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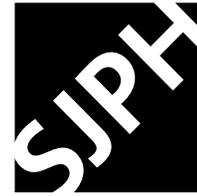


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ORIGINAL ARTICLE

## Lung cancer mortality: Comparing Sweden with other countries in the European Union

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### Abstract

**Aims:** To describe how snus use has reduced smoking among men in Sweden, and to estimate how smoking-attributable lung cancer mortality would decline in other European Union countries if they had the smoking prevalence of Sweden. **Methods:** Lung cancer mortality rates (LCMRs) and numbers of deaths among men and women age 45+ years in 25 EU countries in 2002 were obtained from the World Health Organization mortality database, and the number of lung cancer deaths expected in each country at the LCMR of Sweden was calculated. LCMRs for EU countries were obtained during the period 1950–2004, and per capita consumption of nicotine from cigarettes and snus was estimated for men in Sweden from 1931 to 2004. **Results:** There were 172,000 lung cancer deaths among men in the EU in 2002. If all EU countries had the LCMR of men in Sweden, there would have been 92,000 (54%) fewer deaths. In contrast, the LCMR among Swedish women was the sixth highest in the EU; at the Swedish rate, deaths among EU women would have increased by 14,500 (26%). These LCMR patterns were in place for most of the last 50 years, and LCMRs among Swedish men can be correlated with snus and cigarette consumption. **Conclusions:** This study shows that snus use has had a profound effect on smoking prevalence and LCMRs among Swedish men. While it cannot be proven that snus would have the same effect in other EU countries, the potential reduction in smoking-attributable deaths is considerable.

**Key Words:** Cigarette smoking, European Union, lung cancer mortality, snus, Sweden

### Background and Aims

For more than two centuries men in Sweden and other Scandinavian countries have used snus, which consists of ground tobacco, salt, water and flavouring agents that undergoes heat treatment to prevent formation of unwanted contaminants [1]. Snus, available in loose form and more recently in small pouches, is placed inside the upper lip.

Several studies have shown that the use of snus has played a substantial role in the low smoking rate among Swedish men [2–5]. However, that explanation has been judged as not compelling by some authorities, such as the European Commission's Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR). Recently, a SCENIHR report acknowledged that "particularly in Swedish men, there is a clear trend over recent

decades for smoking prevalence to decrease and for use of oral tobacco (snus) to increase," but it concluded that "these trends could also be due to successful smoking reduction programs or other socio-cultural factors, and it is therefore not clear whether or by how much the availability of snus has influenced smoking prevalence." [1] The report also stated that "it is not possible to extrapolate the trends in prevalence of smoking and use of oral tobacco if it were made available in a European Union (EU) country where it is now unavailable."

The purpose of this study is to clarify how much the availability of snus has influenced smoking among men in Sweden, in the context of all other EU countries. Studying smoking prevalence per se in the EU is difficult because standardized and comparable data are not available for all 27 countries. But there is

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(Accepted 26 March 2009)

© 2009 the Nordic Societies of Public Health  
DOI: 10.1177/1403494809105797

a measure that reflects differences in smoking among EU countries: lung cancer mortality. Lung cancer is the sentinel disease of smoking [6], and a country's lung cancer mortality rate (LCMR) in any single year provides a reasonable indication of the amount of smoking in that country about 20 years earlier. While it is not possible to predict to what extent the availability of snus would reduce smoking prevalence in EU countries other than Sweden, it is possible to estimate how smoking-attributable mortality would decline if these countries had the smoking prevalence of Sweden.

## Methods

LCMRs and numbers of deaths were obtained separately for men and women age 45+ years in 25 EU countries in 2002 (Denmark, 2001) from the World Health Organization (WHO) mortality database [7]. No data are available for Cyprus and the latest data for Belgium are from 1997. LCMRs were age-adjusted by the WHO to the World Standard Population and were expressed as deaths per 100,000 person-years. We calculated rate ratios for each country, expressed as that country's LCMR divided by the Swedish LCMR. A rate ratio greater than one indicates that the country's LCMR is higher than that of Sweden; a ratio less than one indicates that the Swedish rate is higher. For both genders we calculated the number of lung cancer deaths expected if each country had the LCMR of Sweden.

LCMRs for EU countries except Cyprus were obtained for all available years during the period 1950–2004. Based on data availability and general LCMR trends, the countries were divided into two groups: the 15 countries comprising the EU in 1995 (EU-1995 countries) and the 11 countries that joined the EU in either 2004 or 2007 (EU-expansion countries). Countries with similar LCMRs were combined, and data are illustrated as three-year moving averages.

We estimated the annual per capita consumption of nicotine from cigarettes and snus by men in Sweden from 1931 to 2004. Annual population estimates (men and women aged 15+ years) and annual Swedish tobacco consumption (number of cigarettes and the amount of snus in grams) were obtained from Research and Consulting Bureau VECA (Hässelby, Sweden). It was assumed that all snus consumption was by men. Cigarette consumption by men in each year was estimated by adjusting total consumption using gender-specific LCMRs 20 years later. LCMR trends were projected to 2024 to estimate gender-specific cigarette consumption

through 2004. We estimated per capita nicotine consumption using conversions developed by Fagerström [8], 1.4 mg of nicotine per cigarette and 2.0 mg per g of snus. The snus conversion applies to traditional snus, which provides more nicotine than portion-pack forms that became popular recently [8].

## Results

### *LCMRs among men in the EU*

In 2002 the LCMR among men in the 25 EU countries was 166 (Table I). The LCMR among men in Sweden was 77, the lowest of all countries. The LCMR among Portuguese men (105), the second lowest in the EU, was 36% higher than that of Sweden, and 17 EU countries had LCMRs that were over twice as large as that of Sweden. The number of lung cancer deaths among all men in the EU was 172,000. If all countries had the LCMR of Swedish men, 80,000 deaths would have occurred, representing 92,000 fewer lives lost to lung cancer, a 54% reduction.

Figure 1a shows the LCMRs among men in Sweden and among men in other EU-1995 countries from 1950 to 2004. The LCMR among men in Sweden was 32 in 1951 and peaked in 1978 at 96, followed by a gradual decline to 77 in 2002. These LCMRs were much lower for all years than those for all but one EU-1995 country. The exception is Portugal, which had an LCMR of 26 in 1955 and has experienced a gradual increase ever since, passing Sweden in 1986. Spain, Italy, France, Ireland, Denmark and Greece also had low LCMRs initially (31–64 in 1952), with subsequent peaks between 180 and 220. Data are available for Germany starting in 1973, and the LCMR pattern is consistent with the overall pattern for this group. Belgium and the Netherlands had LCMRs of about 100 in the mid-1950s, with subsequent peaks near 300 in the early to mid-1980s. Finland and the United Kingdom (UK) had LCMRs above 150 in 1952, with subsequent peaks in the early 1970s at 261 and 281 respectively. No data are available prior to 1973 for Luxembourg, which had a peak LCMR of 273 in 1982. Austria had an LCMR similar to Finland in 1955, but its peak at 196 occurred in 1968. Despite the different LCMR patterns among these countries, there was a convergence of the rates over the last 20 years. By 2002 the range of LCMRs was from 120 (Finland) to 188 (the Netherlands) in all countries except Sweden and Portugal.

Figure 1b shows LCMRs among men in Sweden compared with those in EU-expansion countries.

Table I. Lung cancer mortality rates.<sup>a</sup> Number of deaths observed and number expected at Swedish rates among men and women in 25 European countries, 2002.

Country	Men				Women			
	Rate <sup>a</sup>	Observed deaths	Rate ratio <sup>b</sup>	Expected deaths <sup>c</sup>	Rate <sup>a</sup>	Observed deaths	Rate ratio <sup>b</sup>	Expected deaths <sup>c</sup>
Austria	138	2,354	1.79	1,313	44	1,002	0.84	1,194
Bulgaria	144	2,388	1.86	1,282	23	500	0.43	1,152
Czech Rep	217	4,242	2.80	1,511	46	1,258	0.87	1,440
Denmark	160	1,938	2.07	934	106	1,467	2.02	727
Estonia	227	551	2.95	187	28	122	0.54	227
Finland	120	1,376	1.55	887	30	462	0.58	803
France	163	20,315	2.12	9,586	29	4,646	0.55	8,437
Germany	148	28,320	1.91	14,793	41	10,077	0.78	12,981
Greece	175	4,715	2.26	2,082	26	858	0.50	1,706
Hungary	287	5,506	3.72	1,482	78	2,169	1.50	1,447
Ireland	135	920	1.75	525	63	533	1.21	442
Italy	170	25,492	2.20	11,582	32	6,344	0.61	10,336
Latvia	214	878	2.78	316	23	176	0.44	398
Lithuania	206	1,198	2.68	448	17	179	0.32	561
Luxembourg	164	145	2.13	68	31	33	0.59	56
Malta	158	122	2.04	60	18	13	0.35	38
Netherlands	188	6,321	2.43	2,599	66	2,425	1.25	1,933
Poland	260	16,426	3.37	4,880	50	4,393	0.96	4,586
Portugal	105	2,370	1.36	1,742	19	552	0.36	1,552
Romania	173	6,814	2.25	3,032	28	1,442	0.53	2,723
Slovakia	199	1,661	2.57	645	26	318	0.50	630
Slovenia	183	701	2.38	295	44	226	0.83	272
Spain	168	15,605	2.18	7,153	17	1,964	0.33	5,937
Sweden	77	1,761	–	1,761	52	1,329	–	1,329
UK	143	20,124	1.86	10,842	74	13,279	1.42	9,347
All	166	172,243	2.15	80,005	41	55,767	0.79	70,254

<sup>a</sup>Deaths per 100,000 person-years, age-adjusted to the World Standard Population.<sup>b</sup>Country rate/Swedish rate.<sup>c</sup>At the Swedish rate. UK = United Kingdom.

Data from these countries is more limited, but some trends are apparent. Swedish LCMRs are much lower than those for all other countries for all years. Among countries with data from at least 1960, Romania had an LCMR of 68 in 1959, with a pattern similar to that in Spain. LCMRs in Poland and Hungary in 1960 were 62 and 109, with subsequent peaks at 269 (1994) and 306 (1996) respectively. By 2002 LCMRs were declining in all of these countries except Romania and Bulgaria. However, in 2002 only Romania, Bulgaria and Malta had LCMRs that were lower than 188, the highest LCMR among EU-1995 countries in that year.

#### *LCMRs among women in the EU*

In 2002 the LCMR among women in the 25 EU countries was 41. The LCMR among women in Sweden was relatively high at 52; only Denmark, Hungary, Ireland, the Netherlands and the UK had higher rates. In 2002, the number of lung cancer

deaths among women in the EU was 55,800. If women of all countries had the LCMR of Swedish women, 70,300 lung cancer deaths would have occurred, a 26% increase.

LCMRs among women in EU-1995 countries during the period from 1950 to 2004 are shown in Figure 2a. In the mid-1950s LCMRs ranged from 7 in Portugal to 23 in the UK. Denmark showed the sharpest increase to a peak of 104 in 1995, with little decline afterward. Ireland and the UK peaked at 75–79 in 1988–89, followed by modest declines to about 70. A peak has not occurred in any other country, although there are five separate slopes. The Netherlands' LCMR was at the level of that in Ireland and the UK in 2002, while Sweden had an LCMR of 52, which is fifth highest in this group. In 2004 Austria, Germany and Luxembourg had LCMRs around 40; France, Finland, Greece and Italy had LCMRs of 30; Portugal and Spain were the lowest among EU-1995 countries at 20.

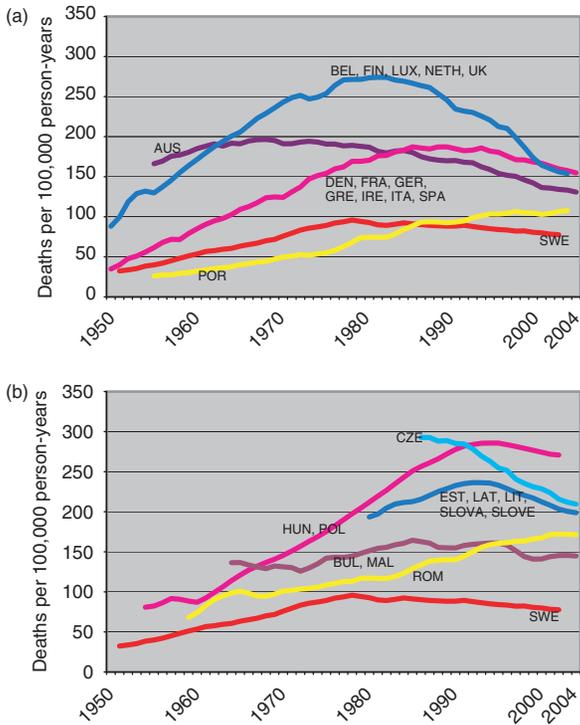


Figure 1. LCMRs among men age 45+ years in Sweden, in (a) EU-1995, and (b) EU-expansion countries, 1950-2004.

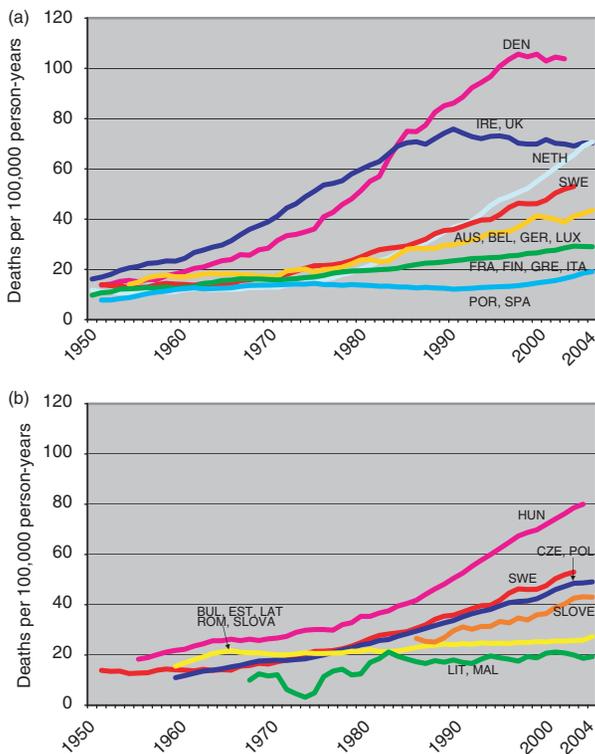


Figure 2. LCMRs among women age 45+ years in Sweden, in (a) EU-1995 and (b) EU-expansion countries, 1950-2004.

Figure 2b shows LCMRs among women in Sweden compared with those in EU-expansion countries. Throughout most of the period LCMRs among Swedish women were lower than those only in Hungary, which had a rate of 80 in 2003. LCMRs in the Czech Republic and Poland approached 50 by 2004, and the LCMR in Slovenia was over 40. LCMRs increased more slowly in Bulgaria, Romania, Slovakia, Estonia and Latvia, generally staying in the mid-20s. LCMRs in Malta and Lithuania were essentially stable at 20.

*Nicotine consumption by Swedish men, 1931-2004*

Figure 3 shows estimated annual per capita consumption of nicotine from cigarettes and snus by Swedish men age 15+ years. Prior to 1952, snus was the dominant nicotine source but was declining while cigarette consumption was increasing. Cigarettes were the preferred nicotine source from 1955 to 1985, but consumption peaked by 1975; the nadir of snus consumption was in 1969. After 1985 snus regained dominance, and the snus-cigarette gap has widened ever since.

Nicotine consumption from snus and cigarettes are strongly and inversely correlated (correlation coefficient = -0.86), but annual per capita nicotine consumption from both sources combined was fairly stable. The mean for all years was 4,600 mg. Nicotine consumption fell below 4,000 mg only during World War II (1942-45). Consumption was above 5,000 from about 1972 to 1988; during this period snus use increased while cigarette smoking had just started to decline. These usage patterns accelerated afterwards with total nicotine consumption remaining above 4,000 mg.

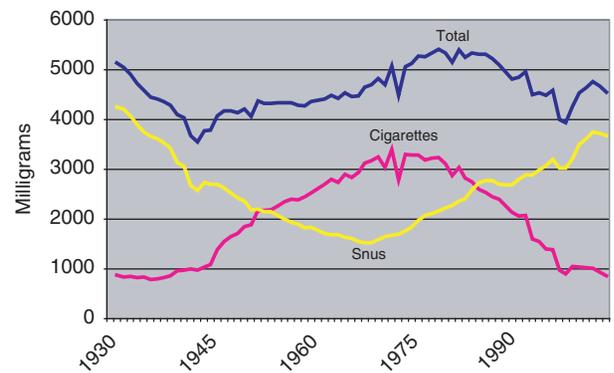


Figure 3. Estimated annual per capita nicotine consumption (mg) from cigarettes and snus by men in Sweden, 1931-2004.

## Discussion

The major finding of this study is that snus use is inversely correlated with cigarette consumption among men in Sweden, resulting in the lowest LCMRs in Europe for most of the past 50 years. In 2002, there were 172,000 lung cancer deaths among men in the EU. If all EU countries had the LCMR of men in Sweden, there would have been 92,000 fewer lung cancer deaths. But the potential impact of low Swedish smoking rates is not limited to lung cancer. For men in the EU, 91% of all lung cancer deaths are attributed to smoking, and lung cancer accounts for only 31% of all smoking-attributable deaths [9]. Thus, we estimate that there were 511,000 smoking-attributable deaths among men in EU countries in 2002, which is consistent with other recent estimates [9]. If all EU countries had the smoking rates of Swedish men, there would have been only 237,000 deaths from all smoking-related diseases. In other words, 274,000 smoking-attributable deaths would have been avoided throughout the EU in 2002. In addition, longitudinal LCMR trends indicate that the difference between Swedish men and that of other EU countries was modest in 2002 compared with previous years.

The large differences in LCMRs between Sweden and other EU countries occur only in men. For most of the last 50 years, the LCMR among Swedish women was the sixth highest in the EU. This context is important, because it has been suggested that vigorous anti-smoking campaigns since the 1970s are the major determinant of the low Swedish smoking rates [10]. It is implausible that these campaigns were highly effective for Swedish men and almost completely ineffective for Swedish women. The striking difference in the relative EU ranking of Swedish men and women is firm evidence that snus use, not anti-smoking campaigns, has played the primary role in low LCMR rates among men in Sweden for over a half century.

World War II created millions of male smokers, resulting in very high LCMRs throughout Europe in the 1960s and 1970s. Men in Portugal, Spain and Italy, which had LCMRs similar to those in Sweden in the early 1950s, later experienced peak LCMRs that were four to six times higher, while the peak in Sweden represented only a three-fold increase. Even though snus consumption declined until 1969, its use was high enough to suppress smoking by Swedish men and to keep their LCMR among the lowest in the EU. Increasing snus consumption in the last two decades has been accompanied by further declines in smoking. If current trends hold, the LCMR

for Swedish men may become lower than that for Swedish women by 2011. However, there is evidence that snus has started to become popular among Swedish women, with a consequential impact on smoking [3,11].

There are other risk factors for lung cancer besides smoking, but the latter is certainly the dominant cause throughout the EU. Furthermore, the proportion of lung cancer cases due to other causes is unlikely to differ significantly across countries, with the possible exception of women in Lithuania, Spain and Portugal, who have extremely low LCMRs [9]. Thus, while the number of lung cancer deaths reported here are not entirely due to smoking, other risk factors play a minor role in the trends seen in this study.

Nicotine consumption from snus and cigarettes are strongly and inversely correlated. But the LCMR decline among Swedish men started just 10 years after the upturn in snus consumption and only six years after cigarette consumption peaked. The expected lag is about 20 years. A possible explanation relates to differences in the available data; we had information on snus and cigarette consumption only for all men (age 15+ years), but lung cancer is mainly seen in persons age 45+ years. In the 1950s and 1960s snus use was seen predominantly in older Swedish men [12], which may have influenced the timing of the LCMR peak and decline in this study.

Currently, snus is banned in all EU countries except Sweden. While it cannot be proven that the availability of snus would reduce smoking prevalence in other EU countries, this study shows that snus use has had a profound effect on smoking among Swedish men. It also reveals that 274,000 smoking-attributable deaths would be avoided if all men in all EU countries had the smoking prevalence of men in Sweden. Britton and Edwards recently wrote that "the absence of effective harm reduction options for smokers is perverse, unjust, and acts against the rights and best interests of smokers and the public health." [13]. It is time for the European Commission to revise the Tobacco Directive to make snus available to all European smokers.

## Acknowledgments

This study was supported by unrestricted grants from smokeless tobacco manufacturers (US Smokeless Tobacco Company and Swedish Match AB) to the University of Louisville. The terms of the grants assure that the sponsors are unaware of this study, and thus had no scientific input or other influence

with respect to its design, analysis, interpretation or preparation of the manuscript. Neither author has any financial or other personal relationship with regard to the sponsors.

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