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## **Snus and snuff use in Switzerland among young men: are there beneficial effects on smoking?**

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## **ABSTRACT**

### **Introduction**

There are few recent longitudinal studies on smokeless tobacco products (SLT) and smoking outside the United States or European Nordic countries. The present longitudinal study tests whether Swedish type snus and nasal snuff use decreases smoking incidence and prevalence in a central European country.

### **Methods**

The sample consisted of 5,198 Swiss men (around 20 years of age). Retention rate was 91.5% over 15 months. Regression models, adjusting for a variety of psychosocial, smoking-related, and other risk factors, assessed whether no, low (<weekly) and high (weekly+) use baseline groups showed changes or maintenance in snus and snuff use related to smoking initiation, cessation, and reduction.

### **Results**

Among baseline non-smokers, snus initiators (OR=1.90, p=.003) and low baseline maintainers (OR=4.51, p<.001) were more likely to start smoking (reference: persistent non-users of snus). Among baseline smokers, initiators (OR=2.79, p<.001) and low baseline maintainers (OR=2.71, p=.005) more often continued smoking, whereas snus quitters less frequently continued smoking (OR=0.57, p=.009). High baseline maintainers were non-significantly less likely to continue smoking (OR=0.71, p=.315). Among continuing smokers, only snus quitters significantly reduced the number of cigarettes smoked per day (b=-1.61, p=.002) compared to persistent non-users of snus. Results were similar for snuff.

### **Conclusions**

SLT use did not have any significant beneficial effects on young men in Switzerland, but significantly increased the likelihood of smoking initiation and continuation, independent of whether the substance is legally sold (snuff) or not (snus). This does not exclude that there may be beneficial effects at older ages.

## **IMPLICATIONS**

Our research provides evidence that SLT use has no benefits for cigarette smoking initiation, cessation or reduction among young men in a central European country, where SLT is not highly promoted or receives tax incentives. This is true for both legally sold nasal snuff and Swedish type snus that cannot be legally sold. Results indicate that without incentives for using it, among young people shifts from smoking to SLT use are questionable, and confirms the need for country-specific studies before the global public health community engages in promoting smokeless tobacco.

## INTRODUCTION

Due to the increased pressure by public health authorities to reduce smoking, the tobacco industry has promoted numerous products that seem to be less harmful, such as “light” cigarettes.<sup>1</sup> More recently, electronic cigarettes (e-cigarettes) were patented as a cigarette substitute to help smokers quit,<sup>2</sup> and quickly became popular.<sup>2,3</sup> This has created a heated debate on the pros and cons of e-cigarette use.<sup>4-6</sup> Other smokeless tobacco (SLT) products, such as dipping tobacco (moist snuff), Swedish snus or nasal snuff have currently received less attention. Recent reviews claimed that the existing literature is outdated and focused on the United States and Nordic countries in Europe.<sup>7,8</sup> Therefore, the evidence whether SLT use encourages cessation or reduced smoking is not compelling.<sup>9</sup> The present study looks at the association between cigarette smoking and SLT (Swedish type snus and nasal snuff) use among young men in Switzerland. E-cigarettes have been analysed separately in another study using the same cohort.<sup>10</sup>

Smokeless tobacco products, although not free of health risks, do not carry the same risks as combustible, smoked tobaccos and may be a less harmful alternative.<sup>9,11,12</sup> The increase in snus use, predominantly in Nordic countries such as Sweden or Norway, is purported to have contributed to lower smoking rates and reduced tobacco-related mortality.<sup>13-15</sup> Critics have countered that decreases in smoking are mainly related to tobacco control initiatives and probably not due to snus use, since age groups having the highest increases in snus use have the lowest quitting rates among smokers.<sup>16</sup> The observation in Scandinavia could not be confirmed in the United States; one of a few non-Nordic countries with long availability of SLT.<sup>17</sup> The authors therefore recommended that country-specific studies are needed before the global public health community engages in promoting smokeless tobacco as a way to increase smoking cessation rates.

One of the crucial questions is whether SLT is a gateway to smoking or a help away from smoking,<sup>18</sup> particularly among young people.<sup>1</sup> However, the gateway effect may apply only to a small minority, since most SLT users either never began smoking, or began prior to using SLT.<sup>19</sup> It is important to distinguish between studies on young people and general population surveys of all ages.

Older people might start using tobacco by smoking, then attempt to quit by using SLT, whereas younger people might start with SLT, then experiment with conventional cigarettes, leading to dual use or cigarettes only.<sup>20</sup> The potential for SLT to act as an aid for smoking cessation in older populations, after years of heavy smoking and higher levels of nicotine dependence, might not have an equivalent mechanism in younger people.<sup>21</sup>

Furthermore, SLT use as an aid to smoking cessation is debated. Popova and Ling<sup>22</sup> found numerous attempts to quit among SLT users, with little indication of successful cessation. Randomized trials on SLT use for smoking cessation found few long-term benefits.<sup>23,24</sup> SLT is sometimes used in addition to cigarettes to provide nicotine in situations where smoking is forbidden, such as in public places.<sup>20</sup> SLT use may actually reinforce smoking, and the dual use may make it even more difficult to quit.<sup>25</sup>

### **Snus use in Nordic countries**

Most studies on adolescents and young adults stem from Nordic countries. In Norway, a three-year-follow up study among more than 1,000 16-year-old males showed increased odds of becoming dual users among baseline snus only users compared with no tobacco users or non-smokers.<sup>15</sup> Dual users were more likely to become smokers only than were snus only users. The authors concluded that snus use may facilitate smoking.

Galanti et al.<sup>26</sup> analysed nearly 3,000 11-year-old children in Sweden with 4 annual follow-ups. Despite the great availability of snus in Sweden, 69.5% of tobacco users started by smoking cigarettes, 11.2% by using snus, and 19.3% by using snus and cigarettes during the same year. Cigarette starters were not significantly more likely than snus starters to be smokers by the end of follow-up, but mixed starters were more likely to be smokers than the other two starter groups. This indicated that starting with snus does not prevent later smoking compared to starting with cigarettes, and even increased smoking in follow-up among dual users.

Finland, like Switzerland, has a sales ban on oral snuff like snus, but has easy access to snus via Sweden or Norway. Here, 7th graders were followed for 3 years.<sup>27</sup> Experimentation with oral moist snuff predicted later weekly smoking. Despite the fact that many snus users were active in sports and presumed to be less likely to smoke for health reasons, fewer than 10% of snus users had never smoked cigarettes by the end of follow-up.

### **SLT use in the US**

Studies in Nordic countries may not be comparable to situations in other countries, because of unique historical and cultural factors associated with SLT use.<sup>17</sup> For example, snus use has a long history of over a century in Sweden,<sup>28</sup> and prices were commonly lower due to lower taxes for snus than for cigarettes.<sup>17</sup>

Tomar found that males aged 12-18 who were not smokers at baseline but regularly used SLT products had a more than three-fold increase in smoking 4 years later, compared with never-users of such products.<sup>29</sup> O'Connor et al.<sup>30</sup> re-analysed the same dataset taking into account a number of well-known psychosocial factors shown to be related to smoking onset or initiation. The Odds Ratios (OR) of Tomar<sup>29</sup> for regular SLT use were halved and became non-significant after adjustment. Similarly, Timberlake et al.<sup>31</sup> showed that among middle and high school students, a crude significant increase in smoking among SLT users became non-significant after propensity matching on a number of demographics, smoking-related exposures (e.g. smoking parents), and other risky behaviours (cannabis use, binge drinking or not using seat belts). Thus, third variables may be responsible for both the uptake of smoking and SLT use. However, even after adjusting for similar confounders other authors found that adolescent and young adult SLT users were more likely to initiate smoking than were non-SLT users.<sup>32,33</sup> Nevertheless, Rodu et al.,<sup>34</sup> have shown that once nicotine use starts, SLT initiators may be less likely than cigarettes only or dual (in the same year) initiators to become current smokers. The study did not compare non-smoking SLT users to non-smoking, non-SLT users, hence did not directly answer the question whether SLT use versus no use is a risk factor for future smoking.

## **Hypotheses for Swedish snus and nasal snuff use in Switzerland**

The present research compares the use of nasal snuff which can be legally bought in shops in Switzerland and is the most widely used SLT product with a 12-month prevalence of 24% among young men in Switzerland<sup>35</sup> together with Swedish type snus (9%), which cannot be sold in Swiss shops but can be legally imported on an individual basis.<sup>36</sup>

Since there is little evidence outside the United States or the European Nordic countries, the following two-tailed hypotheses were tested in Switzerland.

- 1) Among baseline non-smokers, SLT use (snus and snuff) is differentially associated with smoking initiation compared to non-use of SLT.
- 2) Among baseline smokers, SLT use is differentially associated with smoking cessation compared to non-use of SLT.
- 3) Among baseline smokers who continue to smoke at follow-up, SLT use is differentially associated with smoking reduction compared to non-use of SLT.

## **METHODS**

### **Study design and participants**

Data of the present study come from the Cohort Study on Substance Use Risk Factors (C-SURF) of participants enrolled in army recruitment centres during one year. Determination of eligibility for military or civil service is mandatory for young males. Virtually all males at age 20 must report to army recruitment centres, except those who are severely mentally or physically disabled. Enrolment was in three of six army centres, encompassing 21 of the 26 Swiss cantons. Although enrolment began in the centres, the research was entirely independent of the army. Questionnaires in French or German according to the respondents' language were sent to the home addresses of recruits via email with an individual link to an online questionnaire, though participants could request a paper and



pencil version. The research protocol (15/07) has been approved by the ethics committee for clinical research of Lausanne University Medical School.

A total of 7,556 participants gave their written consent, and 5,987 (79.2%) of these completed a baseline questionnaire between September 2010 and March 2012. A follow-up questionnaire was completed by 5,479 (91.5%) baseline responders between March 2012 and January 2014. The length of the follow-up was 15 months on average, but could slightly vary depending on the number of reminders needed to receive the completed questionnaires. After listwise deletion of missing values, the final analytical sample consisted of 5,198 respondents.

Details of the enrolment procedure and nonparticipation rates have been presented in a previous study.<sup>37</sup> Briefly, differences between respondents, non-respondents and non-consenters were commonly small and were in different directions. For example, respondents were more often alcohol users (93.7%) compared with the total population (92.6%). However, respondents were less likely to smoke (37.8%) and to use cannabis (32.5%) compared to the total population (46.2% vs 34.3%), respectively.

### **Main independent and dependent measures**

Snus and nasal snuff use frequency was assessed in the past 12 months with a 7-point response format ranging from never to daily, coded into frequent (weekly or more often), infrequent (less often than weekly) and no use in the past 12 months. Pictures of SLT were provided to help respondents distinguish between Swedish type snus (pouches) and nasal snuff. A longitudinal use pattern variable for snus and snuff was constructed, indicating whether non-users, infrequent, or frequent users at baseline continued using at follow-up. Because only 6.7% (n=8) of frequent snus users and 12.2% (n=24) of frequent snuff users at baseline stopped use at follow-up, we combined frequent and infrequent baseline users of snus and frequent and infrequent baseline users of snuff when they stopped use at follow-up. Also rare were baseline infrequent users who became frequent users, since most of them either continued infrequent use or stopped completely. Therefore we

combined separately for snus and snuff infrequent and frequent users at follow-up. Thus, the following groups were created: 1) no use at both baseline and follow-up (persistent non-users), 2) no use at baseline, but use at follow-up (initiators), 3) frequent/infrequent use at baseline but no use at follow-up (quitters), 4) infrequent use at baseline and continued use at follow-up (low baseline maintainers) and 5) frequent use at baseline and continued use at follow-up (high baseline maintainers).

For smoking, participants were asked at baseline and follow-up whether they had smoked cigarettes in the previous twelve months, and how often and how many on typical smoking days. They were grouped as non-smokers, occasional (less than daily) smokers, and daily smokers. The number of cigarettes smoked per day was also recorded.

### **Adjustment variables**

As the smoking-SLT-use link may be confounded by other substance use (binge drinking, cannabis), risky or deviant behaviours (e.g. physical fights, non-use of seatbelts), smoking norms, or predisposing factors (e.g., depressive symptoms, impulsivity), we attempted to adjust for as many baseline variables as have been used in prior literature<sup>30-33</sup>.

Frequency of three **delinquent behaviours** (conflicts with police/authorities, arguments or fights, and causing property damage) was assessed in the past 12 months, ranging from never, 1-2 times to 10 times or more. Items originally stem from USA college surveys making explicit mention of alcohol attribution,<sup>38</sup> but herein were asked without reference to substance use in order to avoid predictor-criterion contamination.<sup>39</sup>

Frequency of baseline **cannabis use** in the past 12 months was re-coded into three categories (at least weekly, less than weekly, and no use) to provide a measure of risky use. Frequency of **binge drinking** in the past 12 months, i.e. drinking 6 or more standard drinks on an occasion (comparable to the 5+ measure with 12 grams per standard drink) was dichotomized into binge drinking at least monthly and less than monthly or never.

**Aggressive personality trait** was assessed with the 10-item scale in the short form of the Zuckerman-Kuhlman Personality Questionnaire (ZKPQ-50-cc).<sup>40</sup> Participants indicated the endorsement of 10 dichotomous statements (e.g., *When I get mad, I say ugly things; I can't help being a little rude to people I do not like*), resulting in a score ranging from 0-10.

**Depressive symptomatology** was assessed with the Major Depressive Inventory (MDI), a screening instrument with 10-items on a 6-point scale, ranging from never to all the time.<sup>41</sup> The MDI was used to measure depressive symptomatology and not as a dichotomous diagnostic tool, thus a total score for the severity of symptoms from 0 (no depression) to 50 (extreme depression) was computed.<sup>41</sup>

**Sensation seeking** was measured using the 8-item Brief Sensation Seeking Scale (BSSS).<sup>42</sup> A mean score across all items ranging from 1 (strongly disagree) to 5 (strongly agree) was computed.

**Norm perception** of smoking by others was measured with the question “What do you think, what percent of young men your age smoke cigarettes?” ranging from 0 to 100. An association with own smoking has been shown within the C-SURF sample.<sup>43</sup>

As stated in e-cigarettes research,<sup>5</sup> **nicotine dependence** may have a particular impact on the effectiveness as an aid for smoking cessation. This was adjusted, using the continuous score of the Fagerström Test for Nicotine Dependence,<sup>44</sup> ranging from ‘no symptoms of dependence’ (0) to ‘high number of symptoms of dependence’ (10).

Finally, it was adjusted for the **sociodemographic variables** age, linguistic region (French vs. German-speaking), and the perceived financial situation of parents compared with the average in Switzerland (below average income, average income and above average income) at baseline.

## **Statistical analysis**

Chi-squared tests for nominal variables and analysis of variance for continuous variables were used to assess baseline differences between non-users, infrequent (less than weekly) and frequent (weekly or more often) users of snus and snuff. Changes in prevalence rates of smoking status (non-

smokers, occasional smokers and daily smokers) were descriptively and unadjusted related to changes in snus and snuff use, and then tested in logistic regression models (unadjusted and adjusted). Initiation of smoking was tested for baseline non-smokers, and smoking continuation (versus cessation) was tested for baseline smokers. Additionally, among consistent smokers at both waves, changes in the number of cigarettes smoked from baseline to follow-up were estimated with ordinary least squares (OLS) regression. The difference measure was distributed sufficiently normal and allowed an easy interpretation of changes in number of cigarettes smoked per day.

## RESULTS

Baseline users of snus (9.1% of the sample) or snuff (23.5% of the sample) differ from non-users (see supplementary table S1) in several significant ways. For example, they were more likely to binge drink or use cannabis, had higher sensation seeking and aggressive personality scores, and less depressive symptomatology (among snuff users). They were also more likely to engage in deviant behaviours, such as property damage, arguments or fights, or problems with the police. Users of snus and snuff also had higher nicotine dependence scores.

Table 1 describes unadjusted changes in cigarette smoking status from baseline to follow-up for persistent non-users (snus and snuff), quitters, initiators, and low and high maintainers of SLT use. Of the daily smokers at baseline, 6.7% became non-smokers at follow-up if they persistently did not use snuff, and 2.5% of daily smokers at baseline became non-smokers if they initiated snuff use. Tables 2-4 display the results of the appropriate statistical tests (see supplementary tables S2-4 for the same models showing adjustment variables).

In adjusted models of smoking initiation by baseline non-smokers (Table 2), snus and snuff quitters did not differ in smoking initiation rates from persistent non-users. Those initiating snus (OR =1.90,  $p=.003$ ) or snuff use (OR=3.09,  $p<.001$ ) or maintaining snus or snuff use with low use at baseline (OR=4.51,  $p<.001$  for snus, OR =2.18,  $p<.001$  for snuff), were significantly more likely to initiate smoking by follow-up. High baseline SLT maintainers did not differ significantly from persistent

non-users in initiating smoking, but showed, in the case of snus, non-significantly reduced risk of smoking initiation (OR=0.68, p=.418). Adjusting for potential confounders mitigated the effects of the unadjusted analyses somewhat, but commonly did not change any levels of significance, except for high baseline snuff use maintainers, whose initiation rates of smoking became non-significant (OR=1.85, p=.070).

Baseline smokers who stopped SLT use during follow-up (Table 3) were less likely to continue smoking compared to persistent non-users of SLT (OR =0.57, p=.009 for snus; OR =0.66, p=.016 for snuff). Initiators of snus (OR=2.79, p<.001) or snuff (OR=1.88, p=.004) were more likely to continue smoking than were persistent non-users, as were low baseline maintainers (OR=2.71, p=.005 for snus; OR=1.48, p=.031 for snuff). High baseline maintainers did not differ significantly from persistent non-users of SLT, but showed, in the case of snus, non-significantly reduced risk for continued smoking (OR=0.71, p=.315). Significance levels did not change when models were adjusted; an exception being low baseline snuff maintainers, who were more likely to continue smoking in the adjusted model.

Table 4 shows that, when compared to persistent non-users of SLT, consistent smokers differed in number of cigarettes smoked only among SLT quitters. Snus quitters smoked about 1.6 cigarettes per day fewer than did persistent non-users (b = -1.61, p=.002); unadjusted changes were +.81 cigarettes for persistent non-users and -.83 cigarettes for quitters. Snuff quitters reduced smoking by about 1 cigarette per day fewer than persistent non-users (b = -.99, p = .008; unadjusted changes were +.66 for persistent non-users and -.27 for quitters).

## **DISCUSSION**

To our knowledge, the present research is one of the few longitudinal studies on SLT use in Europe outside the Nordic countries.<sup>7,9</sup> Following our hypotheses, we found that:

- 1) Among baseline non-smokers, SLT initiators and low baseline maintainers were more likely to start smoking. SLT quitters and high baseline maintainers did not differ on smoking initiation, compared to persistent non-users of SLT.
- 2) Among baseline smokers, SLT initiators and low baseline maintainers more often continued smoking. In comparison, SLT quitters less often maintained their smoking habit. High baseline maintainers did not differ on smoking continuation, compared to persistent non-users of SLT.
- 3) Among consistent smokers, only those stopping SLT use significantly reduced the number of cigarettes smoked per day between baseline and follow-up.

Overall, our findings indicated there were no significant beneficial effects from use of SLT on smoking initiation, cessation or reduction for those either initiating or maintaining SLT use. There were significant detrimental effects among SLT initiators and low baseline maintainers on smoking initiation and cessation. However, for those stopping SLT use, the effects on smoking cessation and reduction attempts were beneficial. These findings are consistent with numerous studies among young people in Nordic countries<sup>15,26,27</sup> and in the USA.<sup>29,32,33</sup> It has been argued that a lack of beneficial effects may be due to differences between SLT users and non-users in psychosocial factors, smoking related exposures, and other risk taking behaviours.<sup>30,31</sup> Nonetheless, even after extensive statistical adjustments for these factors, the findings were only partly mitigated (but essentially unchanged), despite significant differences in confounding variables between SLT users and non-users. This strengthens our findings that the increased odds of smoking initiation and the decreased odds of smoking cessation are mainly due to SLT use and not confounding.

There were differences between persistent non-users and SLT maintainers, depending on whether their use was infrequent (less often than weekly) or frequent (weekly or more often). Low baseline maintainers were different from persistent non-users as regards smoking outcomes, but not high baseline maintainers. This may indicate that there are two distinct types of “dual users”. There may be one group of infrequent users who complement smoking in situations where cigarettes are not allowed.<sup>20</sup> This dual use may actually make it more difficult to quit smoking.<sup>22,25</sup> There may also be

another group who actually attempt to cut down or quit smoking by using SLT frequently. High baseline maintainers for snus showed non-significantly reduced risks for smoking reduction and cessation, whereby non-significance may be due to the low prevalence of snus users in Switzerland and may have reached significance in countries with higher use prevalence rates. Beneficial effects might be observed best among daily or near daily SLT users. This hypothesis could be investigated by creating similar research paradigms as for e-cigarette use, since it has been suggested that daily e-cigarette users are more likely to have recently quit smoking and that most youthful e-cigarette users are infrequent users.<sup>45</sup>

Unfortunately, in our data, daily or near daily use was too rare to conduct separate analyses. Only 1.3% (n=69) were daily or near daily snus users at baseline and 0.9% (n= 48) were snuff users at baseline. There were 0.9% (n=49) with daily or near daily snus use at both baseline and follow-up, and 0.25% (n=13) daily or near daily snuff maintainers. Thus, even if there were beneficial effects from daily SLT use, this relationship would apply only to a small minority of users in Switzerland.

We expected differences between “illegal” snus (legal to use, but not to sell in Switzerland) and legal snuff. Swedish-type snus might be predominantly used in Switzerland because ice hockey is popular here, and snus is used to imitate certain behaviours of hockey players in North America and in Nordic countries.<sup>46</sup> Snus use played some role in active sports in the present sample,<sup>46</sup> but we could not find differential effects of snus and snuff use. This supports the findings of Haukkala et al.,<sup>27</sup> that even among snus users active in sports, very few of them do not smoke.

It should be noted that (legal) snuff use was far more prevalent (23.5%) than was snus use (9.1%). This could be due to easier availability, but could also be the result of snuff use having a long tradition of being a popular substance in central Europe, which includes Switzerland.<sup>35,47</sup> Even with greater availability of legal snuff, it was not easier to reach goals of smoking cessation or reduction. Clearly, our results must be interpreted in the light of differences in the so-called smoking epidemic and the historical popularity of SLT in Nordic countries.<sup>28</sup> For example snus use prevalence rates are much higher in Norway and Sweden compared to Switzerland,<sup>14,48</sup> and may therefore be a culturally

more acceptable means for smoking cessation. Thus, snus users in Switzerland may be qualitatively different from snus users in countries where its use is more common. The prevalence of daily smoking in this sample at baseline was 19.3% (Table 1), which is much higher than prevalence rates among 15-24 year old men in Sweden (7.6%) or Norway (5.9%).<sup>49</sup> This may mean that in Switzerland the smoking epidemic has not yet reached a stage, in which SLT use to reduced or quit smoking has become an important alternative.

This research contains several caveats. First, the sample consists entirely of young men, around age 20. Thus, the study cannot be generalized to older people, many of whom may have decades-long smoking histories, and who consider SLT use to be a way out of smoking.<sup>21</sup> However, randomized trials on SLT use and smoking cessation reveal few long-term benefits from SLT use,<sup>23,24</sup> and the restriction to men is not unique to the present study. Many other studies have excluded women because they rarely use SLT.<sup>15,21,26,27,33</sup>

A second caveat is that use of these products was assessed in the past 12 months at follow-up. This was done to have a comparable recall period with other measures in C-SURF. Thus, for dual use initiation during follow-up, we do not know which came first, SLT use or conventional cigarette smoking. However, we do know (for the majority of baseline non-smoking SLT users) that the likelihood of becoming smokers was higher than for persistent non-users of SLT, independent of whether they already were users (low baseline maintainers) or initiators of SLT use. Similarly, with the past 12-months assessment maintainers may be misclassified if they have already stopped their behaviour at the time of the follow-up interview. Also, respondents may be wrongly labelled as initiators when they used SLT before the 12-months baseline assessment and restarted use at follow-up.

### **Conclusion:**

SLT use did not have any beneficial effects on young men in Switzerland, but was probably detrimental, independent of whether the substances are sold legally (snuff) or not (snus). Whether sustained and frequent SLT use can produce beneficial effects in a relatively small group of people



deserves further study. For example, the increases in daily snus use were accompanied by strong reductions in the smoking prevalence in Norway or Sweden suggesting a beneficial impact of snus.<sup>14,48</sup> Randomized trials have shown short-term effects of snus use for smoking cessation that were similar to nicotine replacement therapies<sup>50</sup>, and beneficial compared with placebo<sup>24</sup> or counselling,<sup>23</sup> but generally no long term effects. From a public health perspective in Switzerland, under the current regulation of SLT products and the high smoking prevalence, SLT cessation seems a more likely means of lessening the burden from smoking than does continued SLT use.

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## **DECLARATION OF INTERESTS**

I, Gerhard Gmel, declare for all authors that there is no conflict of interest. All authors have had full access to all of the data in the study and took responsibility for the integrity of the data and the accuracy of the data analysis. The manuscript was not reviewed by the funding agency (SNSF) prior to submission, and is not under review—and will not be under review—by another publication whilst it is being considered by *Nicotine & Tobacco Research*.

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Table 1. Descriptive changes in smoking status by snus and snuff use between baseline and follow-up

Baseline smoking	Follow-up smoking	Snus					Snuff				
		Persistent non-users	Quitters	Initiators	Low baseline maintainers	High baseline maintainers	Persistent non-users	Quitters	Initiators	Low baseline maintainers	High baseline maintainers
Non-smokers	n	2535	42	142	38	46	2130	116	290	205	62
	Non-smokers	87.2%	83.3%	75.4%	52.6%	84.8%	89.2%	87.1%	72.1%	74.6%	77.4%
	Occasional	11.1%	14.3%	21.8%	36.8%	15.2%	9.3%	9.5%	24.8%	22.4%	21.0%
	Daily	1.7%	2.4%	2.8%	10.5%	0.0%	1.5%	3.4%	3.1%	2.9%	1.6%
Occasional smokers	n	1036	86	140	89	44	650	183	189	295	78
	Non-smokers	22.2%	33.7%	8.6%	10.1%	27.3%	22.6%	32.2%	13.2%	15.3%	20.5%
	Occasional	60.8%	57.0%	74.3%	76.4%	54.5%	59.8%	55.2%	70.4%	67.8%	66.7%
	Daily	17.0%	9.3%	17.1%	13.5%	18.2%	17.5%	12.6%	16.4%	16.9%	12.8%
Daily smokers	n	787	54	86	60	13	594	109	120	151	26
	Non-smokers	6.0%	11.1%	3.5%	1.7%	0.0%	6.7%	5.5%	2.5%	4.6%	3.8%
	Occasional	9.3%	9.3%	10.5%	8.3%	23.1%	9.3%	15.6%	8.3%	7.3%	7.7%
	Daily	84.8%	79.6%	86.0%	90.0%	76.9%	84.0%	78.9%	89.2%	88.1%	88.5%

*Note.* Never users: neither use at baseline nor follow-up; Initiators: no use at baseline, but follow-up use; Quitters: mostly infrequent (and very rarely frequent) user at baseline, but no use at follow-up; Low baseline maintainers: infrequent use at baseline and continued use at follow-up; High baseline maintainers: frequent use at baseline and continued use at follow-up.



Table 2. Initiation of smoking at follow-up of baseline non-smokers by snus and snuff use changes between baseline and follow-up

	Unadjusted models				Adjusted models*			
	b	SE	Odds Ratio	p-value	b	SE	Odds Ratio	p-value
<b>Snus</b> (reference: Persistent non-users)								
Quitters	0.37	0.42	1.44	.383	-0.07	0.43	0.94	.879
Initiators	0.78	0.21	2.18	<.001	0.64	0.21	1.90	.003
Low baseline maintainers	1.86	0.33	6.44	<.001	1.51	0.35	4.51	<.001
High baseline maintainers	0.13	0.44	1.13	.778	-0.39	0.48	0.68	.418
<b>Snuff</b> (reference: Persistent non-users)								
Quitters	0.24	0.29	1.27	.407	0.03	0.30	1.03	.932
Initiators	1.17	0.15	3.21	<.001	1.13	0.15	3.09	<.001
Low baseline maintainers	1.04	0.18	2.82	<.001	0.78	0.19	2.18	<.001
High baseline maintainers	0.97	0.33	2.63	.003	0.62	0.34	1.85	.070

*Note.* b = coefficient of association; SE = standard error of b. Persistent non-users: neither use at baseline nor follow-up; Initiators: no use at baseline, but follow-up use; Quitters: mostly infrequent (and very rarely frequent) users at baseline, but no use at follow-up; Low baseline maintainers: infrequent use at baseline and continued use at follow-up; High baseline maintainers: frequent use at baseline and continued use at follow-up. \*Adjustment for age, linguistic region, perceived parental financial situation, depressive symptomatology, aggressive personality, sensation seeking, cannabis use, binge drinking, having had problems with the police or authorities, arguments or fights, having caused property damage, and perceived tobacco norms.

Table 3. Continuation of smoking among baseline smokers by snus and snuff use changes between baseline and follow-up

	Unadjusted models				Adjusted models*			
	b	SE	Odds Ratio	p-value	b	SE	Odds Ratio	p-value
<b>Snus</b> (reference: Persistent non-users)								
Quitters	-0.62	0.21	0.54	.003	-0.57	0.22	0.57	.009
Initiators	0.90	0.28	2.46	.001	1.03	0.28	2.79	<.001
Low baseline maintainers	1.00	0.35	2.72	.004	1.00	0.36	2.71	.005
High baseline maintainers	-0.41	0.33	0.66	.211	-0.34	0.34	0.71	.315
<b>Snuff</b> (reference: Persistent non-users)								
Quitters	-0.52	0.16	0.59	.001	-0.41	0.17	0.66	.016
Initiators	0.53	0.21	1.70	.013	0.63	0.22	1.88	.004
Low baseline maintainers	0.28	0.17	1.32	.102	0.39	0.18	1.48	.031
High baseline maintainers	-0.07	0.28	0.93	.808	0.15	0.30	1.16	.619

*Note.* b = coefficient of association; SE = standard error of b. Persistent non-users: neither use at baseline nor follow-up; Initiators: no use at baseline, but follow-up use; Quitters: mostly infrequent (and very rarely frequent) users at baseline, but no use at follow-up; Low baseline maintainers: infrequent use at baseline and continued use at follow-up; High baseline maintainers: frequent use at baseline and continued use at follow-up. \*Adjustment for age, linguistic region, perceived parental financial situation, depressive symptomatology, aggressive personality, sensation seeking, cannabis use, binge drinking, having had problems with the police or authorities, arguments or fights, having caused property damage, perceived tobacco norms, and nicotine dependence scores.

Table 4. Changes in number of cigarettes smoked among continuing smokers by snus and snuff users from baseline to follow-up

	Unadjusted models			Adjusted models*		
	b	SE	p-value	b	SE	p-value
<b>Snus</b> (reference: Persistent non-users)						
Quitters	-1.64	0.52	.002	-1.61	0.51	.002
Initiators	0.89	0.38	.019	0.67	0.38	.078
Low baseline maintainers	-0.21	0.46	.640	-0.41	0.46	.368
High baseline maintainers	-0.11	0.78	.885	-0.33	0.77	.662
<b>Snuff</b> (reference: Persistent non-users)						
Quitters	-0.93	0.38	.014	-0.99	0.38	.008
Initiators	0.55	0.35	.116	0.29	0.34	.395
Low baseline maintainers	0.69	0.31	.024	0.42	0.31	.177
High baseline maintainers	1.09	0.57	.057	0.58	0.58	.314

*Note.* b = coefficient of association; SE = standard error of b. Persistent non-users: neither use at baseline nor follow-up; Initiators: no use at baseline, but follow-up use; Quitters: mostly infrequent (and very rarely frequent) users at baseline, but no use at follow-up; Low baseline maintainers: infrequent use at baseline and continued use at follow-up; High baseline maintainers: frequent use at baseline and continued use at follow-up. \*Adjustment for age, linguistic region, perceived parental financial situation, depressive symptomatology, aggressive personality, sensation seeking, cannabis use, binge drinking, having had problems with the police or authorities, arguments or fights, having caused property damage, perceived tobacco norms, and nicotine dependence scores.