

# Use of smokeless tobacco is a risk factor for cigarette smoking

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**This study assessed the risk of smoking uptake over 2 years in adolescent boys (in grades 7 and 9) who had used smokeless tobacco (ST). We used logistic regression to determine whether the odds of adolescent boys taking up regular smoking over a period of 2 years were greater among initial nonsmokers who used ST, compared with nonusers of ST, after accounting for six well-established predictors of smoking. Initiation of weekly smoking 2 years after baseline was associated with ST use at baseline, even after including dichotomous measures of parent, sibling, or close friend smoking; low academic grades; 30-day alcohol use; and a scale measure of deviant behavior. With these other predictors included in the model, the odds ratio for the association of ST use with weekly smoking after 2 years was strong and significant ( $OR=2.55$ , 95%  $CI$  1.45–4.47,  $p<.001$ ). The use of ST in the 7th and 9th grades is a significant risk factor for subsequent smoking even when controlling for other factors.**

## Introduction

Recent articles, news report, and editorials have promoted the use of smokeless tobacco (ST; moist snuff and chewing tobacco) as a “safer alternative” to cigarette smoking. Although there is broad consensus that the relative risks of morbidity and premature mortality are lower for ST use than for cigarette smoking (Levy et al., 2004; Rodu, 1998), several expert panels have concluded that ST use is a cause of serious oral health effects and cancer in humans (Cogliano et al., 2004; U.S. Department of Health & Human Services, 1986). As a result of the lower relative risk when compared with smoking cigarettes, the U.S. Smokeless Tobacco Company, which manufactures and sells the vast majority of the moist snuff products sold in the United States, requested permission in 2002 from the U.S. Federal Trade Commission to “communicate in advertising that smokeless tobacco products are considered to be a significantly reduced risk alternative as compared to cigarette smoking” ([www.ftc.gov/os/comments/smokelesscomments/reqadvisoryop.pdf](http://www.ftc.gov/os/comments/smokelesscomments/reqadvisoryop.pdf)). Although makers of ST products have promoted ST as an

alternative to smoking and as a possible strategy for smoking cessation through a switch to ST products, there is scant evidence to date of this being a viable strategy for smoking cessation.

ST use may also be a health risk because it increases the subsequent use of cigarettes. Some researchers have claimed that snuff use by young people may prevent smoking initiation (Bates et al., 2003; Kozlowski, O'Connor, Quinio Edwards, & Flaherty, 2003; Ramstrom, 2000), whereas others have argued that ST use increases the likelihood of subsequent smoking (Tomar, 2003).

The debate as to whether ST use increases the use of cigarettes has been controversial; various authors have suggested different conclusions from analyses of the same datasets. Tomar (2003) concluded from his analysis of the 1989 TAPS-1 and follow-up with the 1993 TAPS-2 datasets that males aged 12–18 years who in 1989 were not smokers, but regularly used ST products, were three times more likely than never-users to be current smokers 4 years later. In contrast, only 2.4% of current smokers and 1.5% of never-smokers at baseline became current ST users by the follow-up assessment. Tomar concluded that the earlier use of ST at baseline assessment was a significant risk factor for subsequent smoking among young U.S. males.

O'Connor, Flaherty, Edwards, and Kozlowski (2003) provided an alternative analysis of the same dataset. They took into account a number of

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well-known psychosocial factors shown to be related to smoking onset or initiation, and added six more variables to the predictive model: experimenting with smoking, performing below average in school, having other household members who smoke, showing frequent depressive symptoms, fighting, and riding a motorcycle (a risk-taking proxy). Their multivariate model showed that the odds ratio for ST predicting later cigarette smoking was not significant when these additional six variables were included. O'Connor et al. (2003) also criticized Tomar in one instance for his definition of *smoker*. From two questions on the survey, Tomar had focused on those who "had not smoked a cigarette at baseline," whereas O'Connor considered a second variable that identified those who had never experimented with cigarettes, not even a few puffs.

Despite the promotion of ST use as a safe alternative to smoking, early use of ST may be a risk factor for young people subsequently taking up smoking. The present study used a longitudinal dataset to evaluate whether use of ST increases the likelihood of subsequently taking up smoking. The study also examined predictors of ST use, given that ST use is a health hazard, and because the dataset enabled such an analysis.

## Method

### *Design overview*

We collected data as part of an experimental evaluation of the Project SixTeen community intervention to prevent adolescent tobacco use (Biglan, Ary, Smolkowski, Duncan, & Black, 2000). Students completed surveys between 1994 and 1999, with a questionnaire asking about tobacco and other substance use, other problem behaviors, associations with deviant peers, and family relations. All survey instruments and procedures for data collection were reviewed and approved by the institutional review board of the Oregon Research Institute.

In each community, 7th- and 9th-grade students completed assessments on computer-scannable surveys. Two years later (in grades 9 and 11), they completed an additional survey. The surveys measured participants' use of ST and cigarettes at each time point. Answers to the baseline survey facilitated students' classification as either smokers or nonsmokers. At both points, we assessed their use of ST and their use of cigarettes.

We used a subsample of the data for these specific analyses. Because of the nature of the analyses, survey data had to be available for subjects at baseline and again 2 years later. Girls' data were not included in these analyses because only three nonsmoker girls reported any ST use at baseline. Consistent with our

previous analyses (Forrester, Biglan, Severson, & Smolkowski, 2007), data for 7th- and 9th-grade boys were combined; previous tests had shown that, for this sample, grade was not a significant predictor in the models. We identified 2,263 subjects who met our criteria of being a nonsmoking male at Time 1 and having sufficient data at the two time points so that we could carry out the analyses.

### *Measures*

The main variable of interest in modeling the initiation of smoking was ST use, measured as a self-report of any ST use in the past 30 days. Several measures generally considered predictive of smoking also were included: dichotomous measures of parent, sibling, and close friend smoking; low academic grades; and 30-day alcohol use. The model also included an index of deviant behavior other than tobacco use, similar to other studies (Biglan, Duncan, Ary, & Smolkowski, 1995; O'Connor et al., 2003; Tomar, 2001). This previously published index (Biglan et al., 2000) used an average of self-reports for six antisocial behaviors: lying to parents, staying out all night, fighting, skipping school, stealing, and vandalizing property (Cronbach's  $\alpha = .7295$ ).

The outcome variable imitated a previously published index of weekly smoking, constructed from responses to four survey questions (Biglan et al., 2000). With four items, the measure of regular cigarette use should be more stable and more conservative than if we had considered only one item. Subjects answered the question "How much do you currently smoke?" The 10 response options ranged from "I have never smoked" and "not at all in the last 12 months" to "a pack or more each day." Subjects also reported the number of cigarettes they smoked, even a puff, in the past 24 hr, the past week, and the past month. The answers to these four questions were recoded into weekly measures and averaged for a weekly smoking index. For this analysis, we considered subjects to be nonsmokers at baseline if they scored 0 on the weekly smoking index. To score 0, they must have responded "I have never smoked" to the question "How much do you currently smoke?" and also answered 0 to each category for the question "How many cigarettes have you smoked, even a puff, in the past 24 hours, past 7 days, and past month?" They were considered to be current regular smokers at follow-up if their weekly smoking index score was 1 or more; that is, if they reported smoking at least once a week using an average of the four measures of cigarette use. We restricted the definition of nonsmoker even further than that used in the original scale, which previously allowed subjects to be considered current nonsmokers even if they responded "not at all in the past year" to the question "How much do you currently smoke?"

To keep the focus on nonsmokers, we excluded from the analyses of smoking initiation those who reported any smoking at baseline (e.g., if the smoking index was greater than 0). Similarly, to estimate the initiation of ST use by baseline smoking prevalence, we included in the model only those reporting no ST use in their lifetime.

### Data analyses

The primary analysis in this study involved calculation of the relative odds of smoking initiation over 2 years among male users and nonusers of ST. Second, we assessed the odds ratio of initiation of ST use at 2 years as a function of smoking status at baseline. This analysis considered only boys, since few girls in this sample reported any ST use.

Because the data came from an intervention study in which subjects were nested in communities, we tested whether a community variable was related to either the outcome or the covariates, to determine if an individual-level model was appropriate. Calculated interclass correlations ranged from .002 to .02, and calculated adjusted design effects ranged from 1.008 to 1.071, confirming that the effect of not including community as a grouping variable changed overall models only minimally.

Logistic regression analysis, using SPSS-Unix statistical software, was used to estimate odds ratios (*OR*) and confidence intervals (*CI*) for the independent factors. A factor was considered a significant contributor to the model if the odds ratio was significant at the .05 level, that is, if the 95% confidence interval of the odds ratio excluded 1.

For the first analysis, initially we entered school grade and the six aforementioned factors predicting cigarette use into a logistic regression model, with weekly cigarette smoking as the dichotomous outcome variable. Subsequently, a dichotomous measure of ST use (1=used at least once in past month) was entered into the model to determine whether this variable added predictive value to the model. Although

grade-level interactions of each variable were initially tested, we found that the relatively small number of ST users made an interaction model unstable, so we excluded grade interactions in the final model. Grade interactions were nonsignificant in separate analyses involving a larger sample from this dataset (Forrester et al., 2007).

In a second analysis, we used students who reported no ST use at Time 1 in a separate model, with ST use as the outcome variable. We entered the same predictors into this model as before and then added a variable for cigarette smoking to determine whether a measure of cigarette smoking predicted ST use, over and above the other variables in the model.

## Results

### Prevalence of tobacco use

In the original sample, 77.1% reported at baseline that they were nonusers of cigarettes; 18.4% were infrequent users (less than one cigarette a week or had smoked previously), and 4.5% smoked once weekly or more (Table 1). In addition, 10.4% reported baseline ST use, 3.1% of those reported using infrequently, and 7.3% reported using monthly or more. At the 2-year follow-up, 57.2% were still nonsmokers, 27.8% were infrequent smokers or had smoked previously, and 15.0% smoked weekly. ST use also increased to 4.9% infrequent and 15.4% monthly.

In our subsample of baseline nonsmokers, 1.5% used ST infrequently and 3.0% ( $n=67$ ) used monthly or more. At follow-up, 21.0% of initial nonsmokers reported infrequent cigarette use, and 8.6% reported weekly smoking or more.

In the subsample of baseline ST nonusers, 82.2% were nonsmokers at baseline, 15.2% infrequent users, and 2.6% smoked weekly or more. At follow-up, 61.5% were still nonsmokers, 26.0% infrequent users, and 12.5% used weekly or more, whereas 4.1% had started using ST infrequently and 10.2% used ST at least once in the past month.

**Table 1.** Tobacco use status of 7th- and 9th-grade boys in subsamples at baseline and at 2-year follow-up.

Tobacco use status	Entire sample ( $N=2,935$ )		Nonsmoking ( $n=2,263$ )		Non ST user ( $n=2,634$ )	
	Baseline	Follow-up	Baseline	Follow-up	Baseline	Follow-up
Cigarette smoking						
None	2,263 (77.1%)	1,678 (57.2%)	2,263 (100.0%)	1,593 (70.4%)	2,161 (82.2%)	1,618 (61.5%)
Infrequent user (less than weekly)	541 (18.4%)	817 (27.8%)	0	475 (21.0%)	399 (15.2%)	683 (26.0%)
Weekly+user	131 (4.5%)	440 (15.0%)	0	195 (8.6%)	69 (2.6%)	328 (12.5%)
Smokeless tobacco use						
None	2,639 (89.6%)	2,359 (80.2%)	2,161 (95.5%)	1,942 (85.8%)	2,634 (100%)	2,252 (85.7%)
Infrequent user (less than monthly)	92 (3.1%)	145 (4.9%)	35 (1.5%)	79 (3.5%)	0	108 (4.1%)
Monthly+user	214 (7.3%)	451 (15.4%)	67 (3.0%)	242 (10.7%)	0	269 (10.2%)

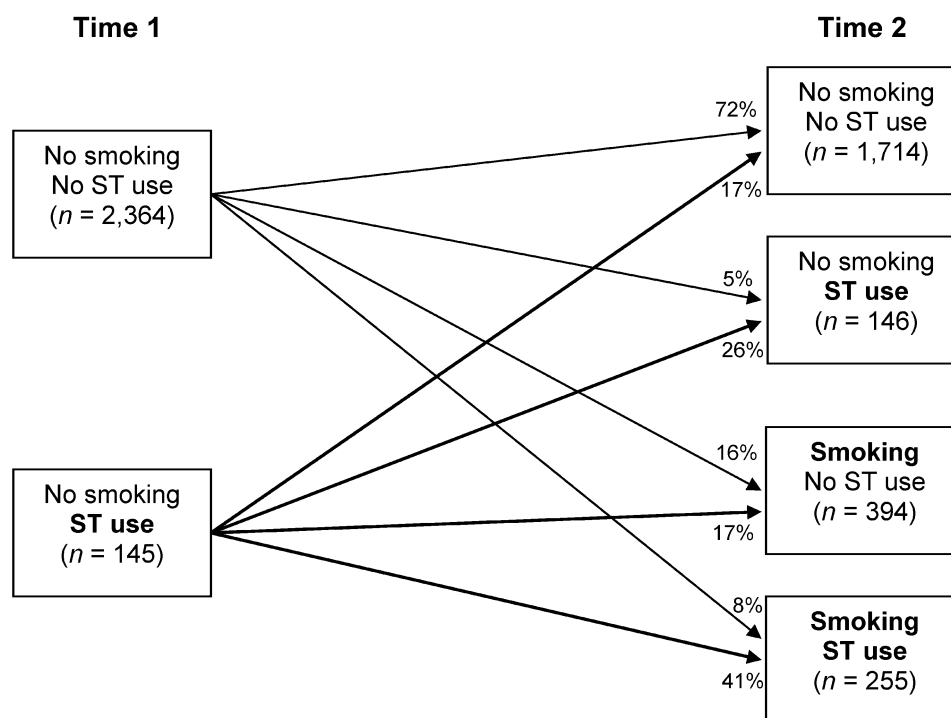
*Note.* All values are numbers of subjects (percent). Data derived from the Project SixTeen survey data. Includes cases with baseline and follow-up data.

### Prediction of smoking

An initial inspection of the association between any tobacco use at baseline and follow-up smoking status provided evidence that ST use and subsequent smoking are related. Figure 1 shows the proportion of baseline nonsmokers and their reported use of any tobacco products at follow-up, broken out by ST use at baseline. This gives a snapshot of the initiation of cigarette and ST use over the 2 years. Although 71.5% of nonsmokers who also had never used ST were nonsmokers at follow up, only 16.6% of baseline nonsmokers who had used ST were also nonsmoking and did not use ST 2 years later. Of nonsmoking ST users, 26.2% maintained their nonsmoking ST user status, 16.6% switched from ST to cigarette use, and 40.7% were using both products at follow-up; over half (57.3%) of nonsmokers who used ST at baseline subsequently

reported smoking cigarettes at follow-up. In contrast, 24.0% of nonsmoking, nonusers of ST subsequently reported smoking; 15.7% reported using cigarettes only, and 8.3% reported using both cigarettes and ST at follow-up. Although the initial number of ST users was small ( $n=145$ ) compared with the number of nonusers ( $n=2,364$ ), these figures provide evidence that ST use significantly increased the likelihood of young people subsequently smoking cigarettes.

We constructed a logistic regression model, putting well-known predictors of smoking into the model before adding the measure of ST use. Table 2 presents odds ratios and confidence intervals for smoking prediction. Even with well-known predictors—such as parental, sibling, or friend smoking; deviant behavior; low academic performance; and use of alcohol—the addition of the monthly tobacco use variable added significantly to the prediction of



**Figure 1.** Development of any tobacco use among Time 1 nonsmokers.

**Table 2.** Logistic regression model predicting weekly smoking at 2-year follow-up, for 7th- and 9th-grade boys at baseline.

Baseline variable	B (SE)	OR	95% CI
School grade (1=9th grade)	-.17 (.18)	0.84	(0.59–1.19)
Parent smokes (1=yes)	.43 (.18)	1.54**	(1.09–2.16)
Sibling smokes (1=yes)	.59 (.21)	1.80**	(1.18–2.74)
Close friend smokes (1=yes)	.02 (.23)	1.02	(0.65–1.59)
Deviant behavior construct <sup>a</sup>	.56 (.19)	1.75**	(1.21–2.52)
Low school grades (1=C or below)	.72 (.18)	2.06***	(1.46–2.97)
Alcohol, any use past 30 days (1=yes)	.65 (.29)	1.92*	(1.09–3.39)
Use smokeless tobacco monthly (1=yes)	.96 (.35)	2.62**	(1.31–5.22)

Note. OR, odds ratio; CI, confidence interval. <sup>a</sup>The deviant behavior construct is measured as a continuous variable; therefore, the odds ratio represents the change in odds per unit change in the deviant behavior scale. \* $p<.05$ ; \*\* $p<.01$ ; \*\*\* $p<.001$ .

weekly smoking at follow-up ( $\chi^2=6.709, p<.05$ ). The ST use variable was a strong predictor of subsequent smoking ( $OR=2.62, 95\% CI 1.31-5.22, p<.01$ ). Thus, for adolescents who used ST at least monthly at baseline, the odds ratio for being weekly smokers at follow-up was more than two-and-a-half times that of those who were not ST users at Time 1.

ST use was as strong a predictor of smoking in this sample as any other well-studied smoking predictor. For example, those with average grades of C or below had twice the odds of being smokers at follow-up, compared with those with averages of B or better. Those reporting a parent smoking had 1.54 times the odds of being smokers at follow-up, compared with those who had no smoking parent(s). Similarly, those who reported having a sibling who smoked had 1.80 times the odds of smoking compared with those with no smoking siblings. Once parent and sibling smoking status was in the model, friend's smoking status was not a significant predictor of subsequent smoking. Alcohol use in the past 30 days nearly doubled the odds of being a smoker at follow-up. Finally, for the deviant behavior scale, a continuous index, every one-unit increase in the measure of deviant behavior increased the odds of subsequent smoking by 1.75 times.

#### *Prediction of smokeless tobacco use*

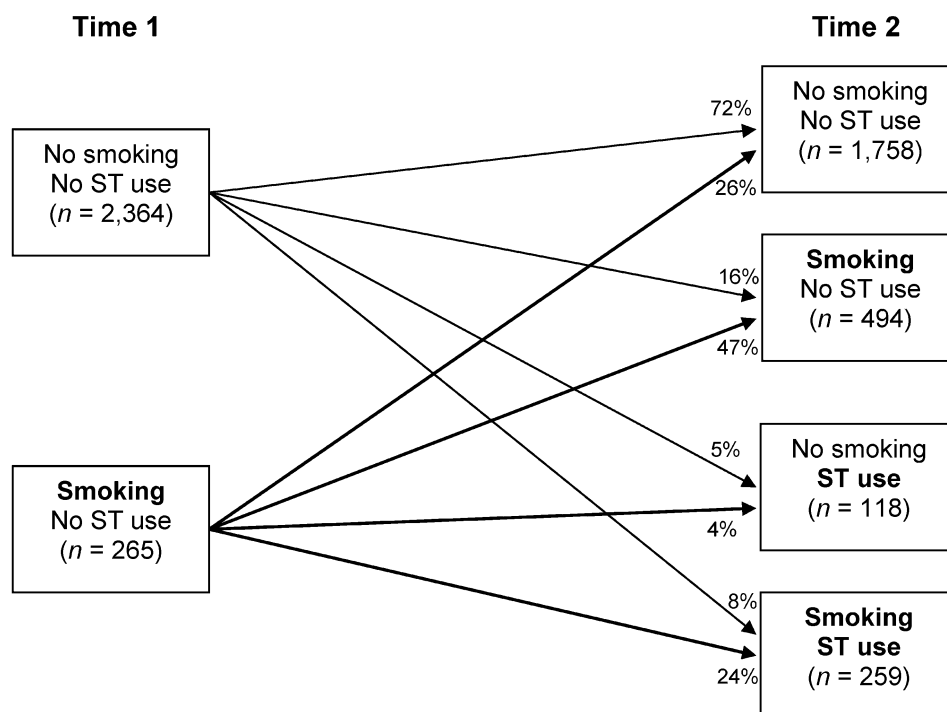
We examined whether baseline nonusers of ST were more likely to initiate use of ST if they smoked cigarettes at baseline. As Figure 2 shows, 4.6% of

nonsmokers started using ST but not cigarettes over the 2-year period, and 8.3% reported using both cigarettes and ST, whereas 15.7% initiated smoking. In contrast, 3.8% of those who had reported any smoking at baseline switched and used only ST at follow-up; 23.8% had added ST use to their current cigarette use, and 46.8% continued to use only cigarettes.

Table 3 shows odds ratios and confidence intervals for prediction of ST use among smoking and nonsmoking 7th- and 9th-grade boys at baseline. The evidence indicated that the relationship between ST use and subsequent cigarette smoking described in Table 3 was not related solely to the boys switching between ST and cigarettes. Although parent smoking, deviant behavior, and low school grades were all related to increased odds of using ST at follow-up, weekly smoking at baseline did not add significantly to this model and was not a significant predictor at the 95% confidence level ( $OR=1.52, 95\% CI 0.76-3.03, ns$ ). Although baseline smoking and subsequent ST use have a significant zero-order relationship, this is no longer significant when taking other common predictors of smoking into account.

#### **Discussion**

ST use by 7th- and 9th-grade boys was a significant predictor of smoking initiation 2 years later, even when several well-established predictors of cigarette use were included in the prediction model. The results were consistent with those reported by Tomar



**Figure 2.** Development of any smokeless tobacco use among Time 1 nonusers.

**Table 3.** Logistic regression model predicting monthly smokeless tobacco use at 2-year follow-up, for 7th- and 9th-grade boys at baseline.

Baseline variable	<i>B</i> ( <i>SE</i> )	<i>OR</i>	95% <i>CI</i>
School grade (1=9th grade)	.16 (.15)	1.17	(0.88–1.57)
Parent smokes (1=yes)	.54 (.15)	1.72**	(1.29–2.31)
Sibling smokes (1=yes)	.04 (.19)	1.04	(0.72–1.50)
Close friend smokes (1=yes)	-.04 (.19)	0.96	(0.66–1.40)
Deviant behavior construct <sup>a</sup>	.58 (.14)	1.79***	(1.36–2.37)
Low school grades (1=C or below)	.37 (.16)	1.44*	(1.06–1.96)
Alcohol, any use past 30 days (1=yes)	.32 (.24)	1.37	(0.86–2.17)
Smoke cigarettes weekly (1=yes)	.42 (.35)	1.52	(0.76–3.04)

*Note.* *OR*, odds ratio; *CI*, confidence interval. <sup>a</sup>The deviant behavior construct is measured as a continuous variable; therefore, the odds ratio represents the change in odds per unit change in the deviant behavior scale. \* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

(2003), in which he reported the initial use of ST as a significant risk factor for subsequent smoking. The period of 1989–1993 that he analyzed was slightly earlier than the present study's data collection period, and his sample was a national probability sample from the TAPS dataset, but the results were quite similar. Tomar reported an odds ratio of 3.45, whereas we found an odds ratio of 2.6. In each study, early ST use greatly increased the likelihood of subsequent smoking.

The observed relationship between ST use and later smoking was not related simply to a general tendency for tobacco users to switch from one tobacco product to another. We found that smoking in the 7th and 9th grades did not predict ST use among 9th and 11th graders 2 years later, at least when other predictors were included in the model. This finding is important, given that the relationship appeared to go only in one direction: Early use of cigarettes was not a risk factor for subsequent ST use. A number of possible hypotheses could explain why boys might start with ST and move later to smoking cigarettes. It may be that boys can use ST without being caught, given that this is a more surreptitious behavior that can be done in schools without detection, but they may later find that this behavior is less socially acceptable, especially with girls, and that smoking is both more acceptable and more popular with older teens as an acceptable way to use tobacco. Early ST use also could develop nicotine dependence in the user, which is then satisfied later with smoking as they observe that smoking is more popular with peers. The spitting of tobacco juice also may be a detriment to use of ST later as this gets negative reactions from peers and females in their environment and smoking is more acceptable in social settings. Interviews and more in-depth studies of boys who start using ST but switch to smoking could elucidate this relationship more fully.

Tomar was criticized for his earlier study that overlooked factors related to smoking onset. We included these factors in our analysis but still found

ST use to be a risk factor for smoking uptake. Our results support Tomar's (2003) conclusions but run contrary to the reports by O'Connor et al. (2003) even though we include the same factors in our analysis.

ST manufacturers currently tout ST as a safe alternative to smoking, but cessation studies for ST users found that participants currently using both cigarettes and ST were much less likely to succeed in cessation attempts (Severson & Hatsukami, 1999). This finding provides some support for not encouraging use of multiple tobacco products because it may make tobacco cessation more difficult.

Reduction in or prevention of ST use among youth could help prevent smoking of cigarettes by adolescents. Future research should focus on longitudinal tracking of tobacco use to determine the sequence of tobacco product initiation and how initiation of one tobacco product may play a role in long-term dependent use of other products. ST use has often been cited as a form of tobacco that is easier to use in schools without detection, and our acceptance of ST use by young people may inadvertently increase the risk of young people becoming dependent on tobacco products and subsequently becoming smokers in other environments.

Reports show that the perceived risk of harm from both smoking and ST use has increased from 1992 to 2003, whereas the prevalence of use for both smoking and ST has decreased. Tomar and Hatsukami (in press) report that high school seniors perceive higher levels of risk for smoking than they do for ST use (74 vs. 44%) and that the level of perceived risk is related to their current use of these products (e.g., users perceive lower risk than do nonusers). The challenge, then, is to communicate these risks in an accurate way without encouraging any tobacco use by young people. We do not know the best way to communicate these messages to provide accurate information and to discourage ST use as a "safer alternative to smoking." However, it seems clear that early use of ST can increase the likelihood of an adolescent's subsequent use of cigarettes. If our goal is to reduce tobacco dependence among adolescents, we should

focus more efforts on prevention of ST use among them.

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