# Pharmacokinetics and pharmacodynamics of moist snuff in humans

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## Abstract

*Objective*—To examine the effects of four brands of commercially available moist snuff and non-tobacco mint "snuff" on plasma nicotine concentration, heart rate, blood pressure, and subjective measures.
*Intervention*—Four brands of moist snuff and a non-tobacco mint snuff were tested. Subjects reported to the laboratory for five experimental sessions. After baseline measurement of dependent variables, each subject placed 2 g of one of the brands of snuff (or one Skoal Bandits pouch) between the cheek and gum for 30 minutes. The subjects remained in the experimental laboratory for an additional 60 minutes.
*Subjects*—Ten volunteers who were daily users of smokeless tobacco.
*Main outcome measures*—Plasma nicotine concentration, cardiovascular effects, and subjective effects.
*Results*—Large amounts of nicotine were delivered rapidly to the bloodstream. The amount of nicotine absorbed and the rate of absorption were related to the pH of the snuff product in aqueous suspension. Cardiovascular and subjective effects were related to the amount of nicotine absorbed.
*Conclusions*—Snuff products are capable of rapidly delivering high doses of nicotine, which can lead to dependence. Long-term use of snuff can lead to a number of adverse health effects including oral cancers, cardiovascular diseases, and gingival diseases. For these reasons, it is important that the public health community considers oral snuff use as a burden on public health in the same way that cigarette smoking is recognised.

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## Introduction

According to the 1998 Monitoring the Future Study, 11.4%, 15.0%, and 19.% of 8th grade (13–14 year old), 10th grade (15–16 year old), and 12th grade (17–18 year old) males, respectively, reported in 1996 using smokeless tobacco in the previous month.[1] The public health implications of this use are enormous. For example, Tomar *et al* recently reported that 38% of American adolescents who use snuff daily have oral lesions, a mucosal condition that may be considered potentially premalignant.[2] In addition, there is evidence that smokeless tobacco use may increase the risk of cardiovascular diseases and cancers of the larynx, oesophagus, and other sites, as well as disease of gingival and periodontal tissues.[3] Recent data suggest that some forms of smokeless tobacco may increase the risk of dental caries.[4] Smokeless tobacco use by minors is also associated with an increased probability of subsequent cigarette smoking, alcohol bingeing, and marijuana smoking.[5] Because of the increased use of smokeless tobacco among young people and the broad range of adverse health consequences, more research on the reasons for use, including the addiction potential of these products, is needed.

Although there are several forms of smokeless tobacco, the moist snuff form is most popular among young people and appears to incorporate the most extensive engineering for nicotine dosage control so that when the product is placed between gum and cheek, the product itself becomes a primary determinant of nicotine intake.[6 7] The nicotine-dosing potential of moist snuff is determined by at least three factors: the amount of nicotine in the product, the pH level of the product, and the size of the tobacco cutting.[8] Henningfield *et al* found that the nicotine content of six moist snuff products ranged from 7.5 mg/g (Skoal Bandits Wintergreen) to 11.4 mg/g (Copenhagen), and that the pH of these products ranged from 6.9 to 8.6.[8] The pH of the snuff is important because nicotine most readily crosses the oral mucosa in the unionised form. The degree to which nicotine is unionised is pH dependent—at higher pH levels (more alkaline), more nicotine is unionised. The differences in the pH values of the products in the study by Henningfield *et al* account for concentrations of unionised nicotine in aqueous suspension that were estimated to range from 0.53 mg/g to 9.03 mg/g for Skoal Bandits and Copenhagen, respectively—a 17-fold difference in nicotine availability.[8] In contrast to moist snuff, chewing tobacco products are generally more coarsely cut, lower in pH, and lower in moisture content.[7] As the plug of chewing tobacco becomes moistened, its pH is raised and nicotine delivery accelerated.[7]

Although there are data that predict that nicotine absorption would be significantly higher for moist snuff products with higher nicotine content and higher pH values, there are few studies that have directly examined the effects of pH on nicotine absorption. Beckett *et al* found very little buccal absorption of

nicotine from tobacco when the pH was 5.5, 10% absorption at pH of 7, and about 30% at pH of 9.0.[9] Henningfield *et al* found that rinsing with acidic beverages such as coffee or cola before chewing nicotine polacrilex nearly eliminated nicotine absorption.[10] These results indicate that pH is an important determinant of buccal absorption of nicotine.

Benowitz *et al* compared nicotine absorption from a moist snuff form of smokeless tobacco (Copenhagen or Hawken Wintergreen) to that from cigarette smoking and nicotine gum.[11] The authors estimated absorbed doses of nicotine to be twice as high for moist snuff compared with smoking (1.8 *v* 3.6 mg for smoking and snuff, respectively). However, the authors made no comparisons between different brands of snuff. The current study sought to examine the nicotine plasma levels produced by use of four popular brands of moist snuff. The products were chosen on the basis of their known differences in pH, but similar nicotine content (except for Skoal Bandits, which contain less tobacco). The study also examined the physiological and subjective effects of these products in relation to non-tobacco mint snuff. This is the first study that directly compares moist snuff products in the same subjects under controlled laboratory conditions.

## Methods

### SUBJECTS

Subjects were 10 male community volunteers recruited via newspaper advertisements that solicited persons who used smokeless tobacco. Subjects signed informed consent forms before participation and were financially compensated for their participation. The average age of the subjects was 32.2 years (range: 26–45) and reported using smokeless tobacco for a mean of 12.5 years (range: 2–26). The subjects reported using a mean of 6.4 dips per day (range: 3–12). A can (approximately 15 g of snuff) was reported to last a mean of 3.05 days (1.5–7). On a test of smokeless tobacco dependence[12] in which scores can range from 4 to 19, scores for subjects in this study averaged 9.6 (range: 7–13). Nine of the 10 subjects reported prior unsuccessful attempts to quit smokeless tobacco. Three of the subjects reported occasional cigarette smoking in addition to their smokeless tobacco use.

### PROCEDURE

Four brands of moist tobacco snuff were tested: Copenhagen, Skoal Long Cut Cherry, Skoal Original Wintergreen, and Skoal Bandits (US Tobacco, Inc, Nashville, Tennessee). A commercially available, non-tobacco mint snuff (either Smokey Mountain Snuff (Smokey Mountain Chew, Inc, Addison, Texas) or Oregon Mint Snuff (Oregon Mint Snuff Company, Tillamook, Oregon)) was also tested. Individual subjects reported to the laboratory for five experimental sessions, each lasting approximately two hours. Subjects were asked to refrain from tobacco use during the three hours before sessions. After baseline measurement of dependent variables, each subject placed 2 g of one of the brands of moist snuff (or one Skoal Bandit pouch) between the cheek and gum. Skoal Bandits pouches contain approximately 0.5 g of tobacco. The order of presentation was controlled using Latin squares. Products were kept in the mouth for 30 minutes during which time the subject was allowed to expectorate as desired. After 30 minutes, subjects removed the product from their mouths and rinsed their mouths with water. The subjects remained in the experimental laboratory for an additional 60 minutes during which dependent measures were collected. During the experimental sessions, subjects were allowed to read or watch television.

### DEPENDENT MEASURES

Blood samples for nicotine analysis were collected from a forearm vein before snuff administration and at the following timepoints after administration (minutes): 1, 2, 3, 4, 6, 8, 10, 15, 20, 25, 30, 35, 40, 45, 60, 75, and 90. The blood samples were centrifuged, plasma was withdrawn from the blood, and frozen for later analysis by an independent laboratory (University of Utah Center for Human Toxicology, Salt Lake City, Utah) using gas chromatography–mass spectrometry (GC-MS). Of the 900 plasma samples, 837 were analysed using a limit of quantification (LOQ) of <2.5 ng/ml. For 63 of the samples, the LOQ was <5 ng/ml.

Heart rate and blood pressure were measured using an automated system (IVAC, San Diego, California) at the same times as blood samples (above). Electroencephalographic measures were taken before administration, and 15, 30, and 60 minutes after administration. These results will be reported elsewhere.

A subjective rating of product "strength" was also obtained using a 100 mm visual analogue scale anchored with the labels "not at all" to "extremely" at the same timepoints as the blood sampling. In addition, other 100 mm visual analogue scales were presented 20 minutes after snuff was placed in the mouth measuring: overall product strength, amount swallowed, how well the product "packed", increased salivation, burning sensations in the mouth, mouth tingling, and nausea.

### DATA ANALYSIS

Peak and area under the curve (AUC) values were calculated from the data from each session on measures of: plasma nicotine concentration, heart rate, systolic blood pressure, diastolic blood pressure, and subjective ratings of drug strength. Area under the curve values were calculated by the trapezoidal rule. Within-subjects one-way analyses of variance were calculated to assess peak and AUC differences between snuff products. Where there were significant differences on the analyses of variance, Tukey's honestly significant different test was used to make comparisons between products.
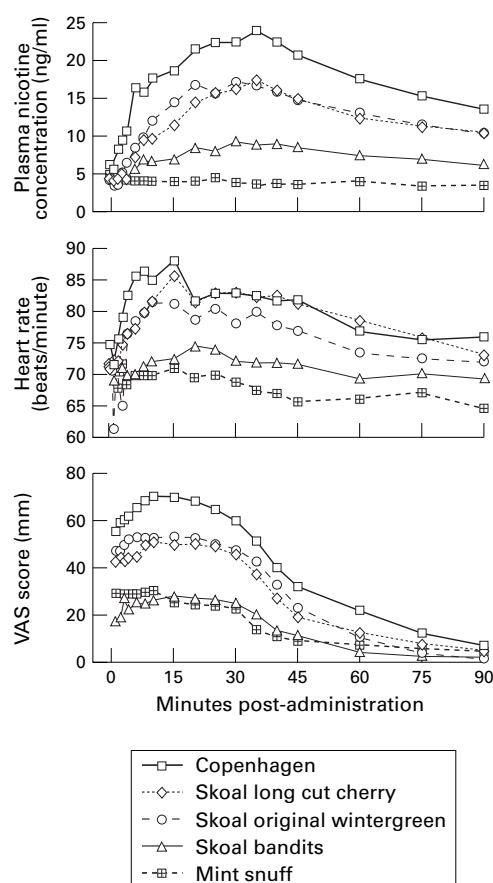
*Figure 1   Mean plasma nicotine concentration, heart rate, and visual analogue scale (VAS) score (product "strength") after administration of each of four smokeless tobacco products, or mint snuff.*

## Results

Figure 1 illustrates the time course of nicotine plasma concentrations, heart rate, and subjective ratings of drug strength for each of the five products tested. Table 1 compares the peak effects and AUC values between products on plasma nicotine concentrations, heart rate, blood pressure, and subjective ratings of drug strength.

Pretreatment plasma nicotine concentrations averaged 5.3 ng/ml (SD 5.4) and mean baseline concentrations were similar across treatment conditions. The maximum mean increase in plasma nicotine concentration was highest for Copenhagen (mean = 19.5 ng/ml). Lower increments in nicotine concentrations were shown for Skoal Long Cut Cherry and Skoal Original Wintergreen which increased nicotine concentrations an average of 14.9 ng/ml. Only small increases in nicotine concentration were shown for Skoal Bandits, which increased nicotine concentrations an average of 4.2 ng/ml. Two of the subjects showed no increase in plasma nicotine concentrations after administration of Skoal Bandits. Similarly, AUC values for plasma nicotine concentrations during the 30 minutes in which the snuff was held in the mouth were highest for Copenhagen, lower for Skoal Long Cut Cherry and Skoal Original Wintergreen, and much lower for Skoal Bandits.

The average time taken to reach peak nicotine concentrations ($T_{max}$) was similar across the snuff products with peak concentrations generally being reached 5–10 minutes before or after removal of snuff from the mouth. Plasma nicotine concentrations increased much more rapidly following administration of Copenhagen than for Skoal Original Wintergreen and Skoal Long Cut Cherry. After administration of Copenhagen, average nicotine concentrations of 10 ng/ml were reached within four minutes of administration, and levels of 15 ng/ml were reached within six minutes. In contrast, after administration of Skoal Original Wintergreen, levels of 10 ng/ml and 15 ng/ml were reached after 10 and 20 minutes; these same levels were reached 15 and 25 minutes after administration of Skoal Long Cut Cherry.

Pretreatment heart rate values averaged 72.2 beats per minute and pretreatment blood pressure values averaged 124.4/72.9 mm Hg. Average pretreatment values on these cardiovascular measures were similar for all treatment conditions. The peak increase in heart rate relative to baseline was significantly greater for Copenhagen, Skoal Long Cut Cherry, and Skoal Original Wintergreen than for Skoal Bandits or mint snuff. There were no significant differences between Copenhagen,

*Table 1   Comparison of nicotine plasma concentrations, cardiovascular effects, and rating of drug strength between snuff products tested (mean ( SEM))*

| Parameter | Mint "snuff" | Copenhagen | Skoal Long Cut Cherry | Skoal Original Wintergreen | Skoal Bandits |
|---|---|---|---|---|---|
| Plasma nicotine concentration | | | | | |
|   Maximal increase (ng/ml)*** | 0.9 (0.4) | 19.5 (4.1)[ab] | 14.9 (3.0)[ab] | 14.9 (2.4)[ab] | 4.2 (1.4) |
|   $AUC_{(0-30)}$ (ng/ml min$^{-1}$)*** | 119.4 (43.6) | 530.4 (120.8)[abcd] | 333.9 (60.7)[a] | 376.3 (61.6)[ab] | 208.0 (33.0) |
| Heart rate | | | | | |
|   Maximal increase (bpm)*** | 5.1 (1.5) | 16.1 (3.3)[ab] | 17.9 (3.3)[ab] | 14.7 (2.7)[ab] | 4.7 (1.3) |
|   $AUC_{(0-30)}$ (bpm min$^{-1}$)*** | 1951.7 (75.1) | 2351.8 (91.3)[a] | 2280.7 (80.8) | 2221.1 (70.8) | 2028.2 (56.7) |
| Systolic blood pressure | | | | | |
|   Maximal increase (mm Hg) | 8.6 (2.3) | 16.8 (3.0) | 15.9 (2.4) | 14.9 (2.8) | 9.4 (2.0) |
|   $AUC_{(0-30)}$ (mm Hg min$^{-1}$)*** | 3341.0 (100.3) | 3688.2 (88.0)[abcd] | 3537.7 (105.2)[a] | 3551.7 (58.5)[a] | 3486.2 (76.4)[a] |
| Diastolic blood pressure | | | | | |
|   Maximal increase (mm Hg) | 12.5 (3.2) | 14.2 (1.6) | 13.4 (3.0) | 14.0 (2.1) | 10.3 (1.8) |
|   $AUC_{(0-30)}$ (mm Hg min$^{-1}$)*** | 2010.8 (80.7) | 2263.0 (56.1)[abd] | 2129.2 (69.4)[a] | 2191.1 (56.0)[ab] | 2036.8 (70.0) |
| Product strength | | | | | |
|   Maximum score (mm)*** | 38.0 (9.3) | 81.4 (3.3)[abd] | 60.6 (4.1)[ab] | 65.4 (7.8)[ab] | 34.4 (4.1) |
|   $AUC_{(0-30)}$ (mm/min)*** | 755.6 (186.9) | 1917.6 (95.5)[abcd] | 1394.3 (77.9)[ab] | 1487.6 (188.7)[ab] | 750.6 (105.6) |

Results of the repeated measures analyses of variance: *p<0.05; **p<0.01; ***p<.001. Where there were significant differences on the analyses of variance, Tukey's honestly significant difference test was performed to assess differences between products. Superscripted letters indicate significantly higher scores relative to: (a) non-tobacco "mint" snuff; (b) Skoal Bandits; (c) Skoal Original Wintergreen; (d) Skoal Long Cut Cherry; and (e) Copenhagen.

*Table 2  Comparison of subjective responses to the snuff products tested (mean (SEM))*

| Measure | Mint "snuff" | Copenhagen | Skoal Long Cut Cherry | Skoal Original Wintergreen | Skoal Bandits |
|---|---|---|---|---|---|
| Overall how strong*** | 34.2 (10.1) | 85.6 (3.9)[abcd] | 51.2 (6.4)[b] | 62.4 (6.1)[ab] | 23.7 (3.4) |
| How much swallowed | 18.3 (9.5) | 23.5 (8.6) | 15.0 (3.0) | 26.4 (6.5) | 5.6 (2.6) |
| How well packed*** | 73.5 (9.9)[e] | 21.5 (8.5) | 80.1 (4.8)[ce] | 44.4 (10.2) | 87.3 (6.9)[ce] |
| Increased salivation* | 53.2 (9.0) | 69.4 (5.8)[b] | 63.3 (6.7) | 65.5 (6.8) | 45.3 (6.6) |
| Burning sensations | 32.1 (8.7) | 28.3 (6.7) | 20.6 (6.2) | 27.5 (7.4) | 16.2 (3.8) |
| Tingling | 23.5 (8.5) | 28.0 (8.1) | 28.3 (8.0) | 22.1 (7.5) | 20.1 (6.7) |
| Nausea** | 2.8 (1.2) | 26.3 (11.3)[abcd] | 5.5 (2.2) | 3.0 (1.1) | 5.1 (2.2) |
| Heart racing*** | 3.7 (1.2) | 42.2 (9.8)[abd] | 21.7 (8.5) | 22.5 (8.1) | 11.3 (2.3) |
| Head rush*** | 7.1 (3.0) | 51.3 (11.0)[abd] | 29.6 (8.8)[a] | 25.9 (7.7) | 11.2 (3.3) |
| Relaxed | 60.3 (8.7) | 43.8 (10.1) | 57.0 (7.9) | 42.5 (6.8) | 45.5 (9.6) |
| Anxious** | 7.3 (2.9) | 41.2 (11.5)[ab] | 19.2 (8.3) | 20.0 (6.9) | 12.1 (2.0) |
| Craving nicotine | 28.9 (7.4) | 29.9 (9.7) | 20.9 (6.4) | 20.7 (5.1) | 20.2 (6.8) |
| Liking | 45.5 (10.7) | 38.0 (11.9) | 63.9 (6.7) | 49.4 (9.2) | 34.2 (6.5) |
| Feeling alert* | 45.1 (12.3) | 73.9 (8.0)[ab] | 66.7 (7.0) | 62.0 (8.4) | 40.2 (7.0) |

Results of the repeated measures analyses of variance: *$p<0.05$; **$p<0.01$; ***$p<0.001$. Where there were significant differences on the analyses of variance, Tukey's honestly significant difference test was performed to assess differences between products. Superscripted letters indicate significantly higher scores relative to: (a) non-tobacco "mint" snuff; (b) Skoal Bandits; (c) Skoal Original Wintergreen; (d) Skoal Long Cut Cherry; and (e) Copenhagen.

Skoal Long Cut Cherry, and Skoal Original Wintergreen in average peak increase in heart rate, and there was no difference between mint snuff and Skoal Bandits. AUC values were significantly different between mint snuff and Copenhagen only. As figure 1 shows, average heart rate peaked about 15 minutes after the product was placed in the mouth. The peak increase in systolic blood pressure was not significantly different between conditions. The AUC values for systolic blood pressure were significantly higher during Copenhagen administration than for any other condition; values for all of the tobacco snuff products were significantly higher that for mint snuff. The peak increase in diastolic blood pressure was not significantly different between conditions. The AUC values for diastolic blood pressure were significantly higher for Copenhagen, Skoal Long Cut Cherry, and Skoal Original Wintergreen than for mint snuff.

Peak subjective ratings of product strength were highest for Copenhagen, followed by Skoal Original Wintergreen, and Skoal Long Cut Cherry; each of these produced significantly higher peak ratings than mint snuff or Skoal Bandits. The AUC values of these ratings were significantly higher for Copenhagen than for any other product tested. In addition, the AUC values of these ratings were significantly higher for Skoal Original Wintergreen and Skoal Long Cut Cherry relative to mint snuff or Skoal Bandits. There was no significant difference between mint snuff and Skoal Bandits on this measure. As shown in figure 1, scores generally peaked around 10–15 minutes after the product was placed in the mouth.

Table 2 compares the mean responses on subjective ratings between products. Copenhagen produced the highest ratings on measurers of: overall product strength, increased salivation, nausea, heart racing, head rush, anxious, and feeling alert, and the lowest rating of how well packed. In general, scores on these measures were somewhat lower for Skoal Long Cut Cherry and Skoal Original Wintergreen, and lowest for mint snuff and Skoal Bandits. There were no significant differences between Skoal Bandits and mint snuff on any of these subjective measures.

## Discussion

The study clearly shows that large amounts of nicotine are delivered rapidly to the bloodstream during use of moist snuff. In fact, venous nicotine concentrations are as high, or higher, than those that have been observed following cigarette smoking. For example, Benowitz et al found that average peak blood nicotine concentrations increased 14.3 ng/ml after smoking one cigarette or using 2.5 g moist snuff for 30 minutes.[11] Another study found similar increases of 14.5 ng/ml produced by 2 g of Swedish snuff.[13] The current study found peak plasma nicotine concentrations increased as much as 19.5 ng/ml after administration of 2.0 g Copenhagen held in the mouth for 30 minutes, and slightly lower amounts, 14.9 ng/ml, produced by Skoal Long Cut Cherry and Skoal Original Wintergreen. Skoal Bandits produced only small increases in peak plasma nicotine concentration, 4.2 ng/ml, an increase not significantly greater than non-tobacco, non-nicotine mint snuff. This relatively small increase in peak plasma nicotine concentration produced by Skoal Bandits was at least partly due to the fact that each pouch contains 0.5 g of tobacco, compared with the 2 g of tobacco administered in the other product conditions. It should be noted that there was considerable variation among individuals in the amount of nicotine absorbed from smokeless tobacco, even though they all placed the same-sized dose in their mouths. This is consistent with the variability found in previous research by Benowitz et al.[11] Differences between individuals in nicotine absorption may have been due to a variety of factors including individual differences in saliva pH, rate of salivation and expectoration, and differences in mucosal characteristics.

Absorption of nicotine from moist snuff occurs primarily across the oral mucosa. As shown in the figure, the rate of absorption was highest when the snuff was first placed in the mouth, and plasma concentrations continued to rise until the stuff was removed from the mouth. Absorption continued even after the

snuff was removed in some subjects, presumably because of the slow release of nicotine from the mucosa into the plasma or absorption of swallowed nicotine in the gut.

Henningfield *et al* reported that Copenhagen, Skoal Original Wintergreen, and Skoal Long Cut Cherry have comparable nicotine content (11.4, 10.4, and 11.4 mg/g, respectively), but produce different pH values in suspension (8.6, 7.6, and 7.5, respectively).[8] Because of the different pH values of these products in suspension, one would expect nicotine bioavailability to be much greater for Copenhagen than for Skoal Wintergreen and Skoal Long Cut Cherry. Indeed, nicotine delivery was shown to be significantly higher and faster for Copenhagen than for these other two products. Thus the results of the present study confirm that the pH of these products in suspension is a significant factor in determining nicotine bioavailability and absorption and that products with similar nicotine content can deliver significantly different amounts of nicotine.

Nicotine administration from smoked tobacco increases heart rate and blood pressure.[14] The current study demonstrated increased heart rate after moist snuff administration that was associated with the nicotine levels attained by each product. Heart rate increased significantly following administration of Copenhagen, Skoal Original Wintergreen, and Skoal Long Cut Cherry, relative to mint snuff or Skoal Bandits. Heart rate increases followed a similar time course as the plasma nicotine levels during the first 15 minutes of administration; however, heart rate levelled off or declined after about 15 minutes of administration despite continued increases in nicotine plasma concentration, possibly because of acute tolerance development. This levelling of heart rate after 15 minutes of administration despite continued increases in nicotine plasma concentration was also shown by Benowitz *et al*.[11]

Subjective effects of moist snuff were also associated with the changes in plasma nicotine concentrations. Peak changes in scores on the measure of "product strength", taken at each timepoint that plasma was drawn, were highest for Copenhagen, lower for Skoal Original Wintergreen and Skoal Long Cut Cherry, and lowest for mint snuff and Skoal Bandits. As with heart rate, increases in subjective ratings showed a similar timecourse as plasma concentration during the first 10–15 minutes of administration; however, subjective ratings levelled or dropped 10–15 minutes after administration, an effect that may be related to acute tolerance development. It should be noted that, whereas the majority of the subjects typically used Copenhagen, there was variability between subjects in their brand of choice. It is possible that the individual subjects' brand of choice may have influenced their self-report of subjective effects. For example, subjects who typically used Copenhagen may have reported low ratings of other products because they could tolerate higher nicotine concentrations. In contrast, subjects who typically used a prod-

uct that delivers less nicotine might have over-rated the strength of Copenhagen because of lack of tolerance.

The results of the present study have important public health implications. First, the rapid delivery of high doses of nicotine from moist snuff products such as Copenhagen, Skoal Original Wintergreen, and Skoal Long Cut Cherry are sufficient to produce and maintain nicotine dependence. The production of dependence is important because it causes young experimenters to progress to regular use, and regular users to continue use despite negative health consequences. A study by Holm *et al* found no significant differences between cigarette smokers and snuff users on measures of: unpleasantness of abstaining for an hour or two, self-perceived addiction, craving for tobacco, or difficulty in giving up use.[13] In our study, nine out of 10 subjects reported failed quit attempts.

Secondly, the fact that the lower pH products, such as Skoal Bandits, deliver only small amounts of nicotine at a slower rate to users is consistent with the designation and marketing as "starter" products by at least one smokeless tobacco company.[15] In addition to the lower pH, Skoal Bandits contain less tobacco (0.5 g) than is typically used by consumers of snuff that is not marketed in pouches. Because of the lower nicotine absorption, these products may be used by young consumers, who have little experience with nicotine, without producing nausea and vomiting associated with high dose administration to people who have little nicotine tolerance.

Thirdly, the marked cardiovascular effects produced in this study by high nicotine yield snuff products suggests that the cardiovascular hazards of smoking that may be related to nicotine, such as coronary artery disease and hypertension, would also be expected with smokeless tobacco use. These adverse effects of nicotine are in addition to other risks of snuff, such as oral cancers, which are related to the high nitrosamine content of commercial snuff in the United States.[16 17]

In summary, this study shows that snuff products are capable of rapidly delivering high doses of nicotine. Rapid, high-dose delivery of nicotine can lead to nicotine dependence. Long-term use of snuff can lead to a number of adverse health effects including oral cancers, cardiovascular diseases, and gingival diseases. For these reasons, it is important that the public health community consider oral snuff use as a burden on public health in the same way that cigarette smoking is recognised.

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