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Progression of oral snuff use among Finnish 13–16-year-old students and its relation to smoking behaviour

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ABSTRACT

Aims To examine the progression of oral moist snuff use among adolescents and its relation to smoking behaviour and nicotine addiction. **Design and setting** A 3-year smoking prevention study in 27 schools of Helsinki, Finland, starting with the seventh grade to the ninth grade. **Participants and measurements** Pupils ($n = 2816$) completed questionnaires four times, which included information on smoking behaviour, snuff experiments, nicotine addiction (Fagerström Tolerance Questionnaire) and other activities. **Findings** The prevalence of snuff experimentation rose among boys from 7% in the seventh grade to 43% 3 years later in the ninth grade, and among girls from 2% to 13% for the corresponding period. Among boys, smoking predicted later snuff use in all assessments and snuff experimentation predicted later weekly smoking. The impact of snuff experimentation upon later smoking experimentation was smaller than vice versa. Among boys active in sports, smoking was less common but snuff use was more common. Combined use was common; by the end of the follow-up only 10% of weekly smokers had not tried oral snuff. Nicotine dependence scores increased linearly with snuff use among weekly smokers. **Conclusions** Despite the European Union sales ban on oral snuff products since 1995, in Finland snuff use is common among boys. Although combined use of snuff and cigarettes is associated with higher levels of nicotine dependence among adolescent boys, the direction of causality is not known. Unlike cigarette smoking, oral snuff use was tried among boys who spent their free time with sports-related activities.

Keywords Addiction, adolescence, Finland, harm reduction, longitudinal, oral snuff, smokeless tobacco, tobacco, sport.

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INTRODUCTION

Recent public health discussions have considered the possibility that one oral snuff product, oral moist snuff, could be used for harm reduction in relation to cigarette smoking (Stratton *et al.* 2001; Hatsukami, Lemmonds & Tomar 2004). Although snuff use has adverse health consequences, these are clearly smaller than with cigarette smoking (Hatsukami & Severson 1999). Experiences in Sweden, which is the only country within the European Union (EU) that allows oral snuff products, have encouraged particular authors to propose the concept of harm reduction with oral snuff (Fagerström & Schildt 2003). The prevalence of snuff use is highest among Swedish males (20%), but the prevalence of smoking is low compared to many other European countries. Consequently, it is argued that this high usage of snuff compared to smoking is seen to be one cause for lower mortality in Sweden from many smoking-related diseases among males (Foulds *et al.* 2003). This statement has been questioned because smoking has decreased among Swedish females without snuff use as well, and only a small amount of males used snuff as a cessation method (Giljam & Galanti 2003). Furthermore, Henningfield & Fagerström (2001) state that the relationship between oral snuff use and cigarette smoking is complicated and, as yet, unclear. One concern regarding snuff use for harm reduction is the possibility that oral snuff products might increase smoking initiation in adolescence.

Several studies in Sweden (Wickholm *et al.* 2003), Finland (Karvonen, Rimpelä & Rimpelä 1995; Merne,

Tiekso & Syrjänen 1998) and the United States (Hatsukami *et al.* 1999; Tomar 2002) have shown that oral snuff products and cigarettes are used together and that it is only a small number who solely use oral snuff products. In relation to smoking initiation, there is the question of whether oral snuff use is a possible gateway product to cigarette smoking. Some studies conducted among adult populations have asked retrospectively if the respondents first used cigarettes or smokeless tobacco. Little over half of a small selected sample of current smokeless tobacco users had tried smokeless tobacco before cigarettes (Hatsukami *et al.* 1999). Kozlowski *et al.* (2003) and O'Connor *et al.* (2005) compared two large-scale US and one Swedish population-based studies and estimated the proportion of those who used smokeless tobacco before cigarette smoking to be small among males. One of the first prospective studies by Ary *et al.* (1987) found that smokeless tobacco use predicts cigarette smoking 9 months later among male adolescents who had not smoked cigarettes at the baseline. In another study in the United States, seventh grade experimentation with chewing gum predicts heavy smoking 6 years later (Griffin *et al.* 1999). In a larger US study young males, aged 11–19 years, who were not regular smokers at the baseline but were regular smokeless tobacco users were more likely to be regular smokers 4 years later compared to never smokers (Tomar 2003). Furthermore, smokeless tobacco use predicts cigarette smoking 1 year later among adult US military recruits (Haddock *et al.* 2001). However, Kozlowski *et al.* (2003) argue that it is only a small proportion of smokers to whom smokeless tobacco is a gateway product. Furthermore, it has been suggested that there may be common risk factors between both cigarette smoking and smokeless tobacco use (O'Connor *et al.* 2003).

Among Swedish adolescent boys, drinking and smoking have also been associated with oral snuff use and, seemingly, oral snuff use did not substitute for smoking (Galanti *et al.* 2001). In addition, studies from the United States indicate that use of other tobacco products other than cigarettes are related to a wider problem behaviour cluster (Tercyak & Audrain 2002; Gilpin & Pierce 2003). Furthermore, one special target group for smokeless tobacco product companies in the United States (Connolly, Orleans & Blum 1992) and Sweden have been athletes. In a Finnish study, oral snuff use substitutes for smoking among physically active boys compared to inactive boys, but when snuff users were compared to non-users within each group snuff users had a higher prevalence of smoking and alcohol use than non-users in the active and inactive groups (Karvonen *et al.* 1995). Karvonen *et al.* (1995) demonstrate that Finnish sports clubs had an important role in an increase in the use of oral snuff during the 1980s. They conclude that this increase occurred due to social influences through sports clubs rather than active marketing, unlike in the United States (Karvonen *et al.* 1995).

Snuff use among adolescence has been monitored in Finland every second year from 1981 (Rimpelä *et al.* 2003). The sale of oral snuff became illegal in the EU in 1995 except in Sweden. The prevalence of daily snuff use among 14- and 16-year-old adolescents was approximately 1% before 1995 but, surprisingly, usage did not decrease after the ban. In fact, oral snuff use increased after 1994, peaking in 2001 at 3.3% among 16-year-old boys (Rimpelä *et al.* 2003). In an annual school health promotion survey, 5% of ninth grade boys used oral snuff daily and 14% reported irregular use (STAKES 2001). Among the male population aged 15–64 years, 1.7% reported using it regularly in 2003, whereas the prevalence of daily smoking was 26% in the same group (Helakorpi *et al.* 2003). Among 15-year-old boys, the prevalence of daily oral snuff use was 7.2% among those who belonged to a sport club and 2.5% among those boys who did not, in 2002 (Kannas *et al.* 2002).

In Finland, there have been several cross-sectional studies of oral snuff use but no large-scale longitudinal studies, especially with adolescents. The aim of this study is to examine how experimentation with snuff use increases during lower secondary school among girls and boys. Does this experimentation with snuff predict smoking initiation or the other way around? Does smoking and oral snuff use have the same predictors? Finally, how do snuff use and combined use with cigarettes relate to nicotine addiction?

METHODS

Subjects

The subjects were part of a European smoking prevention framework approach (ESFA) study, in which one of the six participant countries was Finland (De Vries *et al.* 2003). The aim of the intervention in Finland was to effect smoking-related attitudes, norms and self-efficacy cognitions with the use of different strategies based on a social influence approach (De Vries *et al.* 2003; Vartiainen *et al.* 2004). During the 3-year period there were five lessons per year and there was also a discussion about oral snuff use during some teacher-led lessons. In Finland the study was conducted in the Helsinki city area, where 13 lower secondary schools were allocated randomly to the experimental condition and 14 other schools were treated as control schools; altogether there were 65 school classes. These schools include all lower secondary schools in Helsinki except for those schools for pupils with special needs, teacher-training schools and Swedish-speaking schools. Baseline measures were

made in all schools in September 1998, when the pupils started their seventh grade (T1). There were 2955 students in those schools at that time. Follow-ups were conducted in the eighth grade in September 1999 (T2), the ninth grade in September 2000 (T3) and the last assessment was in April 2001 at the end of ninth grade (T4). Unfortunately, two of the control schools did not participate in the last T4 assessment. Teachers distributed questionnaires to pupils in all the assessments and the students enclosed the questionnaire in an envelope when they returned the questionnaire. Because of long absences, changes to other schools and missing information in questionnaires, there were 2745 pupils at the baseline with valid information. In the third assessment (T3) there were still 2356 pupils who participated in the study (response rate 79.7%). Because of the two missing schools, in the last assessment (T4) we had 910 boys and 922 girls who offered valid information about snuff use.

Measures

Oral snuff use (snuff) was assessed with one question in all the questionnaires: 'Have you ever used oral snuff?'. The response alternatives were: never, I have used snuff once, I have used snuff 2–50 times or I have used snuff over 50 times in total. This question was adopted from the National Health Behaviour Survey (Rimpelä *et al.* 2003) in order to have comparable information. However, there were some contradictory responses from the follow-up questionnaires, in that some respondents stated their later usage was less than their earlier usage (for example, 1.1% at the T2 respondents gave contradictory responses, for T3 3.5% gave contradictory responses and for T4 2.5% gave contradictory responses). In these contradictory cases, we chose to record the respondents' highest usage claims.

Smoking status was assessed from several questions concerning smoking behaviour according to the algorithm presented in Kremers, Mudde & de Vries (2001). Pupils were categorized into (a) never smokers who had not smoked even a puff; (b) triers who had tried smoking but have not smoked monthly; (c) non-smoking deciders, who have smoked less than a week but have now decided not to smoke; (d) experimenters who have smoked more than one in a month but not more than 100 cigarettes; (e) regular users who smoked at least weekly; and (f) quitters, who have quit smoking after having smoked at least weekly. For the purposes of analysis, we created three groups from this variable by comparing never smokers (a), those who have at least tried (b, c, d, f) and current weekly smokers (e). The amount of smoking was assessed with weekly smoking according to 19 categories that measure from 0 to 70 or more cigarettes per week.

Nicotine dependence. In the last assessment (T4) we used the Fagerström Tolerance Questionnaire (FTQ) for adolescents (Prokhorov *et al.* 1996). Weekly smokers were asked to respond to six items on the original scale. One item concerning daily smoking (more than 26 cigarettes/day = 2 points, 15–25 cigarettes/day = 1 point) was not included in the questionnaire, as there were already several questions concerning weekly smoking. Instead, we gave one point to those who report highest weekly smoking (more that 70 cigarettes per week). Therefore, the mean levels of the FTQ are not comparable to studies using the original six-item scale.

We enquired about free time activities with the question: 'In which three places do you spend most of your free time?' From the list of nine places one item was sports (club, centre, swimming pool, etc.). Those who choose sports as one of the most popular places where they spend their free time were compared to others.

The school achievement grading system in Finnish schools is based on numbers between 4 and 10, where 10 is the best number and 4 is the worst, indicating that pupils have not passed that subject. The pupils reported what kind of average they had for all their school subjects from the former semester according to six groups: (a) less than 5; (b) 5–5, 9; (c) 6–6, 9; (d) 7–7, 9; (e) 8–8, 9; and (f) 9–10.

Statistical analyses

The prevalence of snuff use is displayed by gender and the differences were tested with χ^2 tests. Because so few girls used oral snuff, the following analyses were performed only among boys. Prediction of regular smoking was performed with logistic regression. Weekly smoking at T2 was predicted with snuff use at T1 and weekly smoking at T1. A similar analysis was conducted to predict oral snuff experimentation in T2 by T1 smoking and oral snuff use at T1. For other predictors in multivariate models we used intervention condition, school achievement and sport as a main hobby. Prediction of snuff use was analysed in a comparable way. We made additional analyses with logistic regression in a multivariate model. Hence, we excluded baseline smokers when predicting later smoking and baseline oral snuff tries when we predict later snuff use. Students were clustered according to 27 different schools, therefore a school variable was included in all logistic regression models in order to obtain valid confidence intervals. The confidence intervals are based on a fixed-effects model, which underestimates the standard errors of the coefficients quoted. The FTQ was addressed only in T4 for weekly smokers. In the final analysis, we compared FTQ scores between snuff use groups among weekly smokers with analysis of variance and analysis of covariance. All analyses were conducted with the SPSS 12.0 statistical program.

RESULTS

How snuff use and cigarette smoking increases among the cohort of girls and boys?

In the beginning of this study at the seventh grade, these pupils were on average 13.8 years of age and in the last assessment during the spring semesters of ninth grade, they were on average 16.3 years; 53.4% of the pupils were boys. Table 1 shows that the prevalence of oral snuff experimentation is significantly higher among boys than girls. At the baseline (T1) autumn semester of the seventh grade 7% of boys had tried oral snuff, by the autumn semester of eighth grade (T2) this has already increased to 24% and by the ninth grade it had increased to 42%. The increase in oral snuff use levelled-off between the autumn (T3) and spring (T4) semesters of ninth grade. However, there were significantly more weekly smokers among girls than boys, but the differences were not as large as for oral snuff use. Because the prevalence of oral snuff experimentation is so low among girls we conducted the following analysis only among boys in relation to oral snuff use.

Prevalence of combined use of cigarettes and oral snuff among boys

In Table 2 the percentages of combined use among boys are presented. At T1, 43.2% of those who have tried snuff are already weekly smokers. At T2, 66.2% of those who have used oral snuff over 50 times are weekly smokers and only 4.6% have never smoked cigarettes. These figures remain similar at T3, despite the fact that the prevalence of oral snuff experimentation was increasing. From another perspective, over half the weekly smokers at T1 had never tried oral snuff and only 8.9% had used it over 50 times. This percentage increased during the lower secondary school in the sense that at T3 29.3% of weekly smokers had used oral snuff over 50 times and only 18.7% of weekly smokers had never tried oral snuff (Table 2).

The impact of snuff experimentation upon later smoking and vice versa

With the logistic regression model, we predicted regular smoking at T2 with oral snuff use at T1 among boys. Because there were only few snuff users among never smokers, we compared those who had at least tried oral snuff to those who had never tried. In this logistic regression, those who had tried oral snuff at T1 had a higher risk for regular smoking at T2 {OR = 6.21 [95% confidence intervals (95% CI) 3.20–12.06]} among boys who were not regular smokers at T1. In a similar model, T2 snuff experimentation predicted weekly smoking at T3 [OR = 4.38 95% CI (2.82–6.80)]. Between T3 and T4, oral snuff tries represented a higher risk for weekly smoking [OR = 4.37 95% CI (2.44–7.82)]. In the corresponding models, boys who were regular smokers had a higher risk for oral snuff use later at T2 [OR = 7.26 95% CI (7.26–14.67)], at T3 [OR = 5.63 (2.76–11.51)], and at T4 [OR = 4.76 (2.01–11.30)]. According to population attributable risk estimates, lack of oral snuff experimentation at T2 (prevalence 24%) would decrease smoking experimentation between T2 and T3 by 14% among never smokers at T2. Conversely, lack of smoking experimentation at T2 (prevalence 53%) would decrease oral snuff experimentation by 51% between T2 and T3 among those who have not tried oral snuff at T2.

Table 1 Progression of oral snuff experimentation and smoking during lower secondary school among boys and girls.

	T1 *(7th)*		***T2*** *(8th)*		***T3*** *(9th)*		***T4***[3] *(9th)*	
	Boys	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*
Snuff use[1]								
Never	92.7	97.6	76.1	94.2	57.1	86.8	57.1	86.4
Once	4.1	1.8	9.1	3.8	11.6	7.9	11.0	8.0
2–50 times	2.2	0.3	9.5	1.9	18.3	5.1	18.1	5.0
> 50	1.1	0.3	5.3	0.2	13.1	0.3	13.7	0.5
Total (*n*)	100 (1402)	100 (1125)	100 (1251)	100 (1115)	100 (1177)	100 (1068)	100 (910)	100 (922)
Smoking[2]								
Never	59.9	61.9	47	42.8	34.2	29.2	31.6	24.5
Tried	32	27.1	35.6	33.9	36.6	36.1	35.5	38.2
Weekly	8.1	11.0	17.3	23.3	29.2	34.8	32.9	37.3
Total	100 (1454)	100 (1277)	100 (1297)	100 (1141)	100 (1218)	100 (1084)	100 (936)	100 (926)

[1]χ^2 test for gender differences $P < 0.001$ in all assessments. [2]χ^2 test for gender differences $P < 0.007$ in all assessments. [3]Two schools did not participate in this assessment.

Table 2. Oral snuff experimentation and smoking categories among boys.

	Snuff use T1 (7th)			*Snuff use T2 (8th)*			*Snuff use T3 (9th)*		
Smoking	*Never*	*Tried*[1]	*50+*	*Never*	*Tried*[1]	*50+*	Never	*Tried*[1]	*50+–*
Never	64.3	11.4	6.7	59.3	11.2	4.6	54.2	10.9	4.0
Tried[2]	30.7	45.5	26.7	34.7	42.9	29.2	36.6	39.7	30.9
Weekly	4.9	43.2	66.7	6.0	45.9	66.2	9.3	49.4	65.1
Total	100	100	100	100	100	100	100	100	100
(*n*)	(1295)	(88)	(15)	(950)	(233)	(65)	(670)	(348)	(149)
	Smoking T1 (7th)			*Smoking T2 (8th)*			*Smoking T3 (9th)*		
Snuff use	*Never*	*Tried*[2]	*Weekly*	Never	*Tried*[2]	*Weekly*	*Never*	*Tried*[2]	*Weekly*
Never	98.7	90	57.1	95.1	73.5	27.5	89.2	57.1	18.7
Tried[1]	1.2	9	33.9	4.4	22.3	51.7	9.3	32.2	52
Over 50	0.1	1	8.9	0.5	4.2	20.8	1.5	10.7	29.3
Total	100	100	100	100	100	100	100	100	100
(*n*)	(844)	(442)	(112)	(592)	(449)	(207)	(407)	(429)	(331)

[1]Includes groups of 'once' and '2–50 times'. [2]Includes groups; non-smoking, decider, quitter, trier, experimenter.

Table 3 Logistic regression models to predict oral snuff experimentation at T3 and weekly smoking at T3 with predictors from T2, among boys.

Predictors at T2	*T3 snuff experiment*[1] *(n = 1049)*	*T3 weekly smoking*[2] *(n = 1079)*
Snuff use T2		
Never tried snuff		1.00
Once tried		2.68 (1.55–4.62)
2–50 times		3.77 (2.09–6.78)
over 50 times		2.76 (1.26–6.06)
Smoking T2		
Never	1.00	
Experimenter	5.07 (3.43–7.51)	
Weekly smoking	10.03 (4.70–21.41)	
Control school	1.00	1.00
Experiment school	2.48 (0.37–16.73)	2.30 (0.29–18.06)
No active sports	1.00	1.00
Active sports	1.50 (1.04–2.15)	0.69 (0.49–0.99)
School achievement	0.77 (0.62–0.97)	0.64 (0.52–0.79)

[1]Snuff experiment at T2 in the model, OR = 85.88. [2]Weekly smoking at T2 in the model, OR = 11.79.

Do sport activities and school achievement predict smoking and oral snuff use?

With the use of logistic regression, in the following models we examined if sport as a free-time activity and school achievement similarly predict oral snuff use and weekly smoking. From Table 3 we can see how those boys who experimented with smoking or who were weekly smokers were more likely to try snuff 1 year later compared to those boys who had never smoked. There were no differences between boys from intervention schools compared to boys from control schools in relation to oral snuff experimentation. Those boys who spent more free time with sports were more likely to try oral snuff compared to others. Those who were doing better in school were less likely to try oral snuff. We confirm the results in Table 3 with analyses that include only those who had not experimented with oral snuff at T2 ($n = 809$). Results were otherwise similar to Table 3, except that free time with sports was not a significant predictor of one trying oral snuff at T3 [OR = 1.39 (0.96–2.00)]. We conducted a similar logistic regression as that in Table 3 to predict oral snuff use at T2 with the same variables as T1. The results were similar to Table 3 except that school achievement was not a significant predictor [OR = 0.84 (0.67–1.05)].

The Table 3 results also predict weekly smoking at T3. Boys in all three other oral snuff groups were more likely to become weekly smokers at T3 compared to those who had never used oral snuff. Boys in the experimental schools were as likely to be weekly smokers at T3 as boys in the control schools. Those who were doing better at school achievement were less likely to become weekly smokers. However, as opposed to snuff experimentation, boys who spent time at sports were less likely to become weekly smokers at T3. We confirm the results in Table 3 with analyses that included only those boys who were not regular smokers at T2 ($n = 911$). Results were similar to Table 3 except that sport as the most important free-time activity was not a significant predictor [OR = 0.74 (0.50–1.09)] for regular smoking. Furthermore, we used a similar logistic regression model to predict weekly smoking at T2 with predictors from T1. The results were similar except that boys who participated in sport did not have a lower risk of being weekly smokers at T2 compared to other boys [OR = 0.93 (0.64–1.37)].

How is snuff use related to nicotine addiction among weekly smokers?

In the final analysis, we examined how combined use of oral snuff and smoking is related to nicotine addiction. This analysis is cross-sectional at T4 and was conducted only among weekly smokers because nicotine addiction questions from the FTQ were addressed to weekly smokers. Figure 1 displays means and 95% CI of the FTQ scores by snuff use categories among weekly smoking boys ($F_{3,286} = 10.3$, $P < 0.001$, $\eta^2 = 0.10$). Those who had never used snuff had lower means than those who had tried snuff two or more times and those who have tried once had a lower score than those who had tried with 50 or more times. We also put the amount of smoking as a covariate, although this is a conservative test for association. Still, those who had tried oral snuff over 50 times had higher FTQ scores than never users ($F_{3,285} = 3.9$, $P = 0.009$, $\eta^2 = 0.04$).

DISCUSSION

Oral snuff products have been under a sales ban in Finland since 1995. Despite this sales ban, the prevalence of those who have tried snuff rose from 7% to 43% during a 3-year period for 13–16-year-olds among this longitudinally studied cohort of boys and from 2% to 12% among girls. The use of tobacco products is not illegal in Finland, despite the sales ban of cigarettes to minors under 18. Because the sales ban of oral snuff also applies to adults it could be expected that, in Finnish culture, access to oral snuff would be harder for minors than it is with cigarettes. The high prevalence of oral snuff use among adolescent boys, despite the sales ban in Finland, shows how hard it is to get rid of addictive products once they have been presented to a culture. These experiences are also a challenge for those who want strict regulations which would allow oral snuff products to be available only to adults. It could be questioned what kind of regulations could prevent children from using it, when 5% of adolescent boys are already using oral snuff daily (STAKES 2001) in a country where it should not be available to anyone. This and the following findings highlight the difficulties attached to regarding oral snuff use as a harm reduction strategy for smoking among adolescents.

Some earlier studies have examined extensively what is the causal order of these two products (O'Connor *et al.* 2003; Tomar 2003). As in some other studies (Ary *et al.* 1987; Haddock *et al.* 2001; Tomar 2003), in all assessments we found both that weekly smoking predicted later

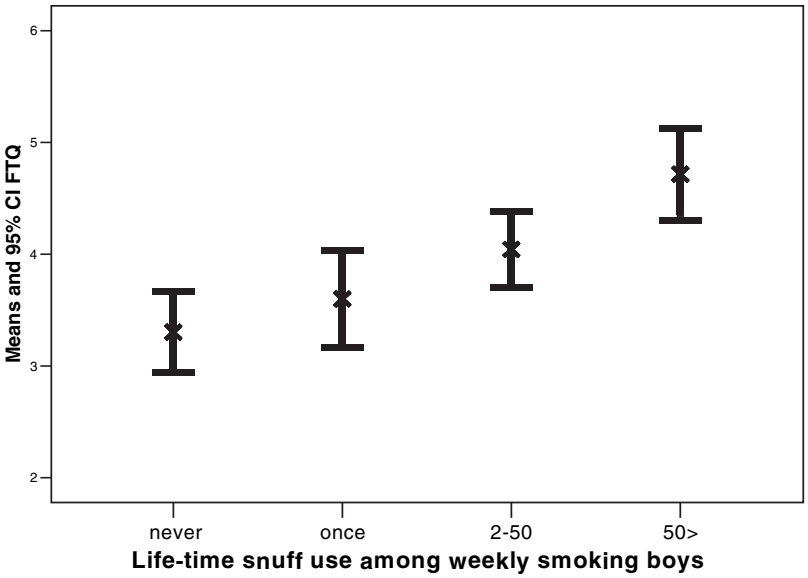

Figure 1 Nicotine addiction (FTQ) mean scores with 95% CI for oral snuff experimentation among weekly smoking boys in the ninth grade

snuff experimentation and that snuff use predicted weekly smoking. The strength of our study compared to earlier ones is that we had several measurements during the critical time period of 13–16 years. This age period, 13–16 years, is the time when experimentation with many other health-risk behaviours occur (Paavola *et al.* 2004a). The order of experimentation with different substances is related strongly to the availability of these substances in a culture. It was suprising that oral snuff experimentation predicted regular smoking in this study, despite the fact that it is much more difficult to have access to oral snuff than cigarettes. However, because smoking experimentation is more prevalent than oral snuff experimentation the impact of snuff experimentation upon later smoking experimentation was smaller than vice versa.

The order of experimentation with different subtances is not only dependent on the availability of these products. It is also dependent on other cultural factors that have diminished, for example gender differences in smoking initiation. The prevalence of oral snuff was low among girls, perhaps because of less positive norms among girls about snuff users, indicating that it is related closely to cultural norms as to who should use it. As we have seen with gender differences in cigarette smoking, these norms and behaviours can change rapidly in societies (Graham 1996). This might be the case with oral snuff as well, not only in relation to gender but in relation to different youth cultures that have been used extensively in cigarette marketing. As in the United States and Sweden (Kozlowski *et al.* 2003), it is expected that in Finland the percentage of those who start with smokeless tobacco products is smaller than the other way around. However, this is the phenomenon that could be changed through cultural changes in society or changes in availability of these products.

Another reason why arguing the causal order of oral snuff use and cigarette smoking is a less important problem is that in whatever order these two products are adopted, combined use was very common in this sample and other studies (Galanti *et al.* 2001; Tomar 2002). To the best of our knowledge, our study is the first to show that the combined use of oral snuff and cigarettes among adolescent weekly smokers increased nicotine addiction even after adjustment for the amount of smoking. For adults, smokeless tobacco products could be marketed as an alternative for smoking or even as an aid for smoking cessation. As earlier studies have suggested (Karvonen *et al.* 1995; Galanti *et al.* 2001), among adolescents oral snuff is not used as a substitute; it is an added health-risk behaviour to try during adolescence. Our results indicate that high doses of nicotine in oral snuff (Benowitz *et al.* 1988; Fant *et al.* 1999) has added to the effect of nicotine addiction among adolescent smokers. This higher addiction level among boys, who are using both oral snuff and cigarettes, will be a barrier to future smoking cessation attempts among them. Henningfield, Rose & Giovino (2002) suggest that there could also be similar problems among adult smokers who are using smokeless tobacco products.

Another aspect of the 'gateway' discussion is that there are common causes for all health-risk behaviours (e.g. Jessor & Jessor 1977). This implies that certain adolescents become smokers whether or not oral snuff is available in the culture. We have used only two risk factors in our study that could be considered similar in causal level to both smoking and oral snuff: school achievement (Paavola, Vartiainen & Haukkala 2004b) and sport as a free-time activity (Karvonen *et al.* 1995). Many other important risk factors, such as parental behaviour (Rosendahl *et al.* 2003) and smoking-related attitudes, were assessed only in relation to cigarette smoking, so we did not use them in these analyses. We found that worse school achievement predicts both oral snuff use and cigarette smoking. Despite the fact that there are common risk factors with smoking, our results suggest that oral snuff is adopted by a group of adolescent boys, namely those who are active in sports, who are less likely to start smoking. These young boys are peraps using it to avoid the more immediate consequences upon one's physical health of smoking. Unfortunately, many of them do become addicted to nicotine because of snuff use. Only a small minority of them continue active training through to adulthood. In the end of our follow-up, less than 10% of oral snuff users reported that they have never smoked cigarettes. Earlier cross-sectional studies in Finland (Karvonen *et al.* 1995; Kannas *et al.* 2002) found that cigarette smoking was the only health-risk behaviour from which belonging to a sport club was a protective factor. Future longitudinal studies should examine whether these snuff users who are active in sports remain only snuff users or do they turn into cigarette smokers or quit both later on in their life-course. For public health it is especially harmful if some factors, here oral snuff, will lower the risk for smoking in the future for a group that is otherwise less likely to start smoking during adolescence.

Limitations

This study was conducted with the aid of data from a school intervention project, in which the aim was smoking prevention (De Vries *et al.* 2003; Vartiainen *et al.* 2004). Although there were lessons during 3 years in which the issue of oral snuff was addressed, there were no differences between control and experimental schools in the progression of oral snuff use. The major limitation of this study is that we did not ask pupils about their current use of oral snuff, only their experimentation. Despite the fact that other studies have also used differ-

ent ever use categories (O'Connor *et al*. 2003; Tomar 2003), in this study it creates some error when some experimenters could have stopped oral snuff use a long time ago. However, compared with another national school survey that was conducted in the same year among same-aged boys (STAKES 2001), the distribution of the results of the experimentation question was nearly identical to our study. In that study, the prevalence of daily use was 5% and irregular use was 14% among the ninth grade boys (STAKES 2001). In another mailed survey to 16-year-old boys, daily users and irregular users together was 12.3% in 2001 (Rimpelä *et al*. 2003). In a Swedish study conducted in 1998, nearly 20% of the boys in ninth grade were daily or irregular oral snuff users (Wickholm *et al*. 2003). For future studies it is important to assess not only daily use, but also the amount of use during the day. Among the 16–23-year-old male daily snuff users, 26% used it one to three times a day but 18% of these boys used snuff more that 10 times a day (Merne *et al*. 1998). As the consumption can be so high, it is clear that the nicotine addiction measures should also reflect oral snuff use and not only smoking, as in the FTQ scale (Prokhorov *et al*. 1996) in our study.

Another limitation was the physical activity question where we used only one question as well. Earlier studies have shown that sport clubs have been especially important for socializing and the adoption of snuff use (Karvonen *et al*. 1995). In this study, we did not ask directly if they are members of certain sports clubs. Similarly to Sweden (Rolandsson & Hugoson 2003), in Finland oral snuff culture is especially related to certain sport cultures. These limitations highlight the need for studies that will especially address oral snuff use behaviour among adolescents, who should be studied longitudinally through to adulthood in order to examine the relations between other factors.

CONCLUSIONS

We believe that this study shows that there are two important considerations before a harm reduction policy in relation to oral snuff use is applied to the population level. First, in this study there were only a few adolescent boys who have tried oral snuff but had never smoked. Those smokers who had used both oral snuff and cigarettes have a higher nicotine addiction than those who use only cigarettes. Secondly, oral snuff was used more in the subpopulation that was less likely to smoke, that is young males who spent their free time among sports. We do not currently have any detailed information about what their smoking behaviour will be when they are adults, but oral snuff use does increase nicotine addiction at the population level.

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