

RESEARCH PAPER

Role of snus in initiation and cessation of tobacco smoking in Sweden

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Objective: To examine patterns of smoking and snus use and identify individual pathways of Swedish tobacco users in order to clarify whether snus use is associated with increased or decreased smoking.

Methods: Retrospective analysis of data from a cross-sectional survey completed by 6752 adult Swedes in 2001–2 focusing on identifying tobacco use history by survey items on current and prior tobacco use and smoking initiation and cessation procedures.

Results: 15% of the men and 19% of the women completing the survey were daily smokers. 21% of the men and 2% of the women were daily snus users. Almost all (91%) male daily smoking began before the age of 23 years, whereas initiation of daily snus use continued throughout the age range (33% of initiation after age 22). 20% of male primary snus users started daily smoking compared to 47% of non-primary snus users. Thus, the odds of initiating daily smoking were significantly lower for men who had started using snus than for those who had not (odds ratio (OR) 0.28, 95% confidence interval (CI) 0.22 to 0.36). Among male primary smokers, 28% started secondary daily snus use and 73% did not. 88% of those secondary snus users had ceased daily smoking completely by the time of the survey as compared with 56% of those primary daily smokers who never became daily snus users (OR 5.7, 95% CI 4.9 to 8.1). Among men who made attempts to quit smoking, snus was the most commonly used cessation aid, being used by 24% on their latest quit attempt. Of those men who had used one single cessation aid 58% had used snus, as compared with 38% for all nicotine replacement therapy products together. Among men who used snus as a single aid, 66% succeeded in quitting completely, as compared with 47% of those using nicotine gum (OR 2.2, 95% CI 1.3 to 3.7) or 32% for those using the nicotine patch (OR 4.2, 95% CI 2.1 to 8.6). Women using snus as an aid were also significantly more likely to quit smoking successfully than those using nicotine patches or gum.

Conclusion: Use of snus in Sweden is associated with a reduced risk of becoming a daily smoker and an increased likelihood of stopping smoking.

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There has been disagreement over the role of smokeless tobacco in promoting or discouraging smoking.^{1,2} Interest in this issue has recently focused on Sweden because of the widespread use of a form of moist smokeless tobacco called "snus" that is particularly low in concentrations of cancer-causing tobacco-specific nitrosamines (TSNAs)^{3–5} and which appears to cause 90–95% less health problems than smoking.^{6,7} The proposed role of snus in reducing smoking and improving health in Sweden^{1,8–11} has been disputed,² partly based on a concern that the men who were quitting smoking in Sweden were not the same people who were taking up snus. It has also been suggested that smokeless tobacco use in young people may increase their risks of progressing to smoking,^{12–14} while other studies have suggested the opposite.^{15–19} There have also been concerns that adult snus use may contribute to increased health risks by delaying smoking cessation.²

In order to clarify whether snus use is associated with an increase or decrease in smoking rates, this study examined patterns of tobacco use in Sweden including the use of snus as an aid to smoking cessation.

METHODS

The data collection for the current study was embedded in the confidential survey entitled "Your Country and Your Life", conducted by the Research Group for Societal and Information Studies (FSI) in collaboration with the Department of Sociology at Stockholm University. Full review by a research ethics committee has not been necessary for

this type of data collection according to the rules of the Swedish Law on Research Ethics Review (2003:460).

Questionnaires in this survey covered a broad range of topics including attitudes regarding social conditions, work, environment, current political issues, health and welfare. In 2001–2 the tobacco section of the questionnaire included four initial screening questions enquiring about current and past cigarette smoking, other smoking, and current and past snus use. Those who had ever been a daily snus user or daily smoker were then asked additional questions covering age of initiation and quitting each product, order of initiation (if applicable), attempts to quit smoking, use of different kinds of smoking cessation aids during the last quit attempt and current use of nicotine replacement therapy (NRT) products.*

During the period September 2001 to May 2002 questionnaires were mailed to over 10 500 addressees in a sample drawn randomly from the national population registry. A series of reminders were provided, ultimately achieving a response rate of 65%. Ninety eight per cent of all questionnaires received contained usable answers to the tobacco questions, yielding a study population of 3238 men and 3514 women which was very well matched to the Swedish

Abbreviations: CI, confidence interval; FSI, Research Group for Societal and Information Studies; ITS, Institute for Tobacco Studies; NRT, nicotine replacement therapy; OR, odds ratio; TSNAs, tobacco-specific nitrosamines

* A copy of the tobacco items of the questionnaire is available by request from the corresponding author.

Table 1 Prevalence of daily tobacco use by sex and age

Tobacco use categories*	Men					Women				
	Age (years)					Age (years)				
	16–24	25–44	45–64	65–79	Total	16–24	25–44	45–64	65–79	Total
1. Daily smoking, no current daily snus use	8%	11%	17%	12%	13%	15%	19%	24%	11%	19%
2. Daily smoking and daily snus use	3%	2%	2%	1%	2%	0%	0%	0%	0%	0%
3. Daily snus use, no current daily smoking	21%	29%	17%	7%	20%	2%	4%	2%	0%	2%
4. No current daily tobacco use	68%	59%	64%	80%	65%	83%	77%	74%	89%	79%
Base	396	1099	1179	564	3238	449	1219	1276	570	3514

*Useful combinations of categories: all daily smoking, categories 1+2; all daily snus use, categories 2+3.

population on its distribution of demographic characteristics such as sex, age and geographic location.

The data processing was carried out at the Institute for Tobacco Studies (ITS), Stockholm, Sweden in collaboration with FSI using the FSI Computer System Statistical Analysis Programme Package. The proportions of men and women following each potential pathway of tobacco use was calculated, as were odds ratios (OR) and their 95% confidence intervals (CI) for onset and cessation of daily smoking. Stratified analyses examined whether observed associations for smoking initiation and cessation remained in subgroups by level of education and age.

RESULTS

Tobacco use prevalence patterns

Occasional (non-daily) snus use was very uncommon (3% in men and 1% in women) whereas occasional smoking was more common (9% and 6% in men and women, respectively). However, as daily use is typical for both snus and smoking, and as both the level of dependence and magnitude of health effects are much greater for daily users, the subsequent analyses focus on daily use.

Table 1 presents the overall patterns of daily smoking and snus use by sex and age.

More women than men were current daily smokers, 19% (95% CI 17.7% to 20.3%) v 15% (95% CI 13.8% to 16.2%). Conversely, current daily use of snus was much higher in men than women, 21%† (95% CI 19.6% to 22.4%) v 2% (95% CI 1.5% to 2.5%). More women than men smoke in every age group except 65–79. Daily snus use is most common in ages 25–44, while daily smoking is most common in ages 45–64. Daily dual use, using both smoking and snus daily, was rare, with just 2% of the men and no women reporting this pattern. Absence of any daily tobacco use was more common among women than among men.

Initiation of tobacco use

The answers to questions regarding age at onset of daily tobacco use showed that among men almost all daily smoking (91%) has been initiated by age 22, while initiation of daily snus use continued throughout the age range (33% occurring after age 22). In a comparison between two birth cohorts of men (current age 22–41 and 42–61, respectively) with regard to initiation in young ages (below 23) we found a shift in patterns of initiation. In the older cohort initiation in young ages was dominated by onset of smoking, while onset of snus use was dominating in the younger cohort. The emergence of dominating snus use in young men was accompanied by decreased initiation of smoking and also by a decrease of total initiation of tobacco use in young men.

†From table 1 the prevalence of daily snus use in all men is 20% + 2%. Since both these percentages are rounded upwards, the sum is rounded down to 21%.

Initiation patterns were analysed also with respect to the order of initiation of daily smoking and daily snus use, respectively, as illustrated in fig 1.

Firstly, two main groups were identified: *primary snus users* (PSNU)—started daily tobacco use as snus users; and *non-primary snus users* (NPSNU).

By subdivision with regard to subsequent steps in the initiation process, five final initiation categories were identified:

- (1) *Primary snus users* who never started daily smoking
- (2) *Primary snus users* who started secondary daily smoking (*secondary smokers*)
- (3) *Primary smokers* (PSMO) who never started daily snus use.
- (4) *Primary smokers* who started secondary daily snus use (*secondary snus users*).
- (5) *Never daily tobacco users* (NTOB).

In 91% of the male primary snus users, the age of onset of daily snus use was lower than 23 years, whereas in the majority (66%) of the secondary snus users (category 4 above) the onset of daily snus use occurred after the age of 22 years. Further, in ages below 23, a majority (79%) of those starting daily snus use are primary snus users, while in ages 23+ the majority (83%) of those starting daily snus use are secondary snus users (a subgroup of primary smokers). These patterns suggest that secondary snus use is initiated in a context of using snus as an aid to smoking cessation.

The data shown in fig 1 demonstrate that 16% of the men started daily tobacco use as a snus user. Among these primary snus users 20% started daily smoking compared to 47% among non-primary snus users (OR 0.28, 95% CI 0.22 to 0.36). Thus, the odds of initiating daily smoking were significantly lower for those who had started using snus than for those who had not. This association pattern remained the same (and still significant) across age groups and levels of education. Among primary smokers, 28% started secondary daily snus use and 73% did not.

The course of tobacco use

Figure 1 shows 13 different pathways with each one leading to one of four different alternatives of current tobacco use. This illustrates the characteristics of different alternatives for the course of tobacco use.

Eighty-eight per cent of the primary smokers with secondary daily snus use (category 4) had ceased daily smoking by the time of the survey, compared to 56% among those primary smokers (category 3) who never started daily snus use (OR 5.7, 95% CI 4.0 to 8.1). Among those primary snus users who started secondary daily smoking (category 2), 74% later ceased daily smoking, 56% returned to exclusive daily snus use, and 18% had by the time of the survey quit daily snus use as well. Among primary smokers who started secondary daily snus use

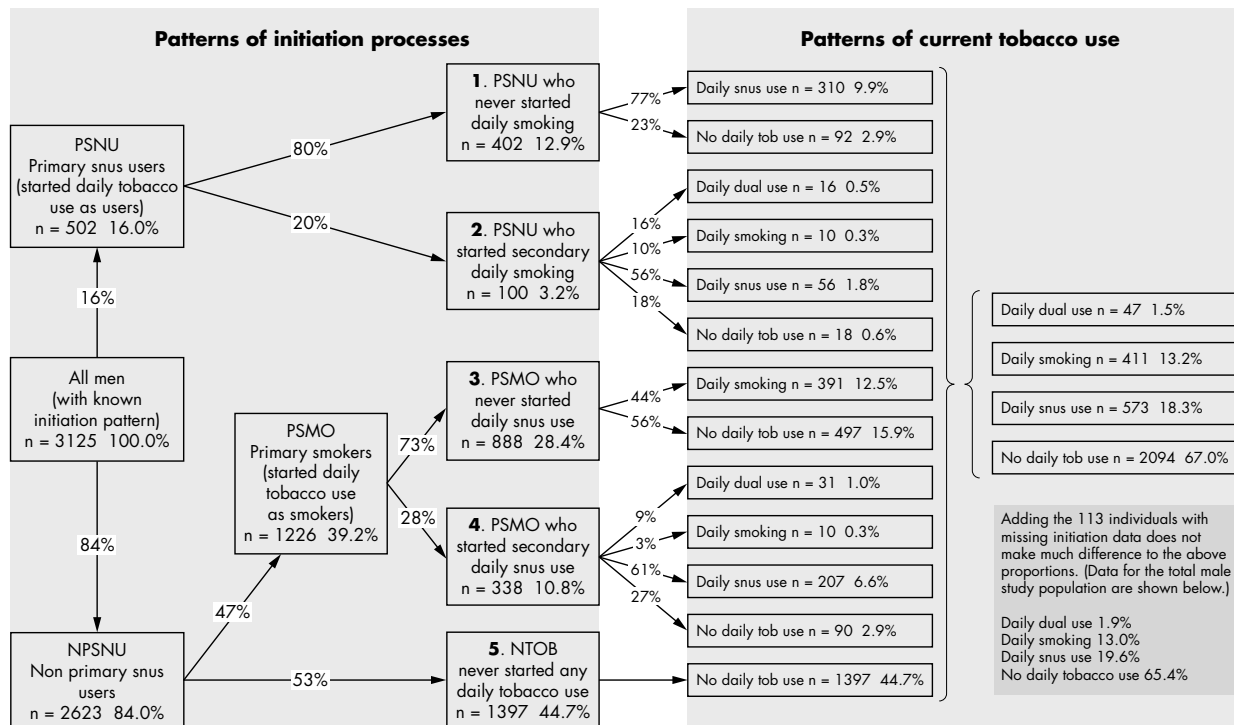


Figure 1 Pathways of male tobacco use (percentages in boxes based on all men ages 16–79). The left section of the figure shows the proportions of men who started daily snus use, smoking, both (and if so, in what order) or no tobacco use. The central section shows, for each initiation category, the proportions of men who continued or quit each type of tobacco use that was initiated. The right section shows the proportions of men following 13 different lifetime pathways to current tobacco use. NPSNU, non-primary snus users; NTOB, never daily tobacco users; PSMO, primary smokers; PSNU, primary snus users.

(category 4), only 3% had returned to exclusive daily smoking by the time of the survey. Among all ever daily smokers, the odds of still being a daily smoker at the time of the survey were significantly higher for those without a history of daily snus use (category 3) as compared to those with a history of daily snus use (categories 2 and 4) (OR 4.4, 95% CI 3.2 to 5.9). Of all the men who reported ever becoming a daily snus user (840), 26.2% (220) were no longer using snus at the time of the survey. A very small proportion (6%) of current daily smokers were initially primary snus users, while the vast majority of current smokers (94%) were primary smokers.

The overall quit rate (proportion of ever daily smokers having stopped completely) was 59% (95% CI 56% to 62%) for men and 49% (95% CI 46% to 52%) for women. Comparing men and women with a history of daily snus use, we found a quit rate of 72% (95% CI 68% to 76%) for

men and 71% (95% CI 61% to 81%) for women, a non-significant difference. Comparing men and women without a history of daily snus use, we found a quit rate of 51% (95% CI 48% to 54%) for men and 48% (95% CI 45% to 51%) for women, a non-significant difference, whereas in each sex the quit rates differ significantly between those with and those without a history of daily snus use.

Smoking cessation practices

Ever daily smokers were asked if they had made quit attempts and, if so, when. Eighty-eight per cent of male and 91% of female ever daily smokers answering that question indicated that they had made at least one quit attempt. Among the ex-smokers (former daily smokers who had quit completely), 84% had quit five or more years previously, whereas among the continuing daily smokers,

Table 2 Use of different aids at latest quit attempt among the 895 triers reporting use of an aid

	Total	Used as the only aid		Used as one of several	
		Men	Women	Men	Women
Nicotine chewing gum	402	87	137	75	103
Nicotine patch	272	41	92	49	90
Nicotine tablets	42	5	10	7	20
Nicotine spray	10	1	1	3	5
Nicotine inhaler	45	5	13	9	18
Bupropion (Zyban) tablets	17	4	5	4	4
Snus	320	213	49	41	17
Other (e.g. psych treatment/counselling)	47	13	18	7	9
Sum	1155*	369	325	195	266

*Number of aids is larger than the number of triers, since some triers used more than one aid.

Table 3 Outcome of latest attempt to quit smoking, by sex and type of cessation aid used (alone or as one of two or three)

Ever daily smokers: outcome of latest quit attempt	Men			Women		
	Cessation aid			Cessation aid		
	All gum users	All patch users	All snus users	All gum users	All patch users	All snus users
Continuing daily smoking	41%	63%	21%	59%	69%	29%
Reduced to occasional smoking	8%	2%	13%	7%	4%	14%
Quit smoking completely	51%	34%	65%	34%	27%	58%
Base	162	90	254	240	182	66

more than half (51%) had made an unsuccessful quit attempt within the past four years.

Those who had made a quit attempt were asked: "At your latest attempt to quit smoking, did you use an aid?" and nine options were given for possible answers.

Forty-one per cent (458) of these men and 35% (437) of these women reported using an aid at their latest quit attempt. Usually just one aid was used, but 9% had used combinations of up to three aids.

Table 2 shows the number of quit attempts where each aid in question was used.

Among ever daily smokers who had tried to quit smoking (and reported on their use/non-use of aids), 24% (254/1057) of the men and 6% (66/1193) of the women had used snus as an aid on their latest quit attempt. Corresponding figures for the sum of all NRT products were 11% (120/1057) for men and 41% (489/1193) for women. Snus was the aid most commonly used on its own and the most commonly used smoking cessation aid overall among men.

For those using the three most common cessation aids the outcome of the latest quit attempt was established in three categories with respect to smoking status at the time of the survey: continuing daily smoking (failure), ceased smoking daily and reduced to occasional smoking (partial success), and quit smoking completely (success). The proportions of these categories in men and women are presented in table 3.

Both among men and women snus users include fewer failures (continuing daily smoking) and more successes than gum and patch users.

The increased likelihood for daily smokers to quit completely by using snus as a cessation aid is clearest in the comparison with patch use. For men the snus:patch OR for success (quitting completely) is 3.6 (95% CI 2.2 to 6.0) and for women the OR is 3.6 (95% CI 2.0 to 6.4). In the comparison between snus and gum use the OR is 1.8 (95% CI 1.2 to 2.7) for men, and for women the OR is 2.7 (95% CI 1.5 to 4.7).

When comparing the outcomes of users of a single aid, the patterns are the same as those in table 3, but the differences between the aids is slightly larger, (for example, among men, 66% of snus users quit, versus 47% of gum users and 32% of patch users). Among men the snus:patch OR for success is 4.2 (95% CI 2.1 to 8.6), and the snus:gum OR for success is 2.2 (95% CI 1.3 to 3.7). Among women the snus:patch OR for success is 3.0 (95% CI 1.4 to 6.1), and the snus:gum OR for success is 2.1 (95% CI 1.1 to 4.1).

In analyses that stratified for age and level of education ("high" defined as "college or college-preparatory high school"), these relationships between use of snus as an aid and smoking cessation (that is, significantly higher quit rates among those using snus) were similar across levels of education and across the age range. These results suggest that it is unlikely that the higher quit rates among snus users are due to confounding with these variables. However, there could have been confounding with some other unmeasured variable (for example, motivation to quit).

Among those 168 subjects (141 men, 27 women) who had completely quit smoking after using snus as single cessation aid, 76% (128/168) were using snus daily at the time of the survey. Among those who had completely quit smoking after using an NRT product as a single cessation aid, 12% were using NRT daily at the time of the survey.

Since NRT products were available from the 1980s only, a comparison was made regarding distribution over time of quit events from 1980 and onwards. The median year for quitters with gum was 1995, for quitters with patch 1996. Among quitters with snus there was an interesting difference between men, median year 1993, and women, median year 1997. In all groups by sex and aid combinations, most ex-smokers had quit smoking for at least three years.

DISCUSSION

In this study men were less likely to be smokers and much more likely to use snus than women. Overall, both male and female ever daily smokers were significantly more likely to have quit smoking if they had a history of daily snus use. The quit rate was almost equal (71–72%) for men and women with a history of snus use. Male primary snus users were significantly less likely than non-snus users to initiate smoking and male primary daily smokers were significantly more likely to quit smoking if they then initiated daily snus use. As with other survey studies, observed associations are not necessarily causal. Also, the accuracy of our description of tobacco use pathways is dependent on the accuracy of the participants' memory of their tobacco use history. As the survey was not focused exclusively on tobacco, only a relatively small number of questions could be asked on this subject. Consequently additional information (such as the quantity of tobacco used by participants or their number of quit attempts) was not available. Despite these limitations, it is difficult reconcile these findings (and those of others)^{9–11 18–20} with concerns that snus use may stimulate initiation of smoking or that those groups who have quit smoking in Sweden are separate from those who have taken up snus.² While the association between use of snus as a smoking cessation aid and success in quitting smoking may not be causal, it is impressively consistent across the sexes, age groups, and levels of education. However, randomised trials will be necessary to test the efficacy of snus as a smoking cessation aid.

The concern that snus use reduces cessation of smoking is frequently associated with an assumption that combined use of snus and cigarettes is very common.² The present study demonstrates that this is not the case. Our finding of 2% dual daily use in males and 0% in women is also consistent with the findings of the Northern Sweden study¹¹ finding of 2% and 2% dual daily use in men and women, respectively. Among the 1108 men who reported that they had made an attempt to stop smoking, 649 had quit completely, 166 of them having used snus as a cessation aid. Therefore, 26% of male ex-smokers in this analysis of cessation procedures quit smoking with the help of snus. This is consistent with

What this paper adds

During recent decades smoking rates have fallen sharply, while use of snus (Swedish moist snuff) has increased in Swedish men. This has raised questions about the potential role of snus in reducing smoking.

This study has, for the first time in a nationwide representative sample of the Swedish population, identified the course and frequencies of different individual pathways of tobacco use from initiation to the current status. Less than 10% of male daily smokers started smoking after age 22, whereas a third of snus users started after age 22. An analysis of these patterns indicates that primary snus use is associated with a decreased probability of starting smoking and that secondary snus use in smokers is associated with an increased probability of successful cessation of smoking.

This study also examined the use of various cessation aids, and compared the outcomes. This analysis indicates that among Swedish men, snus is the most commonly used smoking cessation aid and a higher proportion of men who use snus are successful in quitting smoking as compared with men using other cessation aids.

another Swedish study²⁰ which found that 29% of male ex-smokers had used snus to quit.

So why might snus be effective in reducing smoking? One of the likely factors is its relatively efficient nicotine delivery. Snus is capable of delivering boosts of venous blood nicotine of over 10 ng/ml within 10–15 minutes, and users can achieve levels of over 30 ng/ml with repeated use. These nicotine values are comparable with those from smoking, and are approximately double those typically achieved by current nicotine replacement products.^{21–22} Another likely factor is that those who use snus for smoking cessation tend to use it for a long time. In the present study 76% of those who had successfully used snus as a single smoking cessation aid were still using it at the time of the survey, as compared with only 12% of those who had successfully used NRT to quit smoking. The long term use of snus as a nicotine maintenance and smoking relapse prevention product is probably an additional reason for its potential effectiveness (relative to short term use of low dose NRT) as an aid to smoking cessation.

It is likely that other factors contribute to the ability of snus to reduce smoking in Sweden, and some of these may not easily transfer to other countries. Snus has a long history (over a century) in Sweden, and the Swedes (as the inventors of nicotine replacement therapy²³) have a keen appreciation of the role of nicotine in tobacco addiction and the rationale for switching to less harmful forms of nicotine dependence.

The main lesson from the epidemiology of tobacco use in Sweden would appear to be that if the public is offered a notably less harmful high-nicotine smokeless product with or without tobacco, it can be used either as a short term cessation aid or as a lifestyle product (like coffee, energy drinks or cigarettes), and that significant sections of the population will select it over cigarettes and use it long term instead of smoking. This has implications for the optimal regulation of current and future nicotine replacement therapies,^{24–25} which currently compete with tobacco for market share at a great disadvantage (medications are more expensive, sometimes requiring a doctor's prescription, are only for short term use, and have numerous contraindications).

In conclusion, the present study has added to existing evidence showing that use of snus in Sweden is associated with a reduced risk of becoming a daily smoker and an increased likelihood of stopping smoking.

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Competing interests: LR owns shares in Pfizer Inc, and both he and JF have done paid consultancy work for Pfizer Inc and other agencies involved in public health. LR has periodically been employed as short term consultant with WHO and JF has provided testimony for plaintiffs in law suits against tobacco companies. None of the authors has received any financial support from the tobacco industry.

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