



Factors associated with initiation and use of snus among adolescents

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3 **Factors associated with initiation and use of snus among**
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Abstract

Aim. We investigated factors associated with initiation and continuation of snus use in adolescents in Norway. The associations with adolescents' own educational plans, the parents' educational level(s) and tobacco habits were estimated. *Methods.* In this cross-sectional questionnaire-based study, 1465 patients aged 18–20 years participated. The questionnaire was administered at regular dental examinations in the Public Dental Service. To assess the association between individual factors and initiation of tobacco habits, a generalized structural equation model with random effects at the clinic level was used. Binary responses were modeled using multilevel binary logistic regression, while the number of snus boxes used per month were modeled using a multilevel Poisson regression model. *Results.* Of current (daily and occasional) tobacco users, 85% were snus users, including dual users of both snus and cigarettes. Median age of snus initiation was 16 years. Both parental snus use and smoking were associated with increased risk of snus initiation, snus use, and higher amount of use. An increased risk of using snus was associated with male gender and with no educational plans or planning for further vocational education. Amount of snus used was higher among current snus users with a prior smoking history and among those planning for further vocational educations. *Conclusion* These findings may aid in developing and targeting tobacco prevention strategies aimed at young people. Tobacco prevention measures should start at the elementary school level. The strong association with parental tobacco habits underlines the importance of parents' influence on their children's tobacco use.

Key words (MeSH): Adolescents, Tobacco, Smokeless, Snus, Smokers, Health Risk Behaviors, Educational status, Parents, Social Class, Norway.

Introduction

The consumption of snus, a moist and smokeless tobacco product, has increased in Norway over the last 20 years [1]. The largest increase has been seen among young adults, with a higher increase for women than for men in the past decade. Snus is now the predominant tobacco product used among young people in Norway. It may be too early to draw conclusions, but the prevalence of daily snus use seems to have leveled off at about 25% in young men and 15% in young women (16–24 years) [1]. Adolescents in lower secondary school had an overall low prevalence of tobacco use (2–5%), but in upper secondary school, snus use increased to 12% among girls and 19% among boys. These levels of tobacco use among adolescents have remained stable for the last few years [2]. Nevertheless, high levels of snus use are concerning, since it primarily involves high, prolonged nicotine levels, with accompanying dependence in users as well as a number of adverse health outcomes [3].

Norway, Sweden, and Finland are the European countries with the highest prevalence of snus use among adolescents and young adults [4, 5]. Snus retail is banned in the European Union (EU), except for Sweden [6], but no such ban is in place in Norway, a non-EU member state. Conducting the current study in Norway provides an opportunity to investigate factors relevant to starting and continuing to use alternative tobacco products, such as snus.

Few and contradictory results are available on potential associations between snus/smokeless tobacco use and the educational level of the parents, as well as with the educational ambitions/educational track of adolescents in the period of life when initiation of snus use commonly occurs. However, several studies have shown associations between low socioeconomic status (SES) and cigarette smoking among adolescents and adults [7, 8]; furthermore, both adolescent and adult snus users are reported to share many of the same risk factors as smokers, albeit to a lesser extent [9, 10]. In line with these findings, a study from Norway found that both snus use and occasional smoking had weaker associations with educational ambitions, family SES, and single parenthood than daily smoking among pupils 15–16 years old (in Norway, in their last year of lower secondary school) [11].

Compared to non-users of tobacco, a lower level of academic education reached by parents [12] and a lower proportion of adolescents planning for a university degree have been reported among

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3 snus users [9, 12]. However, one study reported that higher educational level was associated with less
4 smoking among adolescents, while this was not observed for snus use [13]. A study with adolescents
5 in Norway reported less daily snus use but more daily smoking among adolescents growing up in low-
6 income families compared to high-income families [14]. A Finnish study found that adolescents
7 following a vocational education had an increased risk of both snus use and smoking [15].
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13 The present research investigated tobacco use in the age group 18–20 years in a cross-sectional
14 clinical- and questionnaire-based study. The main aim of the present study was to investigate factors
15 associated with initiation and continuation of snus use in adolescents in Norway, with a focus on
16 participants' educational plans along with the tobacco habits and academic educational levels of the
17 parents. This knowledge may contribute to better and more targeted prevention strategies regarding
18 adolescents' snus use.
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29 **Methods**

30 **Study population**

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32 The present study is a cross-sectional study among 18–20-year-olds visiting public dental health clinics
33 in the southeastern region of Norway, recruited between October 2015 and December 2016. Nine dental
34 clinics, both urban and rural, were included. The counties involved were Hedmark, Oppland, Østfold,
35 and Oslo (as they were named before the county administration reform in 2020).
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43 All residents in Norway aged 20 years and younger are offered regular dental examinations and
44 treatment in the public dental health service (PDS) in Norway. The service is free of charge for the age
45 group 0–18 years, while the group aged 19–20 years has a 75% discount. All patients in the age group
46 18–20 years who visited the clinics during the recruitment period were invited to participate in the study
47 concurrent with their regular dental examination in the PDS. Consent was obtained via a form when
48 participants completed the survey. The sample was not randomized but rather based on age and
49 affiliation to the selected clinics (quota sample).
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3 A total of 1899 participants were recruited to the study; this constituted approximately 43% of all
4 patients aged 18–20 years under the supervision of the participating clinics in 2016. Of the total 1899
5 individuals, 1465 were included in the analysis: those not included were 49 participants who did not
6 show up to their scheduled appointment, 135 who refused to participate in the study, 245 who did not
7 fill in the questionnaire and 5 who delivered incomplete responses. The gender distribution was
8 approximately equal, at 49% male participants and 51% female participants. The adolescents were either
9 following vocational education (19.3%) or a specialization in general studies (50.9% university-
10 preparing studies), or did not attend or had just finished upper secondary school (29.8%).

21 **Questionnaire and description of included variables**

22 The questionnaire was only available in Norwegian and consisted of three parts: background
23 characteristics (including socioeconomic factors), oral hygiene habits (not included in this publication),
24 and tobacco habits. The data was collected using the web-based software Easy Research, a Questback
25 product from <https://www.questback.com/no/>. The study was approved by the Regional Committee for
26 Medical Research Ethics (2015/445).

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33 Background characteristics included gender, socioeconomic factors, present educational course
34 or future educational plans (upper secondary school, further vocational education, university/college, no
35 plans), parents' tobacco habits (smoking: yes/no; snus use: yes/no), and parents' completed education
36 levels (elementary school, upper secondary school, university/college). Questions on adolescents'
37 tobacco habits included current and previous use of tobacco products (for details, see Figure 1), the
38 dosage of their tobacco use (number of snus boxes per month, number of cigarettes per week and per
39 month), how often they used cigarettes and snus (occasionally, daily), and how old they were when they
40 began to use a tobacco product. Current snus use and smoking combined daily and occasional use.
41 Current dual use was defined as daily or occasional use of both snus and cigarettes. Dual users were
42 asked whether they first started using snus, cigarettes, or both at the same time. Previous use was defined
43 as previous daily or occasional use of snus and/or cigarettes. The number of portions/pinches in each
44 box of snus may vary across different brands but are usually in the range of 18–24 portions per box, and
45 the dose (in mg/tobacco per portion) may also vary across different snus brands. In addition, users may
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3 use different snus brands simultaneously or over time; therefore, the number of boxes were used as a
4 proxy for the amount of snus used.
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7 The questionnaire was face-validated by experts in the field and pre-tested by three adolescents
8 who were not included in the analysis.
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10 11 12 **Statistical analyses**

13 14 **Characteristics of study participants**

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16 To describe sociodemographic and snus-user characteristics among the study participants, we used
17 descriptive statistics in the form of frequencies and percentages (Figure 1 and Supplementary Table 1).
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20 21 22 **Description of Table 1 (Generalized structural equation model)**

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24 We aimed to explore the relationship between the relative risk of snus and cigarette use/initiation among
25 the participants (outcome measure) and their educational plans, as well as the relationship between
26 use/initiation and their parents' education levels and tobacco habits. For this, we used a generalized
27 structural equation model (GSEM) with random effects at the clinic level. Estimates of relative risk
28 ratios (RRR) obtained from this model indicate an increase in the risk of being in the comparison group
29 relative to the risk of being in the referent group for values of RRR > 1 and vice-versa for values of RRR
30 < 1. We presented both the unadjusted and adjusted model results from the analyses of the data, which
31 used StataSE 16. The significance level was set at $\alpha = 0.05$.
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43 44 **Description of Table 2 (Modeling binary responses)**

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46 Binary responses relating to whether the respondents did or did not use snus were collected from
47 participants at the nine different locations (clinics). Due to the clustered nature of the data, a traditional
48 binary logistic regression model, which assumes independence of observations, was deemed
49 inappropriate. Therefore, we chose a binary logistic model with random effects at the clinic level to
50 account for the variability in responses between the clinics. We also obtained an estimate of the intra-
51 cluster correlation coefficient (ICC), which measures the amount of variability in the response variable
52 that is attributable to differences between the clusters (clinics). An ICC estimate of 0.017 was obtained
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3 from the logistic regression model on snus use, indicating that differences between the clinics (locations)
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5 account for 1.7% of the variability in snus use.
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8 **Description of Table 3 / Figure 2 (Modeling number of snus boxes used)**

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10 The Poisson regression is the basic model for modeling count data, and it assumes that the mean and the
11 variance of the response variable are equal, a relationship called equidispersion. However, the data on
12 counts, or numbers, of snus boxes used in a month were over-dispersed, with the variance being larger
13 than the mean. Moreover, these data were clustered within clinics. Therefore, we extended the Poisson
14 regression model by introducing random effects at the clinic level. Estimates of incidence rate ratios
15 (IRR), which indicate an increase or decrease in the number of snus boxes used in a month, were
16 obtained from the models. Specifically, IRR estimates that were significantly > 1 showed increases in
17 the number of snus boxes used in one month, whereas IRR estimates that were significantly < 1 showed
18 decreases in the number of snus boxes used in one month.
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29 **Modeling strategies**

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31 Two steps preceded the modeling of both binary and count data. First, univariate (unadjusted) multilevel
32 logistic and Poisson models were fitted to the data. Second, we used adjusted the models based on
33 covariates with $P \leq 0.20$ from the univariate analyses. We selected and reported the best models using
34 the Bayesian information criterion (BIC), which states that among competing models, a model with the
35 smallest BIC is considered the better/best fit. Missing information regarding the parents' educational
36 level reduced the total number of participants in the analysis where this variable was included. All
37 analyses were performed using StataSE 15, and the significance level was set at 5%. The numbers from
38 the adjusted analysis are presented in the text below and in Tables 1–3.
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Results

Tobacco habits

The distribution of tobacco habits among the 1465 included participants (18–20 years) is shown in Figure 1. They are categorized into nine different groups based on their current and previous tobacco habits.

Factors associated with initiation of tobacco use

The median age of initiation—defined as starting to use a tobacco product without any previous use of tobacco—was approximately 16 years. Of those reporting which tobacco product they first started using, approximately 72% started with snus, and 28% started with cigarettes. The GSEM showed that the risk of starting with snus was 44% higher for participants who were planning further vocational education, and 69% higher for participants without any educational plans, both compared to those who were planning a university/college education. The equivalent proportions for smoking initiation were 85% and 65%, respectively (Table 1). For participants with either no plans or plans for further vocational education, approximately 59% had never used snus, while the corresponding share of those planning university/college education was 72% (calculated from Supplementary Table 1).

The educational level of the father was not associated with whether the adolescents started with snus or smoking; however, a borderline lower risk for snus initiation was observed for participants whose mothers had only elementary school-level education. If one or both parents were snus users, the relative risk of starting with snus was 83% higher compared to those whose parents had no tobacco habits. However, parental snus use did not affect smoking initiation among participants. In addition, we observed that if one or both parents were smokers, the relative risk of starting with snus increased by 67%, and the risk for smoking increased twofold, compared to those with non-smoking parents (Table 1).

Factors associated with the use of snus

In the binary logistic regression model, increased odds of current snus-only use was observed for male participants, for participants with no plans for education, and for those planning further vocational education. No significant associations were found between the education level of the parents and current snus-only use (Table 2). For participants with either no educational plans or plans for further vocational education, 30% and 34.8% used snus, respectively; of those planning university/college education 21.5% used snus. With the prevalence restricted to current snus users who never smoked, the corresponding numbers are 17.5%, 19.4%, and 13.8% (calculated from Supplementary Table 1).

The highest odds ratio was observed for the association between parental tobacco use and current snus-only use in participants. This association applied to both snus use and smoking among the parents (Table 2).

Factors associated with the number of snus boxes used

For the three user groups—current snus users and never-smokers, current snus users and former smokers, and dual users—the average number of snus boxes used in a month were approximately 8, 9, and 7, respectively (Figure 2). Higher number of snus boxes used in a month was observed for participants with plans for further vocational education or participants with a previous smoking history. In addition, the highest incidence rate ratio observed with higher amount of snus used was parental tobacco use (Table 3).

Discussion

In the first decade after the millennium, a decline in smoking coinciding with an increase in snus use was described among adolescents in Norway [9, 13, 16]; in the second decade, the prevalence of both kinds of tobacco use was relatively stable in this age group [2]. The current study investigated factors associated with three measures—initiation of snus, current snus use, and the amount of snus used—among Norwegian adolescents. About one-third of the participants were current or previous users of a tobacco product, and a majority of the current tobacco users were snus users, which is comparable to

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3 national data from Norway. All three of our measures were associated with parents' tobacco use and
4 with adolescents' educational plans.
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7 An association between snus use and having a non-academic plan for further education was
8 previously reported among 15–16-year-olds in a Norwegian school-based study as well as in a study
9 from Sweden. However, in both studies, the association was weaker than the one with smoking [11, 12].
10 An association between smoking and snus use among adolescents and a non-academic oriented
11 education was also reported in a Finnish study [15], and smokeless tobacco use was observed to be
12 associated with less than high school education among US young adults [17].
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20 In contrast to these studies and our findings, another study reported no significant difference in
21 educational level between young snus users and non-users, using self-reported current school class or
22 other main activity in two Norwegian samples in 2004 and 2007 [13]. These discrepancies may relate
23 to changes in the prevalence of tobacco use over time, as well as to differences in the composition of
24 the tobacco user groups analyzed. Thus, differences in educational orientation in relation to snus use
25 may have become more pronounced in later studies than in the first studies on snus use in Norway. This
26 is in line with the observed differences regarding educational plans for both initiation and continuation
27 of snus use in our study.
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36 The causality between planning or choosing a non-academic educational track and tobacco use
37 can be questioned, as tobacco use is often initiated before the educational track is chosen. However,
38 tobacco use and the future or chosen educational track may share influencing factors. In line with this,
39 a longitudinal study using ability score as a proxy for general cognitive ability at the age of 11 showed
40 that high-ability groups were negatively associated with later tobacco smoking [18]. In addition, a cross-
41 sectional study from Finland observed an association between lower ability score and use of snus,
42 compared to non-users of tobacco [19]. The ability score was used by the Finnish defense forces to
43 measure general ability and logical thinking.
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54 We observed higher levels of current snus use among those planning further vocational
55 education than among those planning university studies. For current snus use, the observed difference
56 in snus use between the two educational tracks became more pronounced for current snus use not
57 restricted to never smokers than among the pure snus-only users. This finding supports the weaker
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3 association observed between educational level and snus users than that between educational level and
4 smokers. Causal factors associated with initiation and use of tobacco are complex, and many factors can
5 affect children before they start experimenting with tobacco products, as discussed by Maralani [20].
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7 These factors were not investigated in the present study.
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11 Similar to the current results, another Norwegian study observed no associations between the
12 parents' educational level and snus use, but did observe a lower parental educational level for smokers
13 [9]. In contrast, a study from Sweden reported a higher prevalence of snus use to be associated with a
14 lower parental education level [12]. Such differences may be due to the recruitment of groups with
15 different SESs at various time points during the increase in snus use prevalence. Our study found no
16 clear associations between the parents' level of education initiation of either use of snus and cigarettes
17 or use of snus. However, we observed an association between the participants' further plans for
18 education and snus use. Indirectly, this finding may be linked to the parents' level of education, as a
19 higher parental education level has been associated with an increased motivation for higher education
20 in their offspring [21]. A similar association between parents' level of education and participants'
21 educational plans was also found in our data (data not shown).
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35 Parental tobacco habits have been shown to affect their progeny's tobacco habits [22]. A meta-
36 analysis showed that parental smoking increased the risk for smoking initiation among adolescents [23]
37 and may also act as a proxy for parental SES [24]. As parental tobacco habits may influence initiation,
38 it has also been reported that attenuation or cessation of parental smoking reduced smoking initiation in
39 their offspring [22]. The association between parental tobacco habits and adolescents' use of snus is less
40 clear; however, a Swedish study reported that paternal use of snus did increase the risk for snus use but
41 not smoking among male adolescents [25]. In line with these findings, we observed that parental tobacco
42 habits, both snus use and smoking, were associated with all three measures of adolescent snus use:
43 initiation, current use, and amount used. Thus, parents likely act as role models for their offspring.
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54 Early initiation of use of tobacco products been observed to be an important predictor for future
55 use of the product [26]. Thus, an important finding in the present study is that 19% of those who ever
56 used tobacco had quitted all tobacco use. Although these participants may later start using tobacco again,
57 it shows that quitting is possible and not unusual at this age. In the past decade, smoking has largely
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3 decreased among both middle and high school students in Norway. Among the youngest students in
4 middle school, snus use has also decreased in recent years, and currently only 2–3% are tobacco users.
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7 However, upon high school initiation, the use of snus increases [2].
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10 The number of snus boxes consumed per month was lowest for dual users (7 boxes), higher for
11 current snus users who never smoked (8 boxes), and highest for current snus users who were previous
12 smokers (9 boxes). An 87% higher snus consumption rate was previously reported for exclusive snus
13 users compared to dual users [27]; this large difference was not observed in the present study. In
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In addition, the most prevalent user combination for dual users was daily use of snus combined with
occasional smoking; daily smoking combined with either daily or occasional snus use was only observed
for approximately 10% of the dual users. The finding that dual use of snus and smoking is usually a
combination of daily use of one product and occasional use of the other product has been observed in
prior work [28]. It could be speculated that the small difference in the number of snus boxes used may
be related to an increased nicotine content in the snus products that are offered on the market today [29].
Thus, the nicotine dose delivered is higher compared to previously available products, and thus
additional smoking may not be necessary to achieve a comparably high dose of nicotine.

The current study included approximately 40% of all the patients aged 18–20 years under the
supervision of the participating clinics in the year 2016. Nevertheless, one strength of our study is its
population-based design in a clinical setting. The sample mainly included patients summoned for a recall
examination; however, some patients may have been recruited when visiting the dental clinic due to an
acute oral health issue. Given the organization of the public dental health service in Norway, and that
our population covers both rural and urban areas, we assume that our study population is representative
of the general population of this age group.

Lifestyle factors, biological factors, and socioeconomic factors are known to affect dental caries
risk. In the Nordic countries, dental caries prevalence in the population has generally declined in recent
decades; however, a parallel polarization of caries prevalence has been observed [30]. High caries
experience (decayed, missed, filled, teeth; DMFT > 9) in the participating counties in the present study
ranged from 3.8–6.2% for those aged 18 years [31]. The snus use prevalence is approximately 21% for

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3 men and 17% for women of this age [32]; thus, we believe that dental caries experience, as a proxy for
4 oral health, had a small impact on participant selection in our study.
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7 The study participants were attending upper secondary school, following vocational education,
8 specializing in general studies, or had just finished school. Members of latter group may just have
9 finished school or may be dropouts: we do not have a more detailed information regarding these
10 participants, which is a weakness of our data.
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15 The primary weakness of our study is the cross-sectional design, wherein all information is
16 collected at one point in time. The information is also self-reported, which may have led to
17 underreporting of both the participants' and the parents' tobacco use and over-reporting of educational
18 ambitions, in line with socially desirable behavior. Most likely, however, the parents' education levels
19 and the tobacco habits were established prior to initiation of tobacco use by the adolescents. It may be
20 more justified to question whether the educational plans of the adolescents were established before or
21 after the establishment of their tobacco habits. While the data were collected in 2016, the prevalence of
22 snus use has more or less remained stable since then; thus, we believe that our data are still
23 representative.
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34 Overall, parents' tobacco use and further vocational education or lack of educational plans were
35 associated with the highest risk for snus initiation, snus use, and amount of snus used among the
36 participants. The knowledge on the SES of young snus users in Scandinavia is scant; few studies have
37 addressed the educational plans of adolescents in relation to their snus use, or the relation between
38 parents' education levels and adolescents' snus use. The present study found a strong association
39 between the tobacco use of parents and the tobacco use of their offspring. Tobacco prevention strategies
40 and measures should start early and are especially important as new tobacco and nicotine products
41 emerge on the market. This study contributes to a better understanding of the factors associated with the
42 early initiation and continuation of snus use and may aid in developing and targeting tobacco prevention
43 strategies for young people. Tobacco prevention measures should start at the elementary school level.
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Figure legends:

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45 Figure 1: Tobacco habits of the participants
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48 Figure 2: Average number of snus boxes used per month depending on user configuration
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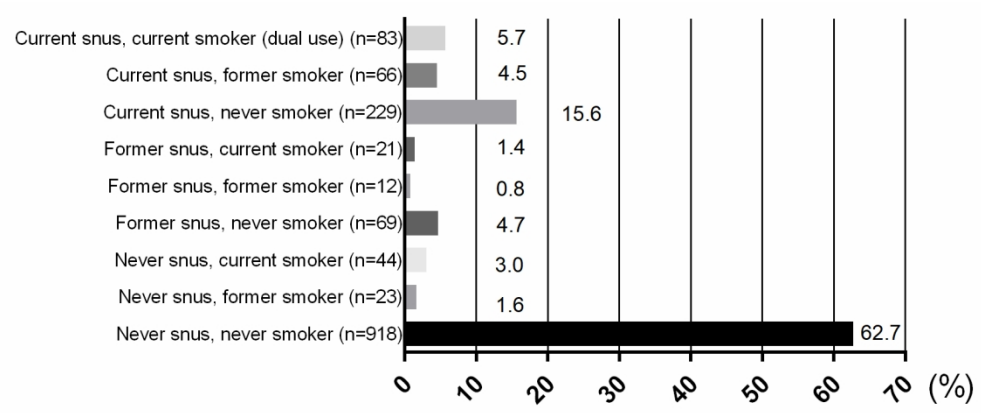


Figure 1: Tobacco habits of the participants

152x65mm (300 x 300 DPI)

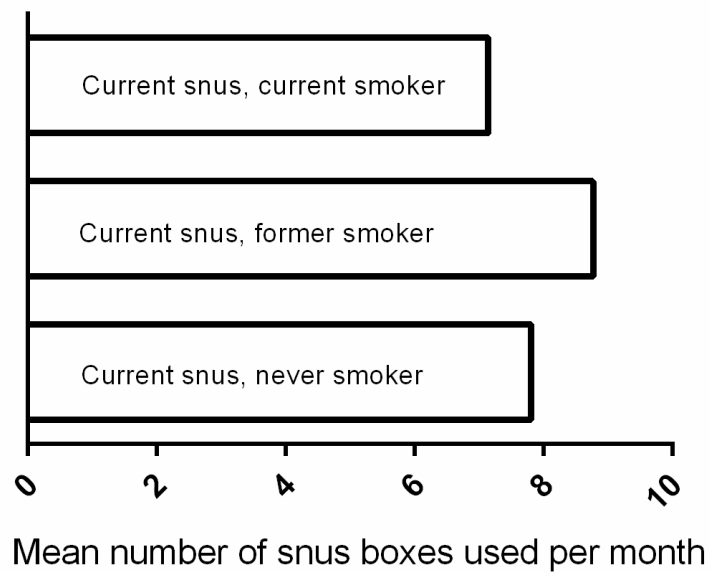


Figure 2: Average number of snus boxes used per month depending on user configuration

118x72mm (300 x 300 DPI)

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Table 1. Relative risk of snus and cigarette initiation, according to own education plans, parents' educational level and the tobacco habits of the parents. RRR (CI).¹

Covariates	Started with snus				Startet with cigarettes			
	Unadjusted		Adjusted		Unadjusted		Adjusted	
	RRR (95% CI)	P-value	RRR (95% CI)	P-value	RRR (95% CI)	P-value	RRR (95% CI)	P-value
Educational plans (ref: University/ college)								
Further vocational education	1.63 (1.18, 2.26)	< 0.01	1.44 (1.02, 2.03)	0.04	2.06 (1.32, 3.20)	< 0.01	1.85 (1.17, 2.93)	0.01
No plans/ do not know	1.75 (1.29, 2.37)	< 0.01	1.69 (1.23, 2.32)	< 0.01	1.76 (1.13, 2.74)	0.01	1.65 (1.04, 2.62)	0.03
Education, mother (ref: University/college)								
Elementary school	0.72 (0.44, 1.18)	0.19	0.60 (0.37, 1.00)	0.05	0.95 (0.48, 1.88)	0.88	0.72 (0.36, 1.44)	0.35
Upper secondary/ vocational	1.11 (0.86, 1.45)	0.42	0.92 (0.70, 1.22)	0.56	1.41 (0.97, 2.05)	0.07	1.09 (0.73, 1.63)	0.67
Education, father (ref: University/college)								
Elementary school	1.09 (0.68, 1.75)	0.71	-	-	1.08 (0.53, 2.07)	0.84	-	-
Upper secondary/ vocational	1.10 (0.84, 1.44)	0.50	-	-	1.08 (0.72, 1.61)	0.71	-	-
Parents smoking status (ref: No)								
Yes (one or both)	1.82 (1.40, 2.37)	< 0.01	1.67 (1.26, 2.20)	< 0.01	2.01 (1.45, 3.04)	< 0.01	2.05 (1.40, 3.02)	0.01
Parents snus status (ref: No)								
Yes (one or both)	2.05 (1.52, 2.76)	< 0.01	1.83 (1.35, 2.48)	< 0.01	0.87 (0.52, 1.46)	0.60	0.75 (0.44, 1.28)	0.29

¹ The relative risk ratios (RRRs) are obtained from a generalized structural equation model (GSEM) with clinic random effects. Covariates with P ≤0.20 in the univariate analyses were used in the adjusted models.

Table 2. Factors associated with current snus only use (versus no tobacco use). The independent variables are listed in the first column. OR (CI).¹

Covariates	Unadjusted		Adjusted	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Gender (ref: Female)				
Male	1.46 (1.12, 1.91)	0.01	1.36 (1.02, 1.80)	0.03
Education plans (ref: University/college)				
Further vocational education	1.84 (1.31, 2.59)	< 0.01	1.53 (1.05, 2.23)	0.03
No plans/do not know	1.61 (1.15, 2.26)	0.01	1.46 (1.02, 2.07)	0.04
Education,mother (ref: University/ college)				
Elementary school	0.67 (0.39, 1.15)	0.15	0.60 (0.32, 1.11)	0.10
Upper secondary/ vocational	0.97 (0.73, 1.29)	0.84	0.80 (0.59, 1.09)	0.15
Education,father (ref: University/ college)				
Elementary school	0.95 (0.55, 1.62)	0.84	-	-
Upper secondary/ vocational	1.09 (0.82, 1.47)	0.55	-	-
Parents smoking status (ref: No)				
Yes (one or both)	1.95 (1.47, 2.59)	< 0.01	1.79 (1.33, 2.42)	< 0.01
Parents snus status (ref: No)				
Yes (one or both)	2.05 (1.49, 2.83)	< 0.01	1.82 (1.31, 2.54)	< 0.01

¹ The odds ratios (ORs) are obtained from a binary logistic model. Covariates with $P \leq 0.20$ in the univariate analyses were used in the adjusted models.

Table 3. Factors associated with the amount of snus boxes used in a month among all snus users (current snus use and current dual use). The independent variables are listed in the first column. IRR (CI).¹

Covariates	Unadjusted		Adjusted	
	IRR (95 % CI)	P-value	IRR (95 % CI)	P-value
Gender (ref: female)				
Male	1.05 (0.98, 1.13)	0.19	1.05 (0.98, 1.14)	0.19
Education plans (ref: University/college)				
Further vocational education	1.25 (1.14, 1.37)	<0.01	1.13 (1.03, 1.24)	0.01
No plans/ do not know	1.17 (1.07, 1.28)	<0.01	1.09 (1.00, 1.20)	0.06
Smoking habits (ref: Never smoked)				
Previous smoker	1.16 (1.05, 1.28)	<0.01	1.13 (1.02, 1.24)	0.02
Daily and occasional smoker	0.91 (0.83, 0.99)	0.05	0.87 (0.79, 0.95)	<0.01
Parents tobacco habits (ref: No habits)				
Snus (one or both)	1.26 (1.16, 1.36)	<0.01	1.20 (1.11, 1.30)	<0.01
Smoking (one or both)	1.47 (1.37, 1.59)	<0.01	1.43 (1.32, 1.54)	<0.01

¹ The incidence rate ratios (IRRs) are obtained from an extended Poisson regression model with clinic random effects. Covariates with $P \leq 0.20$ in the univariate analyses were used in the adjusted models. Factors associated with increased use are shown as $IRR > 1$.

Supplementary material

Statistical analyses

Characteristics of study participants

To describe socio-demographic- and snus-user characteristics among the study participants we used descriptive statistics in the form of frequencies and percentages. Tests of associations between tobacco habits (outcome variables), the categorized socio-demographics and the life style factors of the parental generation were determined from Chi-square tests of association (figure 1 and supplementary table 1).

Description of table 1 (Generalized structural equation model)

We aimed at exploring the relationship between the participants' education plans, their parents' level of education, tobacco habits with the outcome measure that identifies what the participants started with, snus or smoking. For this, we used a generalized structural equation model (GSEM) with random effects at clinic level. Estimates of relative risk ratios (RRR) obtained from this model, indicates an increase in the risk of the outcome being in the comparison group relative to the risk of the outcome being in the referent group for values of $RRR > 1$ and vice-versa for values of $RRR < 1$. We presented both the unadjusted and adjusted model results from the analyses of the data using StataSE 16. The significance level was set at $\alpha = 0.05$.

Description of table 2 (Modeling binary responses)

Binary responses relating to whether the respondents used snus or not were collected from participants at the nine different locations (clinics). Due to the clustered nature of these data, the traditional binary logistic regression model, which assumes independence of observations, is rendered inappropriate. Therefore, we considered a binary logistic model with random effects at clinic level to account for the variability of the responses between the clinics. We also obtained an estimate of intra-cluster correlation coefficient (ICC), which measures the amount of variability in the response variable attributable to differences between the clusters (clinics).

Description of table 3/Figure 2 (Modeling number of snus boxes used)

The Poisson regression is the basic model for modeling count data and it assumes that the mean and the variance of the response variable are equal, a relationship called equi-dispersion. However, the data on counts of snus boxes used in a month were over-dispersed with the variance being larger than the mean.

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3 In addition, these data were clustered within clinics. Therefore, we extended the Poisson regression
4 model by introducing random effects at clinic level. Estimates of incidence rate ratios (IRR), which
5 indicate the increase or decrease in the number of snus boxes used in a month were obtained from the
6 models. In particular, IRR estimates that were significantly > 1 showed an increase in the number of
7 snus boxes used in one month whereas IRR estimates that are significantly < 1 showed decreases in the
8 number of snus boxes used in a month.
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15 **Modeling strategies**

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17 Two steps preceded the modeling of both binary and count data; first, univariate (unadjusted) multilevel
18 logistic and Poisson models were fitted to the data. We considered adjusted models based on covariates
19 with $P \leq 0.05$ and $P \leq 0.20$ in the univariate analyses. However, gender was included in the models as a
20 relevant variable. In addition, we fitted full models to these data. We selected and reported the best
21 models using the Bayesian Information criterion (BIC). The BIC states that among competing models,
22 a model with the smallest BIC is considered a better fit. All analyses were performed using StataSE 15
23 and the significance level was set at 5%.
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		Scandinavian Journal of Public Health									
Totals		Never snus, never smoker	Current snus, never smoker	Current snus, former smoker	Current snus, current smoker	Former snus, never smoker	Former snus, former smoker	Former snus, current smoker	Never snus, current smoker	Never snus former smoker	
1											
2											
3	N = 1465	n = 918	n = 229	n = 66	n = 83	n = 69	n = 12	n = 21	n = 44	n = 23	
4	n (%)										
5	Education plans										
6	No plans/ do not know	303 (100%)	166 (54,8)	53 (17,5)	15 (5,0)	23 (7,6)	23 (7,6)	2 (0,7)	7 (2,3)	12 (4,0)	2 (0,7)
7	Further vocational education	273 (100%)	149 (54,6)	53 (19,4)	19 (7,0)	23 (8,4)	12 (4,4)	0 (0)	4 (1,5)	6 (2,2)	7 (2,6)
8	University/college	889 (100%)	603 (67,8)	123 (13,8)	32 (3,6)	37 (4,2)	34 (3,8)	10 (1,1)	10 (1,1)	26 (2,9)	14 (1,6)
9	Participants currently attending high school										
10	None	436 (100%)	232 (53,2)	81 (18,6)	24 (5,5)	32 (7,3)	27 (6,2)	3 (0,7)	11 (2,5)	18 (4,1)	8 (1,8)
11	Vocational	283 (100%)	168 (59,4)	48 (17,0)	17 (6,0)	20 (7,1)	16 (5,7)	2 (0,7)	1 (0,4)	6 (2,1)	5 (1,8)
12	General education/ studies	746 (100%)	518 (69,4)	100 (13,4)	25 (3,4)	31 (4,2)	26 (3,5)	7 (0,9)	9 (1,2)	20 (2,7)	10 (1,3)
13	Education, mother										
14	Elementary school	132 (100%) *	94 (71,2)	13 (9,8)	6 (4,5)	7 (5,3)	6 (4,5)	2 (1,5)	1 (0,8)	2 (1,5)	1 (0,8)
15	Upper secondary/ vocational	581 (100%) *	346 (59,6)	91 (15,7)	23 (4,0)	47 (8,1)	33 (5,7)	5 (0,9)	7 (1,2)	21 (3,6)	8 (1,4)
16	University/college	737 (100%) *	471 (63,9)	122 (16,6)	34 (4,6)	28 (3,8)	29 (3,9)	5 (0,7)	13 (1,8)	21 (2,8)	14 (1,9)
17	Education, father										
18	Elementary school	122 (100%) **	77 (63,1)	18 (14,8)	3 (2,5)	9 (7,4)	8 (6,6)	2 (1,6)	0 (0)	3 (2,5)	2 (1,6)
19	Upper secondary/ vocational	675 (100%) **	421 (62,4)	112 (16,6)	30 (4,4)	40 (5,9)	36 (5,3)	4 (0,6)	6 (0,9)	20 (3,0)	6 (0,9)
20	University/college	570 (100%) **	364 (63,9)	86 (15,1)	27 (4,7)	23 (4,0)	23 (4,0)	5 (0,9)	11 (1,9)	18 (3,2)	13 (2,3)
21	Parents smoking status										
22	One of the parents	352 (100%)	193 (54,8)	66 (18,8)	21 (6,0)	27 (7,7)	19 (5,4)	2 (0,6)	7 (2,0)	9 (2,6)	8 (2,3)
23	Both parents	91 (100%)	36 (39,6)	19 (20,9)	9 (9,9)	13 (14,3)	3 (3,3)	2 (2,2)	3 (3,3)	5 (5,5)	1 (1,1)
24	None of the parents	1022 (100%)	689 (67,4)	144 (14,1)	36 (3,5)	43 (4,2)	47 (4,6)	8 (0,8)	11 (1,1)	30 (2,9)	14 (1,4)
25	Parents snus status										
26	One of the parents	247 (100%)	129 (52,2)	59 (23,9)	13 (5,3)	21 (8,5)	13 (5,3)	1 (0,4)	4 (1,6)	5 (2,0)	2 (0,8)
27	Both parents	13 (100%)	6 (46,2)	4 (30,8)	1 (7,7)	1 (7,7)	1 (7,7)	0 (0)	0 (0)	0 (0,0)	0 (0)
28	None of the parents	1205 (100%)	783 (65,0)	166 (13,8)	52 (4,3)	61 (5,1)	55 (4,6)	11 (0,9)	17 (1,4)	39 (3,2)	21 (1,7)

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Supplementary table 1: Background characteristics of the participants

*4 in total for all groups, 15 missing values, ** in total for all groups, 98 missing values. Missing information regarding the educational level of the parents may be due to that the parents did not know.

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