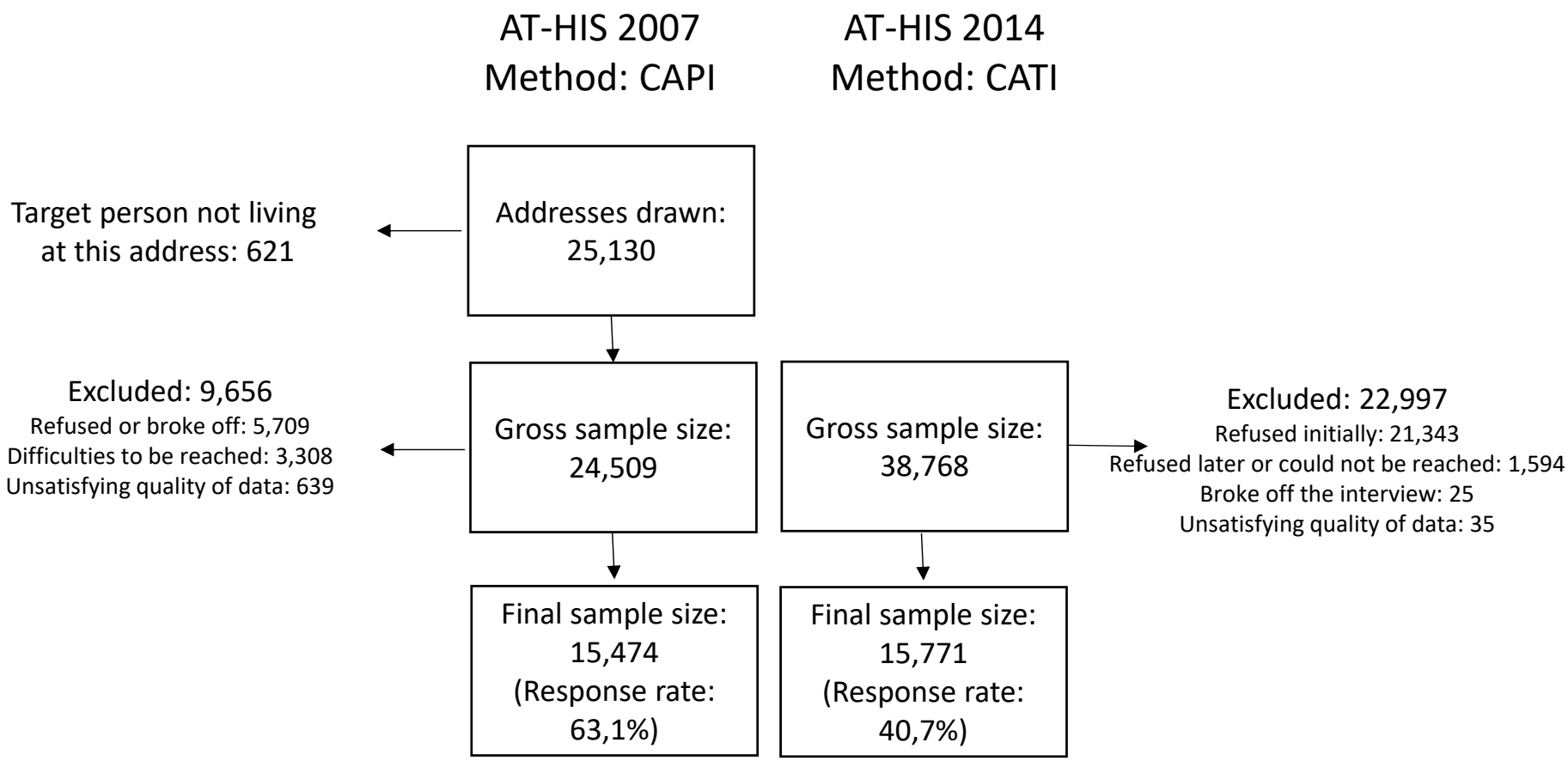
	Men				Women			
	2007	2014	Change	P*	2007	2014	Change	P*
General population	26.0	26.0	±0%	0.998	19.1	22.0	+15%	<0.001
People with at least one chronic disease	23.1	24.0	+4%	0.433	17.4	21.4	+23%	<0.001
Diabetes mellitus	14.5	17.7	+22%	0.219	9.9	16.4	+67%	0.005
Obesity (BMI≥30kg/m²)	23.2	24.7	+6%	0.405	17.1	21.6	+26%	0.010
Hypertension	17.5	20.1	+15%	0.082	11.2	14.2	+27%	0.010
COPD	31.6	28.2	-11%	0.382	24.9	25.7	+3%	0.814
Myocardial infarction	8.9	20.0	+125%	0.094	20.0	14.3	-29%	0.506
Stroke	10.2	17.5	+72%	0.245	9.1	20.0	+120%	0.076

*P-value as results of Chi-squared test between 2007 and 2014

Table 5: Association of socio-demographic and health variables on the likelihood of daily cigarette smoking. Results of multivariate logistic regression model based on both surveys in 2007 and 2014; each included variable is mutually adjusted for all the other variables.

		Men			Women		
		OR	(95% CI)	P	OR	(95% CI)	P
Year	2007	1			1		
	2014	1.04	(0.97 to 1.13)	0.269	1.22	(1.12 to 1.32)	<0.001
Age	15-29	2.51	(2.09 to 3.01)	<0.001	6.10	(5.11 to 7.28)	<0.001
	30-64	2.50	(2.11 to 2.96)	<0.001	5.17	(4.35 to 6.14)	<0.001
	65+	1			1		
Education level	Primary	3.02	(2.54 to 3.59)	<0.001	3.82	(3.21 to 4.55)	<0.001
	Secondary	2.81	(2.42 to 3.26)	<0.001	3.02	(2.58 to 3.55)	<0.001
	Tertiary	1			1		
Employment status	Gainfully employed	1			1		
	Unemployed	1.93	(1.73 to 2.16)	<0.001	1.84	(1.67 to 2.02)	<0.001
	Not gainfully employed	3.70	(3.11 to 4.39)	<0.001	2.87	(2.37 to 3.47)	<0.001
Land of birth	Austria	1			1		

	EU	1.25	(1.08 to 1.46)	0.003	1.26	(1.10 to 1.45)	0.001
	Non-EU	1.52	(1.34 to 1.73)	<0.001	1.12	(0.97 to 1.30)	0.115
Urbanisation	Vienna	1.28	(1.16 to 1.40)	<0.001	1.50	(1.36 to 1.65)	<0.001
	Other federal States	1			1		
Family status	In a relationship	1			1		
	Not in a relationship	1.38	(1.26 to 1.52)	<0.001	1.33	(1.22 to 1.45)	<0.001
Health status	At least one chronic disease	1.04	(0.96 to 1.13)	0.360	1.15	(1.06 to 1.25)	0.002
	No chronic disease	1			1		


AT-HIS 2007
Method: CAPI
AT-HIS 2014
Method: CATI
Addresses drawn: 25,130
Target person not living at this address: 621
Gross sample size: 24,509
Excluded: 9,656
Refused or broke off: 5,709
Difficulties to be reached: 3,308
Unsatisfying quality of data: 639
Gross sample size: 38,768
Excluded: 22,997
Refused initially: 21,343
Refused later or could not be reached: 1,594
Broke off the interview: 25
Unsatisfying quality of data: 35
Final sample size: 15,474 (Response rate: 63,1%)
Final sample size: 15,771 (Response rate: 40,7%)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

"Sex-specific trends in smoking prevalence within seven years in different Austrian populations: results of a time series cross-sectional survey"

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1; 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	*6-8*
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	5-6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	5

		(*e*) Describe any sensitivity analyses	n.a.
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	18, Table 1
		(b) Indicate number of participants with missing data for each variable of interest	n.a.
Outcome data	15*	Report numbers of outcome events or summary measures	18, Table 1
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	18-26, Tables 1-4
		(*b*) Report category boundaries when continuous variables were categorized	n.a.
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n.a.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-10; 20-23, Table 2
Discussion			
Key results	18	Summarise key results with reference to study objectives	11-12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14-15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	11-14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	3

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.