

Original Investigation

Impact of Differing Definitions of Dual Tobacco Use: Implications for Studying Dual Use and a Call for Operational Definitions

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Abstract

Introduction: Concomitant use of two forms of tobacco is an increasing public health concern, yet there is little consensus regarding a consistent definition of so-called "dual use." We defined dual use as cigarette and smokeless tobacco (ST) consumption with either product used daily or nondaily.

Methods: We analyzed a cohort of 36,013 Air Force recruits. We categorized dual tobacco use across 2 dimensions, type of tobacco products (cigarettes, ST, or others), and the frequency of use (daily vs. nondaily). We determined how varying the definition impacted the prevalence estimates and evaluated the prevalence estimate based on our recommended definition of dual use. Multivariate logistic regression analysis was used to evaluate the risk profile of dual users of ST and cigarettes versus mono users of ST and mono users of cigarettes.

Results: Varying definitions of dual use vary prevalence estimates 50-fold (0.5%–25.3%). Including only ST and cigarettes narrows the prevalence estimate to less than 4-fold (2.0%–9.7%). Dual users are more likely to be young Caucasian males, with lower education, and from families with relatively higher incomes. Compared with mono users, dual users of cigarettes and ST have a distinct pattern of risk profiles.

Conclusions: Depending on the definition of dual use, markedly different prevalence and risk profiles are observed. Dual users of ST and cigarettes are a unique group of tobacco users. We propose a common definition of dual use to advance our understanding of this unique group.

Introduction

In 2008, 59.8 million (23.9%) of the U.S. population ≥ 12 years of age were current cigarette smokers, 13.1 million (5.3%) smoked cigars, 8.7 million (3.5%) used smokeless tobacco (ST), and 1.9 million (0.8%) smoked pipes (Substance Abuse and Mental Health Services Administration, 2009). Cigarette smoking is the leading cause of preventable death and disability in the United States (Centers for Disease Control and Prevention [CDC], 2002), and ST is estimated to be the greatest exogenous source of human exposure to carcinogenic nitrosamines (National Toxicology Program, 2005). Most cigarette smokers and ST users are daily tobacco users (CDC, 2009; Ebbert, Carr, & Dale, 2004), placing these two groups at greatest risk for tobacco-related problems. Most cigar smokers are nondaily users (National Cancer Institute, 1998), and pipe smoking is relatively rare among the commonly used and tracked tobacco products.

Concomitant use of two tobacco products is increasingly being recognized as a public health problem (Tomar, Alpert, & Connolly, 2010). Altria, the parent company of Phillip Morris USA, and Reynold's American, Inc. have entered the ST market through the purchase of two large ST manufacturers. Both Camel (Reynold's) and Marlboro (Phillip Morris) flagship brands are now marketed and sold as pasteurized ST products (Rogers, Biener, & Clark, 2010) similar to Swedish snus, a tobacco product made popular in Sweden (Foulds, Ramstrom, Burke, & Fagerstrom, 2003). These new ST products have lower concentrations of cancer-causing tobacco-specific nitrosamines, but they also have lower concentrations of nicotine than traditional ST products (Stepanov, Jensen, Hatsukami, & Hecht, 2008). New ST products are being marketed to be used in situations in which smokers cannot smoke. Current

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manufacturing and marketing of new ST products have significant potential for increasing dual use of ST and cigarettes (Hatsukami & Tomar, 2010). Data from a world-wide case-control study suggest that, compared with cigarette smokers, dual users of cigarettes and ST are at higher risk for acute myocardial infarction (Teo et al., 2006). In addition, dual users have higher levels of nicotine exposure (Wetter et al., 2002), may be less likely to stop tobacco use (Hatsukami & Severson, 1999; Little, Stevens, Severson, & Lichtenstein, 1992; Post, Gilljam, Rosendahl, Bremberg, & Rosaria Galanti, 2010; Stevens, Severson, Lichtenstein, Little, & Leben, 1995; Tomar et al., 2010; Walsh et al., 2003, 2010), and have a lower likelihood of remaining abstinent from tobacco (Rodu, Stegmayr, Nasic, Cole, & Asplund, 2003; Wetter et al., 2002). Compared with other tobacco users, dual users consume larger amounts of alcohol (Accortt, Waterbor, Beall, & Howard, 2002; Wetter et al., 2002) and have a higher prevalence of obesity (Eliasson, Asplund, Nasic, & Rodu, 2004; Johansson, Sundquist, Qvist, & Sundquist, 2005; Rodu et al., 2003).

Tobacco use intervention studies have reported on the outcomes of subjects who use multiple types of tobacco, namely ST and cigarettes (Little et al., 1992; Severson et al., 2000; Stevens et al., 1995; Walsh et al., 2003, 2010). However, the study of multiple types of tobacco use is challenging because of the lack of a consistent definition. In order to advance our understanding of the terminology and definitions of multiple types of tobacco use in the published medical literature, we conducted a systematic review. We identified 373 articles addressing multiple tobacco product use. Of these, twenty-five articles (Backinger et al., 2008; Bombard, Pederson, Nelson, & Malarcher, 2007; Bombard, Rock, Pederson, & Asman, 2008; Chao et al., 2002; Croucher, Islam, & Pau, 2007; Digard, Errington, Richter, & McAdam, 2009; Everett, Malarcher, Sharp, Husten, & Giovino, 2000; Galanti, Rosendahl, & Wickholm, 2008; Gilpin & Pierce, 2003; Horn, Gao, Dino, & Kamal-Bahl, 2000; Lando, Haddock, Klesges, Talcott, & Jensen, 1999; Mumford, Levy, Gitchell, & Blackman, 2005, 2006; Post et al., 2005, 2010; Rigotti, Lee, & Wechsler, 2000; Rodu & Cole, 2009; Rodu, Stegmayr, Nasic, & Asplund, 2002; Skander & Larbaoui, 1989; Spangler et al., 1999, 2001; Tercyak & Audrain, 2002; Tomar, 2002; Wetter et al., 2002; Wickholm, Galanti, Soder, & Gilljam, 2003) reported prevalence data based upon the type and frequency of tobacco use (Supplementary Appendix A). Several different terms were used to describe the simultaneous use of two tobacco products, including "dual use" (Digard et al., 2009; Post et al., 2010; Rodu & Cole, 2009; Spangler et al., 1999, 2001), "concurrent use" (Croucher et al., 2007; Mumford et al., 2005, 2006; Tomar, 2002), "combined use" (Rodu et al., 2002; Wickholm et al., 2003), "poly use" (Lando et al., 1999), "mixed use" (Galanti et al., 2008; Post et al., 2005), "conjoint use" (Horn et al., 2000), "concomitant use" (Wetter et al., 2002), and "use both" (Skander & Larbaoui, 1989). The most commonly used term for use of both cigarettes and ST was "dual use." Of the 17 articles describing use of two tobacco products, five studies (Digard et al., 2009; Post et al., 2010; Rodu & Cole, 2009; Spangler et al., 1999, 2001) defined the use of both cigarettes and ST as "dual use."

In our review, we observed that dual tobacco product use was defined across two dimensions: (a) the type of tobacco products consumed (e.g., cigarettes, ST, cigar, pipe, bidis, or kreteks) and (b) the frequency of use (e.g., per day, per week,

per month, in the last year, or ever use). Most studies (17 of 25) analyzed the use of both cigarettes and ST (Croucher et al., 2007; Digard et al., 2009; Galanti et al., 2008; Horn et al., 2000; Lando et al., 1999; Mumford et al., 2005, 2006; Post et al., 2005, 2010; Rodu & Cole, 2009; Rodu et al., 2002; Skander & Larbaoui, 1989; Spangler et al., 1999, 2001; Tomar, 2002; Wetter et al., 2002; Wickholm et al., 2003); one study analyzed cigarettes, ST, or cigars (Everett et al., 2000); three studies analyzed cigarettes, ST, cigars, and pipes (Backinger et al., 2008; Chao et al., 2002; Rigotti et al., 2000); one study analyzed cigarettes, ST, cigars, or bidis (Gilpin & Pierce, 2003); one study analyzed cigarettes, ST, cigars, pipe, or bidis (Bombard et al., 2007); and two studies analyzed cigarettes, ST, cigars, pipes, bidis, or kreteks (Bombard et al., 2008; Tercyak & Audrain, 2002). The frequency of use requirement to define current tobacco use also varied substantially. In eight studies, current dual use was defined as smoking cigarettes with other tobacco products at any point within the past thirty days, and any number other than zero was considered a current user (Bombard et al., 2008; Everett et al., 2000; Gilpin & Pierce, 2003; Mumford et al., 2005; Post et al., 2005, 2010; Spangler et al., 2001; Tercyak & Audrain, 2002). Five other studies identified a participant as a current dual user if use of tobacco products was "every day or some days" (Bombard et al., 2007; Horn et al., 2000; Rodu & Cole, 2009; Tomar, 2002; Wickholm et al., 2003). Other studies defined current tobacco use as tobacco use at least ten days in the past thirty days (Mumford et al., 2006), tobacco use in the past seven days (Wetter et al., 2002), weekly use for at least three months (Galanti et al., 2008), at enrollment (Chao et al., 2002), or tobacco use in the past year (Rigotti et al., 2000). Two studies required that daily tobacco use be the frequency criterion (Croucher et al., 2007; Rodu et al., 2002). Another study defined current dual use as daily ST use, while cigarette smoking could be daily or occasionally (Digard et al., 2009). One study defined current use as "ever use" of both cigarette and ST (Spangler et al., 1999). Finally, one study (Backinger et al., 2008) varied the definition of current use based on the frequency of cigarette smoking and defined dual use as "currently used" another substance "at the time of interview."

Defining dual use as the concomitant use of cigarettes and ST appears to be justified based upon several arguments. First, cigarettes and ST are the two most prevalent tobacco products consumed daily (CDC, 2009; Ebbert et al., 2004). Second, both cigarettes and ST are being heavily marketed by the tobacco companies, and the two largest cigarette manufacturers in the United States now virtually control the entire U.S. ST market (Tomar et al., 2010). Industry documents suggest that cigarette manufacturers are not going to abandon cigarettes but, rather, promote ST products as situational substitutes and complementary products (Carpenter, Connolly, Ayo-Yusuf, & Wayne, 2009; Tomar et al., 2010). Third, available evidence suggests that the risk posed by concomitant use of cigarettes and ST may be greater than smoking cigarettes alone (Teo et al., 2006). Finally, defining dual use as the concomitant use of ST and cigarettes is the most prevalent definition in the literature.

However, the frequency definitions of ST and cigarettes for dual use are less well defined. In order to expand our understanding of the extent to which alterations of the frequency definition of ST and cigarette "dual use" alter frequency estimates and the characteristics of dual users compared with mono

cigarette and ST users, we analyzed a cohort of military recruits. First, we determined what varying the frequency and type of definition for dual use did to prevalence estimates. Second, based on our recommended definition of dual use being cigarettes and ST, we evaluated ranges of prevalence estimate with ST and cigarettes to determine if the variability of prevalence estimates improved. Third, we evaluated the risk profile of dual users versus mono users of tobacco using both frequency and multivariate equations.

Methods

Study Overview

This investigation was a collaborative effort among the Universities of Memphis, Missouri–Kansas City, and Minnesota with Wilford Hall Medical Center at Lackland Air Force Base. The data presented here were obtained as part of a randomized clinical trial investigating the efficacy of forced cessation combined with a tailored tobacco use prevention and cessation program for Air Force recruits (Klesges et al., 2006). The study protocol was approved by the National Institutes of Health and the Institutional Review Boards of the University of Memphis, University of Missouri–Kansas City, and the US Air Force at Wilford Hall Medical Center in San Antonio, TX.

Participants and Procedures

Participants were 36,013 Air Force recruits who entered basic military training (BMT) between 1999 and 2000. During their second week in BMT, participants completed a 68-item survey measuring tobacco use in addition to demographics, lifestyle attitudes, and health risk behaviors. Because tobacco use is strictly forbidden during BMT, questions were framed retrospectively, for example, “What was your history of cigarette smoking just prior to basic military training?” Available response options were (a) “I have never smoked, not even one puff,” (b) “I smoked only on one or two occasions in the past,” (c) “I smoked regularly (at least once per day) but quit in the past 6 months,” (d) “I smoked regularly (at least once per day) but quit between 6 months and 1 year ago,” (e) “I smoked regularly (at least once per day) but quit more than a year ago,” (f) “I smoked, but not every day,” and (g) “I smoked every day.” Recruits answered five additional questions related to use of ST, cigars, pipes, bidis, and clove cigarettes (i.e., kreteks). Lifestyle attitudes and behaviors were measured with questions about alcohol consumption, rebelliousness, risk-taking behavior (e.g., rock climbing, driving 100 mph), gambling, firearm ownership, driving practices, and serious verbal altercations and/or physical fights during the previous year.

Tobacco use status was categorized according to frequency of use and type of tobacco used (cigarettes, ST, cigars, pipes, clove cigarettes, and bidis). For the purposes of this paper, we examined changes in prevalence of dual use in our military based on different “dual use” criteria. We examined the data using three definitions of use frequency for any two tobacco products (cigarettes, ST, cigars, pipes, bidis, and clove cigarettes): (a) either product used daily or nondaily, (b) one product used daily and the other product used nondaily (daily + nondaily), and (c) both products used daily (daily + daily). Next, we recalculated prevalence estimates based on our recommended definition of ST and cigarettes to determine the degree to which prevalence estimates attenuated.

Statistical Analysis

Multivariate logistic regression modeling was used to compare dual users of both ST and cigarettes to both mono users of ST and mono users of cigarettes. Given that we had very little time (20 min) to administer the entire risk factor questionnaire, we were unable to have Airmen complete a comprehensive assessment battery based on a validated behavior change theory. As such, we focused on common empirical correlates of tobacco use that are common in the civilian literature as well as potential military-related risk factors that seemed plausibly related to tobacco use. For example, both alcohol intake (De Leon et al., 2007; Grant, Hasin, Chou, Stinson, & Dawson, 2004; Severson et al., 2000) and risk taking (Klesges, Sherrill-Mittleman, Ebbert, Talcott, & Debon, 2010) predict tobacco status in the civilian literature. An example of “military-specific” items was whether they believed the ban on tobacco in BMT was a good idea (or not) and how long they planned to stay in the Air Force. Regarding the latter, it was reasoned that those planning on staying in the Air Force longer were more likely to adopt and agree with the policies, procedures, and lifestyles of the Air Force. This would include the Air Force’s discouragement of any lifestyle factors that would reduce military readiness, such as smoking.

We first conducted bivariate logistic regression analyses for each covariate of interest. Potential covariates were age, gender, race, education level, annual income, relationship status, Air Force duty status (Active duty, Guard, or Reserve), and estimated career length in the Air Force (in years). Tobacco-related covariates were smoking status of friends, smoking status of heads of household, attitude toward the BMT tobacco ban, attitude toward the tobacco industry, perceived health benefit that might result from switching from cigarettes to ST, age of first puff from a cigarette, plans for smoking in the future, ownership of tobacco promotional items, and history of using nicotine replacement therapy. Other covariates were frequency of alcohol consumption and amount of intake, enjoyment of risk taking, rebelliousness, incidents of verbal altercations or physical fighting in the past twelve months, frequency of gambling for money, weapon ownership, depressed mood, and driving practices, such as driving aggressively, keeping a weapon in the vehicle, and drinking and driving. Variables with univariate results significant at the $p < .10$ level were used to fit a multivariate model with backward stepwise regression until all remaining covariates were significant at the $p < .05$ level (Hosmer & Lemeshow, 2000).

Results

The demographic characteristics of the study’s population were described elsewhere (Klesges et al., 2006). For the current study, by utilizing daily use as the criteria for mono use and daily use of either ST/cigarettes and at least nondaily use of the other tobacco product, Table 1 presents frequency information of those who are mono users of cigarettes, mono users of ST, and dual users. Overall, the prevalence of mono cigarette smokers was 19.8%, the prevalence of mono ST users was 1.8%, and the prevalence of dual users (daily use of one substance and nondaily use of the other) was 3.3%. The prevalence of dual users of ST and cigarettes is 83% higher than that of mono ST users (3.3% vs. 1.8%).

Table 1. Demographic Distribution of Mono and Dual Cigarette/ST Users Among Air Force Recruits (total N = 36,013)

	Daily mono user of cigarettes (N = 7,148)	Daily mono user of ST (N = 651)	Dual user of ST/cigarettes (N = 1,191)
Age			
21 years or older	1,719 (19.8)	193 (2.2) _a	257 (3.0)
17–20 years	5,429 (19.9)	458 (1.7) _a	934 (3.4)
Gender			
Female	1,986 (21.4) _a	4 (0.04) _a	19 (0.2) _a
Male	5,162 (19.3) _a	647 (2.4) _a	1,172 (4.4) _a
Ethnicity			
White	5,764 (25.0) _a	610 (2.6) _{abc}	1,126 (4.9) _{abc}
Black	530 (8.0) _a	10 (0.2) _{ac}	14 (0.2) _{abc}
Hispanic	356 (10.2) _a	14 (0.4) _b	23 (0.7) _b
Other	498 (17.6) _a	17 (0.6) _c	28 (1.0) _c
Education			
≤High school	5,766 (21.0) _a	488 (1.8)	978 (3.6) _a
>High school	1,381 (16.2) _a	163 (1.9)	213 (2.5) _a
Income			
≤\$25,000	1,782 (19.4) _a	127 (1.4) _a	253 (2.8) _{ac}
>\$25,000–\$45,000	1,712 (18.6) _a	166 (1.8)	256 (2.8) _b
>\$45,000–\$70,000	1,738 (19.0) _b	168 (1.8)	323 (3.5) _a
>\$70,000	1,916 (22.6) _{ab}	190 (2.2) _a	359 (4.2) _c

Note. Percentages are row percentages. Shared subscripts: $p < .01$ within tobacco use category. Definitions: Mono user of ST is daily use of ST, mono user of cigarettes is daily use of use of cigarettes, and dual use is daily use of one substance and nondaily use of the other. ST = smokeless tobacco.

Within demographic groups, the prevalence of cigarette use was greater in females, Caucasians, those with less than a high-school education, and those with a household income greater than \$70,000. ST use was more prevalent among older Airmen, in males (relative to females), was much more prevalent in Caucasians, and among those with family incomes greater than \$70,000. Dual users were more likely to be male, Caucasian, having less than a high-school education, and having family incomes of greater than \$70,000.

Next, we evaluated the various definitions of “dual use” as used in the literature in this dataset. As one might predict, the prevalence of dual use varies markedly as a function of the type of tobacco product used to define dual use as well as a function of frequency of use. One quarter of the sample would be classified as dual users if dual use is defined as the consumption of any two tobacco products with either a daily or nondaily frequency (please note that daily rates are included in nondaily frequencies). This is in marked contrast to the most stringent definition of dual use as daily use of both cigarettes and ST with a prevalence of 0.5%. Thus, depending on the definition of dual use, prevalence varies as much as 50-fold. When using just the two tobacco products recommended in our definition, prevalence estimates are greatly attenuated from 2.0% for daily cigarette/daily ST users to 9.7% for daily cigarette/nondaily ST use. Still, this represents a range of prevalence nearly fourfold but is considerably less than the estimates when other tobacco products are included.

Table 2 presents the multivariate logistic regressions comparing dual users of cigarettes and ST to (a) mono users of cigarettes and (b) mono users of ST. The left side of Table 2

compares the independent correlates of dual users compared with the reference group of mono users of cigarettes. The strongest correlates of dual use is male gender (odds ratio [OR] = 15.93, $CI = 10.05$ – 25.26), Caucasian race (ORs range from 0.18 to 0.43), the belief that switching from cigarettes to ST yields a moderate to large reduction in harm (OR = 2.57, $CI = 2.07$ – 3.20), having a firearm in their vehicle at least once a week (OR = 2.43, $CI = 1.87$ – 3.17), and owning a personal firearm (OR = 1.91, $CI = 1.62$ – 2.25). Weaker but still significant correlates of dual use relative to cigarette smoking was alcohol intake at least once a week (OR = 1.68, $CI = 1.39$ – 2.02), being a Guard or Reservist (vs. Active Duty, OR = 1.36, $CI = 1.11$ – 1.68), a younger age (OR = 1.36, $CI = 1.15$ – 1.61), at least weekly gambling (OR = 1.35, $CI = 1.11$ – 1.64), owning at least one tobacco promotional item (OR = 1.16, $CI = 1.01$ – 1.34), and a younger age at first puff of a cigarette (OR = 1.04, $CI = 1.01$ – 1.06).

The right side of Table 2 evaluates the independent correlates of dual users compared with the reference group of mono users of ST. Dual users were nearly 137 times more likely to predict that they would smoke over the next year relative to mono users of ST (OR = 136.66, $CI = 76.06$ – 245.54). Compared with mono ST users, dual users were nearly 15 times more likely to report that “almost all” of their friends smoke cigarettes (OR = 14.85, $CI = 8.89$ – 24.81). They were also more likely to report nicotine replacement therapy use in the past (OR = 2.66, $CI = 1.72$ – 4.10) and to report plans for staying in the Air Force longer (OR = 1.73, $CI = 1.14$ – 2.62). Interestingly, while dual users were 2.6 times more likely to report harm reduction by switching to ST relative to cigarette smokers, they were less likely to report a harm-reduction benefit to ST relative to ST users (OR = 0.41, $CI = 0.29$ – 0.58).

Table 2. Logistic Regression Comparing Dual Users of Cigarettes and ST Relative to Mono Users of Cigarettes or ST

	^a Dual users (vs. mono cigarette smokers)			^b Dual users (vs. mono ST users)		
	OR	95% CI	p value	OR	95% CI	p value
Age (years)						
≥21	1.00			–		
17–20	1.36	1.15–1.61	<.01	–	–	–
Gender						
Female	1.00			–		
Male	15.93	10.05–25.26	<.01	–	–	–
Race/ethnicity						
White	1.00			–		
Black	0.18	0.10–0.30	<.01	–	–	–
Hispanic	0.43	0.28–0.67	<.01	–	–	–
Other	0.37	0.25–0.55	<.01	–	–	–
Younger age at first cigarette puff	1.04	1.01–1.06	<.01	–	–	–
Air Force duty status						
Active duty	1.00			–		
Guard or Reserve	1.36	1.11–1.68	<.01	–	–	–
Alcohol past thirty days						
Not at all	1.00			–		
≤4 times a month	1.08	0.90–1.29	.41	–	–	–
At least once a week	1.68	1.39–2.02	<.01	–	–	–
Gambling past twelve months						
Not at all	1.00			–		
Less than once a month	1.10	0.92–1.30	.28	–	–	–
Once a month	1.11	0.91–1.34	.31	–	–	–
At least once a week	1.35	1.11–1.64	<.01	–	–	–
Owned personal firearm past twelve months						
No	1.00			–		
Yes	1.91	1.62–2.25	<.01	–	–	–
Firearm in vehicle past twelve months						
Not at all	1.00			–		
Less than once a month	1.37	1.09–1.73	.01	–	–	–
Once a month	1.93	1.42–2.61	<.01	–	–	–
At least once a week	2.43	1.87–3.17	<.01	–	–	–
Own a tobacco promotional item						
No	1.00			–		
Yes	1.16	1.01–1.34	.03	–	–	–
Perceived harm reduction in switching from cigarettes to ST						
No reduction	1.00			1.00		
Small reduction	1.38	1.16–1.64	<.01	0.65	0.46–0.90	.01
Moderate to large reduction	2.57	2.07–3.20	<.01	0.41	0.29–0.58	<.01
Male head of household smokes cigarettes						
No	–			1.00		
Yes	–	–	–	1.48	1.11–1.98	.01
Proportion of friends who smoke cigarettes						
Hardly any	–			1.00		
Some	–	–	–	2.93	1.77–4.83	<.01
Many	–	–	–	6.14	3.79–9.96	<.01
Almost all	–	–	–	14.85	8.89–24.81	<.01
Will smoke a cigarette in next year						
Definitely not	–			1.00		
Probably not	–	–	–	8.22	4.89–13.82	<.01
Probably yes	–	–	–	33.86	20.38–56.24	<.01
Definitely yes	–	–	–	136.66	76.06–245.54	<.01

Table 2. Continued

	^a Dual users (vs. mono cigarette smokers)			^b Dual users (vs. mono ST users)		
	OR	95% CI	p value	OR	95% CI	p value
NRT use						
Never used NRT	–			1.00		
Have used NRT	–	–	–	2.66	1.72–4.10	<.01
Would describe self as rebellious						
Neutral/disagree	–			1.00		
Agree	–	–	–	1.58	1.09–2.30	.02
Air Force career plans						
4 years	–			1.00		
5–16 years	–	–	–	1.37	0.94–2.01	.11
17 years to retirement	–	–	–	1.73	1.14–2.62	.01
Undecided	–	–	–	1.51	1.03–2.22	.04
Hosmer & Lemeshow goodness of fit	² (8) = 11.30, <i>p</i> = .18			² (8) = 10.13, <i>p</i> = .26		

Note. NRT = nicotine replacement therapy; CI = confidence interval; OR = odds ratio; ST = smokeless tobacco.

^aThe left side compares the independent correlates of dual users compared with the reference group of mono users of cigarettes (Hosmer-Lemeshow goodness-of-fit-test $\chi^2(8) = 11.30, p = .18$).

^bThe right side evaluates the independent correlates of dual users compared with the reference group of mono users of ST (Hosmer-Lemeshow goodness-of-fit-test $\chi^2(8) = 10.13, p = .26$).

Discussion

Prevalence rates of dual use vary markedly based on the type of tobacco used to classify dual use as well as the frequency of use. In our cohort of military recruits, estimates of prevalence of dual use vary by up to 50-fold depending upon the definition of dual use. However, when using the more stringent definition of tobacco use being ST and cigarettes, the prevalence ranges greatly reduce but still very close to four fold. Using a definition of daily use of cigarette or ST and at least nondaily use of the other substance yielded prevalence estimates of 3.3%. The prevalence of dual use in this military cohort was 83% greater than that of mono use of ST. Demographically, dual users tend to be male, younger, of Caucasian race, lower education, and from families with relatively higher incomes. The results of the logistic regressions suggest that relative to either mono users of ST or cigarettes, dual users of cigarettes and ST have very different risk profiles, suggesting that interventions tailored for dual users may be warranted.

Our results on prevalence are consistent with the literature, which cites wide prevalence rates across a number of samples. In our review of the literature, prevalence estimates ranged from 6.9% (Bombard et al., 2008) to 19.5% (Everett et al., 2000) in adolescents and from 0.28% (Mumford et al., 2006) to 3.4% (Bombard et al., 2007) in adults in the United States. While it appears that prevalence of dual use is higher in adolescents (Bombard et al., 2008; Everett et al., 2000; Gilpin & Pierce, 2003; Horn et al., 2000; Tercyak & Audrain, 2002) and in Sweden (Digard et al., 2009; Galanti et al., 2008; Post et al., 2005, 2010; Wickholm et al., 2003), direct comparisons of populations is compromised by the lack of a common definition. Our results demonstrate that risk profiles change as the definition of dual use changes. Given the prevalence differences and the differential risk factor profiles, a common operational definition (or perhaps definitions) of dual use is desperately needed.

Regarding frequency of use, we submit that one product should be used daily to indicate chronic use. The other product should be consumed at least weekly to establish regular, but intermittent use, but with sufficient frequency to be concerned with potential health side effects. While we advocate a working definition of dual use as cigarette/ST use that is daily use of one substance and at least weekly use of the other, research on dual use is in its infancy and substantially more research is needed. First, as mentioned above, there is only one study to date that shows a relationship between dual use and adverse health outcomes (Teo et al., 2006). More epidemiological data to establish risk for disease are needed. Accurate estimates of prevalence and risk factors for use are also needed. Our proposed working definition of dual use is not measurable (indeed not even in the current dataset) with several existing surveys as many national survey questions are designed to focus on regular rather than on intermittent use. For example, the National Survey on Drug Use and Health assesses tobacco use by asking about lifetime, past year, and past month use (Substance Abuse and Mental Health Services Administration & Office of Applied Studies, 2008). Beginning in 2000, the questions to determine current ST use status changed from “Do you use {chewing tobacco/snuff} now?” to “Do you now use {chewing tobacco/snuff} everyday, some days, or not at all?” Finally, and most importantly, interventions to treat dual use need to be tested and disseminated.

Our findings also suggest that dual users may be a higher risk group with heavier alcohol consumption, risk-taking behaviors, and surrounded by tobacco users. A particularly interesting finding is that dual users were more likely than cigarettes smokers to believe that ST reduces harm, but they were less likely to agree to this perception relative to ST users. One might postulate that for dual users who smoke, this rationalizes their ST use. However, collectively, our findings indicate that aggressive targeted programs for dual users of tobacco are warranted, at least in military populations. Given that the prevalence of

dual use in our military population exceed the prevalence of mono users of ST, this argues even more cogently for specialized programs for dual users.

Our study has several weaknesses. While a large dataset, the sample has a disproportionate number of males, minorities, and individuals from lower incomes. As a military population, generalizability to civilian populations may be limited. Since the cohort is primarily 18- to 24-year-olds, we may be overestimating dual use as this is the age during which illicit drug, tobacco, and drug experimentations predominantly occur ([Substance Abuse and Mental Health Services Administration, 2009](#)).

In summary, dual users are a unique group of tobacco users compared with mono cigarette and mono ST users. A common definition of dual use is needed to move this field forward.

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Declaration of Interests

None declared.

Supplementary Material

Supplementary Appendix A can be found online at <http://www.ntn.oxfordjournals.org/>

References

- Accortt, N. A., Waterbor, J. W., Beall, C., & Howard, G. (2002). Chronic disease mortality in a cohort of smokeless tobacco users. *American Journal of Epidemiology*, 156, 730–737. doi:10.1093/aje/kwf106
- Backinger, C. L., Fagan, P., O'Connell, M. E., Grana, R., Lawrence, D., & Bishop, J. A. (2008). Use of other tobacco products among U.S. adult cigarette smokers: Prevalence, trends and correlates. *Addictive Behaviors*, 33, 472–489. doi:10.1016/j.addbeh.2007.10.009
- Bombard, J. M., Pederson, L. L., Nelson, D. E., & Malarcher, A. M. (2007). Are smokers only using cigarettes? Exploring current polytobacco use among an adult population. *Addictive Behaviors*, 32, 2411–2419. doi:10.1016/j.addbeh.2007.04.001
- Bombard, J. M., Rock, V. J., Pederson, L. L., & Asman, K. J. (2008). Monitoring polytobacco use among adolescents: Do cigarette smokers use other forms of tobacco? *Nicotine & Tobacco Research*, 10, 1581–1589. doi:10.1080/14622200802412887
- Carpenter, C. M., Connolly, G. N., Ayo-Yusuf, O. A., & Wayne, G. F. (2009). Developing smokeless tobacco products for smokers: An examination of tobacco industry documents. *Tobacco Control*, 18, 54–59. doi:10.1136/tc.2008.026583
- Centers for Disease Control and Prevention. (2002). Annual smoking-attributable mortality, years of potential life lost, and economic costs—United States, 1995–1999. *Morbidity and Mortality Weekly Report*, 51, 300–303. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=12002168
- Centers for Disease Control and Prevention. (2009). Cigarette smoking among adults and trends in smoking cessation - United States, 2008. *Morbidity and Mortality Weekly Report*, 58, 1227–1232. doi:10.1136/1227-1232
- Chao, A., Thun, M. J., Henley, S. J., Jacobs, E. J., McCullough, M. L., & Calle, E. E. (2002). Cigarette smoking, use of other tobacco products and stomach cancer mortality in US adults: The Cancer Prevention Study II. *International Journal of Cancer*, 101, 380–389. doi:10.1002/ijc.10614
- Croucher, R. E., Islam, S. S., & Pau, A. K. (2007). Concurrent tobacco use in a random sample of UK-resident Bangladeshi men. *Journal of Public Health Dentistry*, 67, 83–88. doi:10.1111/j.1752-7325.2007.00019
- De Leon, J., Rendon, D. M., Baca-Garcia, E., Aizpuru, F., Gonzalez-Pinto, A., & Anitua, C. (2007). Association between smoking and alcohol use in the general population: Stable and unstable odds ratios across two years in two different countries. *Alcohol and Alcoholism*, 42, 252–257. doi:10.1093/alcalc/agm029
- Digard, H., Errington, G., Richter, A., & McAdam, K. (2009). Patterns and behaviors of snus consumption in Sweden. *Nicotine & Tobacco Research*, 11, 1175–1181. doi:10.1093/ntn/ntp118
- Ebbert, J. O., Carr, A. B., & Dale, L. C. (2004). Smokeless tobacco: An emerging addiction. *Medical Clinics of North America*, 88, 1593–1605. doi:10.1016/j.mcna.2004.06.003
- Eliasson, M., Asplund, K., Nasic, S., & Rodu, B. (2004). Influence of smoking and snus on the prevalence and incidence of type 2 diabetes amongst men: The northern Sweden MONICA study. *Journal of Internal Medicine*, 256, 101–110. doi:10.1111/j.1365-2796.2004.01344
- Everett, S. A., Malarcher, A. M., Sharp, D. J., Husten, C. G., & Giovino, G. A. (2000). Relationship between cigarette, smokeless tobacco, and cigar use, and other health risk behaviors among U.S. high school students. *Journal of School Health*, 70, 234–240. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=10937370
- Foulds, J., Ramstrom, L., Burke, M., & Fagerstrom, K. (2003). Effect of smokeless tobacco (snus) on smoking and public health in Sweden. *Tobacco Control*, 12, 349–359. doi:10.1136/tc.12.4.349
- Galanti, M. R., Rosendahl, I., & Wickholm, S. (2008). The development of tobacco use in adolescence among “snus starters” and “cigarette starters”: An analysis of the Swedish “BROMS” cohort. *Nicotine & Tobacco Research*, 10, 315–323. doi:10.1080/14622200701825858
- Gilpin, E. A., & Pierce, J. P. (2003). Concurrent use of tobacco products by California adolescents. *Preventive Medicine*, 36, 575–584. doi:10.1016/j.ypmed.2003.06.006

- Grant, B. F., Hasin, D. S., Chou, S. P., Stinson, F. S., & Dawson, D. A. (2004). Nicotine dependence and psychiatric disorders in the United States: Results from the National Epidemiologic Survey on alcohol and related conditions. *Archives of General Psychiatry*, 61, 1107–1115. doi:10.1001/archpsyc.61.11.1107
- Hatsukami, D. K., & Severson, H. H. (1999). Oral spit tobacco: Addiction, prevention and treatment. *Nicotine & Tobacco Research*, 1, 21–44. doi:10.1080/14622299050011131
- Hatsukami, D. K., & Tomar, S. (2010). Commentary on Post et al. (2010): Snus, a cautionary reminder. *Addiction*, 105, 747–748. doi:10.1111/j.1360-0443.2010.02922
- Horn, K. A., Gao, X., Dino, G. A., & Kamal-Bahl, S. (2000). Determinants of youth tobacco use in West Virginia: A comparison of smoking and smokeless tobacco use. *American Journal of Drug and Alcohol Abuse*, 26, 125–138. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=10718168
- Hosmer, D. W., & Lemeshow, S. (2000). *Applied logistic regression* (2nd ed.). New York: John Wiley & Sons.
- Johansson, S. E., Sundquist, K., Qvist, J., & Sundquist, J. (2005). Smokeless tobacco and coronary heart disease: A 12-year follow-up study. *European Journal of Cardiovascular Prevention and Rehabilitation*, 12, 387–392. doi:00149831-200508000-00013
- Klesges, R. C., DeBon, M., Vander Weg, M. W., Haddock, C. K., Lando, H. A., & Relyea, G. E. (2006). Efficacy of a tailored to -bacco control program on long-term use in a population of U.S. military troops. *Journal of Consulting and Clinical Psychology*, 74, 295–306. doi:10.1037/0022-006X.74.2.295
- Klesges, R. C., Sherrill-Mittleman, D., Ebbert, J. O., Talcott, G. W., & Debon, M. (2010). Tobacco use harm reduction, elimination, and escalation in a large military cohort. *American Journal of Public Health*, 100, 2487–2492. doi:10.2105/AJPH.2009.175091
- Lando, H. A., Haddock, C. K., Klesges, R. C., Talcott, G. W., & Jensen, J. (1999). Smokeless tobacco use in a population of young adults. *Addictive Behaviors*, 24, 431–437. doi:S0306-4603(98)00058-6
- Little, S. J., Stevens, V. J., Severson, H. H., & Lichtenstein, E. (1992). Effective smokeless tobacco intervention for dental hygiene patients. *Journal of Dental Hygiene*, 66, 185–190. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=1625002
- Mumford, E. A., Levy, D. T., Gitchell, J. G., & Blackman, K. O. (2005). Tobacco control policies and the concurrent use of smokeless tobacco and cigarettes among men, 1992–2002. *Nicotine & Tobacco Research*, 7, 891–900. doi:10.1080/14622200500266098
- Mumford, E. A., Levy, D. T., Gitchell, J. G., & Blackman, K. O. (2006). Smokeless tobacco use 1992–2002: Trends and measurement in the Current Population Survey-Tobacco Use Supplements. *Tobacco Control*, 15, 166–171. doi:10.1136/tc.2005.012807
- National Cancer Institute. (1998). *Cigars: Health effects and trends*, (Smoking and Tobacco Control Monograph No. 9). Retrieved from <http://cancercontrol.cancer.gov/tcrb/monographs/9/index.html>
- National Toxicology Program. (2005). *11th Report on Carcinogens (RoC)*, Retrieved from <http://ehp.niehs.nih.gov/roc>
- Post, A., Gilljam, H., Rosendahl, I., Bremberg, S., & Rosaria Galanti, M. (2010). Symptoms of nicotine dependence in a cohort of Swedish youths: A comparison between smokers, smokeless tobacco users and dual tobacco users. *Addiction*, 105(4): 747–478. doi:10.1111/j.1360-0443.2009.02852
- Post, A., Gilljam, H., Rosendahl, I., Meurling, L., Bremberg, S., & Galanti, M. R. (2005). Validity of self reports in a cohort of Swedish adolescent smokers and smokeless tobacco (snus) users. *Tobacco Control*, 14, 114–117. doi:10.1136/tc.2004.008789
- Rigotti, N. A., Lee, J. E., & Wechsler, H. (2000). US college students' use of tobacco products: Results of a national survey. *Journal of the American Medical Association*, 284, 699–705. doi:10.1001/jama.284.6.699
- Rodu, B., & Cole, P. (2009). Lung cancer mortality: Comparing Sweden with other countries in the European Union. *Scandinavian Journal of Public Health*, 37, 481–486. doi:10.1177/1403494809105797
- Rodu, B., Stegmayr, B., Nasic, S., & Asplund, K. (2002). Impact of smokeless tobacco use on smoking in northern Sweden. *Journal of Internal Medicine*, 252, 398–404. doi:10.1046/j.1365-2796.2002.01057
- Rodu, B., Stegmayr, B., Nasic, S., Cole, P., & Asplund, K. (2003). Evolving patterns of tobacco use in northern Sweden. *Journal of Internal Medicine*, 253, 660–665. doi:10.1046/j.1365-2796.2002.01057
- Rogers, J. D., Biener, L., & Clark, P. I. (2010). Test marketing of new smokeless tobacco products in four U.S. cities. *Nicotine & Tobacco Research*, 12, 69–72. doi:10.1093/ntr/ntp166
- Severson, H. H., Andrews, J. A., Lichtenstein, E., Gordon, J. S., Barckley, M., & Akers, L. (2000). A self-help cessation program for smokeless tobacco users: Comparison of two interventions. *Nicotine & Tobacco Research*, 2, 363–370. doi:10.1080/713688152
- Skander, F., & Larbaoui, D. (1989). [Epidemiology of smoking in the Wilaya population of Algeria]. *Revue d'Epidemiologie et de Sante Publique*, 37, 143–148. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=2772359
- Spangler, J. G., Bell, R. A., Knick, S., Michielutte, R., Dignan, M. B., & Summerson, J. H. (1999). Epidemiology of tobacco use among Lumbee Indians in North Carolina. *Journal of Cancer Education*, 14, 34–40. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=10328322
- Spangler, J. G., Michielutte, R., Bell, R. A., Knick, S., Dignan, M. B., & Summerson, J. H. (2001). Dual tobacco use among Native American adults in southeastern North Carolina. *Preventive Medicine*, 32, 521–528. doi:10.1006/pmed.2001.0835

- Stepanov, I., Jensen, J., Hatsukami, D., & Hecht, S. S. (2008). New and traditional smokeless tobacco: Comparison of toxicant and carcinogen levels. *Nicotine & Tobacco Research*, 10, 1773–1782. doi:10.1080/14622200802443544
- Stevens, V. J., Severson, H., Lichtenstein, E., Little, S. J., & Leben, J. (1995). Making the most of a teachable moment: A smokeless-tobacco cessation intervention in the dental office. *American Journal of Public Health*, 85, 231–235. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=7856783
- Substance Abuse and Mental Health Services Administration. (2009). *Results from the 2008 National Survey on Drug Use and Health: National findings*, Office of Applied Studies, NSDUH Series H-36, HHS Publication No. SMA 09–4434 Retrieved from <http://www.oas.samhsa.gov/nsduh/2k8nsduh/2k8Results.cfm>
- Substance Abuse and Mental Health Services Administration & Office of Applied Studies. (2008). *Results from the 2007 National Survey on Drug Use and Health: National findings*. (NSDUH Series H-34, DHHS Publication No. SMA 08-4343). Rockville, MD. Retrieved from <http://www.oas.samhsa.gov/nsduh/2k7nsduh/2k7results.cfm>
- Teo, K. K., Ounpuu, S., Hawken, S., Pandey, M. R., Valentin, V., & Hunt, D. (2006). Tobacco use and risk of myocardial infarction in 52 countries in the INTERHEART study: A case-control study. *Lancet*, 368, 647–658. doi:10.1016/S0140-6736(06)69249-0
- Tercyak, K. P., & Audrain, J. (2002). Psychosocial correlates of alternate tobacco product use during early adolescence. *Preventive Medicine*, 35, 193–198. doi:S0091743502910601
- Tomar, S. L. (2002). Snuff use and smoking in U.S. men: Implications for harm reduction. *American Journal of Preventive Medicine*, 23, 143–149. doi:S0749379702004919
- Tomar, S. L., Alpert, H. R., & Connolly, G. N. (2010). Patterns of dual use of cigarettes and smokeless tobacco among US males: Findings from national surveys. *Tobacco Control*, 19, 104–109. doi:10.1136/tc.2009.031070
- Walsh, M. M., Hilton, J. F., Ellison, J. A., Gee, L., Chesney, M. A., & Tomar, S. L. (2003). Spit (smokeless) tobacco intervention for high school athletes: Results after 1 year. *Addictive Behaviors*, 28, 1095–1113. doi:S0306460302002289 [pii]
- Walsh, M. M., Langer, T. J., Kavanagh, N., Mansell, C., MacDougal, W., & Kavanagh, C. (2010). Smokeless tobacco cessation cluster randomized trial with rural high school males: Intervention interaction with baseline smoking. *Nicotine & Tobacco Research*, 12, 543–550. doi:10.1093/ntr/ntq022
- Wetter, D. W., McClure, J. B., de Moor, C., Cofta-Gunn, L., Cummings, S., & Cinciripini, P. M. (2002). Concomitant use of cigarettes and smokeless tobacco: Prevalence, correlates, and correlates of tobacco cessation. *Preventive Medicine*, 34, 638–648. doi:10.1006/pmed.2002.1032
- Wickholm, S., Galanti, M. R., Soder, B., & Gilljam, H. (2003). Cigarette smoking, snuff use and alcohol drinking: Coexisting risk behaviours for oral health in young males. *Community Dentistry and Oral Epidemiology*, 31, 269–274. doi:10.1034/j.1600-0528.2003.00046