Original investigation

Tobacco Use Pattern Among a National Firefighter Cohort

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Abstract

Introduction: To date, there have been no large-scale, national epidemiological studies of tobacco use patterns among firefighters, particularly with a focus on smokeless tobacco (SLT) and dual use with cigarettes. While rates of firefighters' smoking are relatively low compared to the general population, SLT use typically is substantially higher than the populations they protect. In the current study, we systemically examine tobacco use, including SLT and dual use, and the health-related profiles of various tobacco use groups in a national sample of career firefighters.

Methods: Data are from a national cohort study of career departments ($N = 20$) comprised of 947 male firefighters.

Results: Among 947 participants, 197 (21%) were tobacco users, of which, 34.5% used cigarettes, 53.2% used SLT, and 12.2% used both cigarettes and SLT. Adjusted rates of smoking, SLT use, and dual use were 13.2%, 10.5%, and 12.2%, respectively. Tobacco users of all types were significantly younger and had served fewer years in fire service and were significantly more likely to engage in heavy and binge drinking, as well as more likely to show signs of depressive symptoms compared to nontobacco users.

Conclusions: Detailed information on tobacco use pattern will aid in better understanding what factors are contributing to the high rates of SLT and dual use among firefighters in order to guide and develop an appropriate treatment program for the fire service.

Introduction

Tobacco use is one of the leading preventable causes of death in the United States.^{1,2} Since the release of the 1964 Surgeon General's report on smoking and health, rates of smoking in the United States have substantially decreased while the use of other tobacco products, such as smokeless tobacco (SLT), has increased.^{2–4} The emerging trend of greater SLT use suggests that smokers might use SLT due to smoking restrictions and/or the

perception that SLT has lower risks of morbidity and mortality compared to cigarettes.^{5,6}

Firefighters are charged with protecting lives and property in the communities they serve. Health and readiness for duty are of great concern, and a tobacco-free fire service has been a strongly promoted.^{6,7} Thus, rates of smoking among firefighters have decreased and are lower than national prevalence for males.⁸ However, the prevalence of SLT use in the fire service is remarkably high; 18.4% for SLT use and 2.6% for dual use of SLT and cigarettes^{8,9} which is

higher than the general population rates for males^{4,9} and any occupational group reported for the U.S. civilian work force.¹⁰

It has been difficult to explain these high rates of SLT and dual use in the fire service. Extrinsic factors, such as aggressive SLT marketing from tobacco industry^{6,11} partially explain the higher rates. However, personal factors, such as using SLT as an alternative for smoking cessation or as a harm-reduction strategy and the lack of culturally tailored SLT cessation interventions for the fire service also probably contribute to high rates of SLT use among firefighters. Moreover, sociocultural, psychosocial, and behavioral characteristics have been found to be associated with different types of tobacco use, which could play an important role in this trend.^{9,12}

The exceptionally high rates of SLT and dual use among firefighters likely play a role in high rates cardiovascular disease (CVD) and cancer found in this occupation.^{13–15} Given the critical role of firefighters in providing emergency services and the need for them to be healthy and fit to carry out their duties, it is important to better understand what factors are contributing to the high rates of SLT and dual use among firefighters in order to guide the development of an appropriate treatment program for the fire service. However, to date, there have been no large-scale, national epidemiological studies of tobacco use patterns among firefighters, particularly with a focus on SLT and dual use. Most studies and reports to date have focused primarily on cigarettes use and/or have been limited to convenience samples or specific regions of the country. The purpose of this study was to systematically examine tobacco use, including SLT and dual use, and the health-related profiles of various tobacco use groups in a national sample of career firefighters.

Methods

Department Selection/Firefighters Recruitment

Data reported are from the baseline evaluation of a longitudinal cohort study entitled “The impact of the Nutrition Environment in the Fire Service on Health and Safety” (EMW-2009-FP-01971). The primary aim of this study was to examine the impact of wellness/fitness programs on health and safety in career firefighters between 2010 and 2011. The protocol for the protection of human subjects was approved by the National Development and Research Institutes and the University of Texas Houston Health Sciences Center Institutional Review Boards. Sampling methodology and inclusionary criteria have been previously reported.⁶ Briefly, 20 fire departments, those with ($n = 10$) and without ($n = 10$) strong and comprehensive firefighter wellness programs, across 14 U.S. states and territories were recruited by using a purposive sampling approach¹⁶ to serve the primary aim of the parent study. Departments were matched with respect to size, call volume, staffing, and region of the United States. Within departments, firefighters were solicited to participate in the study and were provided an overview of the aims and the risk/benefits involved in study participation. Of the firefighters present and solicited, 94.4% ($N = 1,035$) consented.

For the purpose of this study, data from all departments were aggregated, yielding 1,002 male career firefighters. Data from 33 career firefighters who were either women or did not disclose their gender were excluded due to their low number in the study and the U.S. fire service (i.e., <5%; ref. ¹⁷) and the resulting inability to examine the potential moderating impact of gender. From this sample, 947 (94.5%) provided complete and usable data on tobacco use at baseline. Table 1 provides the demographic and occupational characteristics.

Table 1. Firefighter and Department Demographics

Firefighter demographics	($N = 947$)
Age (years; M [SD])	39.1 (8.8)
Race (% White)	76.4
Marital status (% married or living with a partner)	76.9
Education (% some college or greater)	90.8
Years in the fire service (years; M [SD])	14.2 (8.6)
Rank	
Firefighter	34.9
Firefighter/paramedic	13.7
Driver/operator	19.1
Officer	22.1
Chief	4.1
Other	6.1
Shift structure (%)	
24-hr Shift	82.6
48-hr Shift	14.9
Rotating shift	0.4
Fixed shift	2.0
Other	0.1
Department characteristics ($N = 20$)	
Size (n) ^a	
Small (3 or fewer stations)	7
Medium (3+ stations and less than 350 personnel)	8
Large (more than 350 personnel)	5
Setting (n)	
Rural	4
Suburban	10
Urban	2
Mixed urban	4
Region (n)	
Pacific/West	8
Mountain/Central	8
East/Southeast	4

Percentages may not add to 100 due to rounding. All participants were male.

^aSize classification based on IAFC 2012.

Measures

Tobacco Use

Tobacco use questions were modeled after the Behavioral Risk Factor Surveillance System¹⁸ and the Department of Defense Survey of Health-Related Behaviors Among Active Duty Personnel¹⁹. Three tobacco use questions were used to determine smoking status: (a) Have you ever smoked a cigarette, or even a puff?; (b) Have you smoked at least 100 cigarettes in your entire life?; and (c) Have you smoked a cigarettes, even a puff, in the past 30 days? Participants who answered “no” to question (a) were defined as never-smokers. Those who answered “yes” to question (a) but “no” to question (b) were defined as experimental smokers. Those who answered “yes” to questions (a) and (b) but “no” to question (c) were designated as former smokers while participants who answered “yes” to all three questions were designated as current smokers. Using items similar to the smoking assessment, participants were asked whether they had used chewing tobacco, snuff, or dip in the last 30 days and if “yes,” they were defined as current SLT users. Current users also were asked whether they used SLT before or after joining fire service. Firefighters who used cigars or any other forms of tobacco ($n = 55$) were excluded from analysis.

Body Composition

Participants’ height was measured by using a portable stadiometer. Body weight and body fat percentage (BF%) were determined with

a digital scale and foot-to-foot bioelectrical impedance (Tanita 300; Tanita Corporation of American, Inc.). Waist Circumference (WC) was determined by using a spring loaded nonstretchable tape measure in accordance with recommendations from the U.S. obesity guidelines.²⁰ Obesity status was computed using standard cutpoints for BMI ($\text{BMI} \geq 30.0 \text{ kg/m}^2$), BF% ($\text{BF\%} > 25.0\%$), and WC ($\text{WC} > 102 \text{ cm}$).²⁰

Physical Activity and Estimated $\text{VO}_{2\text{max}}$

The Self-Report of Physical Activity (SRPA) questionnaire was used to estimate participants' physical activity levels during the past 30 days. Vigorous activities were defined as participants engaged in heavy physical exercise $<30 \text{ min/week}$. SRPA scores, along with participants' age, gender, and BMI were used in a nonexercise model to estimate $\text{VO}_{2\text{max}}$.^{21–23} Aerobic capacity sufficient to exceed the National Fire Protection Association fitness standard for return to work postcardiac event was evaluated by comparing the estimated $\text{VO}_{2\text{max}}$ with the suggested cutpoint of ≥ 12 metabolic equivalents ($\text{VO}_{2\text{max}} \approx 42.0 \text{ ml/kg/min}$; ref. ²⁴).

General and Behavioral Health

Blood pressure was assessed using the Omron HEM-711AC (Omron Healthcare, Inc.) in accordance with standard protocols. Participants having systolic blood pressure $>140 \text{ mmHg}$ and/or diastolic blood pressure $>90 \text{ mmHg}$ were considered as hypertensive.²⁵

The Center for Epidemiological Studies Short Depression Scale (CES-D10) was used to assess current depressive symptoms with the total score of four or more indicating a possible concern for depression. The 10-item version was found to have comparable reliability estimates to those reported for the original CESD scale and is highly reliable in the general population (Spearman-Brown, split halves $r = 0.85$; ref. ^{26,27}).

Alcohol use was assessed by asking participants whether they had at least one drink of any alcoholic beverage in the past 30 days. Heavy drinking and binge drinking was assessed by asking the participants to report the number of times during the past 30 days that they had three or more and five or more drinks of any alcoholic beverage on one occasion, respectively. Alcohol use items were modeled after established surveys used in the general population and the military.^{28,29}

Dietary intake was recorded using the 24-hr recall method. All foods and drinks consumed over the previous 24-hr period were recorded by a trained dietary reviewer. Dietary intake were entered and analyzed as described in ref. ³⁰.

Statistical Approach

Age-standardized prevalence rates of tobacco use categories (smokers, SLT users, dual users) were computed to facilitate comparison with national and military estimates.^{19,31–33} Comparisons often are made between the fire service and the military, as the fire service operates under a paramilitary structure, shares several traditions with the military and has a relatively high rate of former military members among its ranks.³⁴ The 2000 U.S. population³⁵ and 2011 Department of Defense (DoD) health-related behaviors survey of active duty military personnel¹⁹ were used for the standards for general U.S. and military populations, respectively. StatsDirect Statistical Software version 2.7.8 (StatsDirect Ltd, 2010) was used to compute the age-standardized rates using the direct method.³⁶

All statistical models examining correlates of different categories of tobacco use were conducted using IBM SPSS 21.0 (SPSS). In order to explore potential differences between different tobacco

use patterns, participants were categorized by tobacco use status and models were developed examining demographic, occupational, and health status differences based on previous studies^{8,37,38} with the significance level set at $p < .01$ given the number of comparisons. Odds ratios (ORs) and their 95% confidence intervals (CI) were also computed as measures of association between tobacco use and correlates.

Results

Overall Tobacco Use

Among 947 participants, 750 participants (79.2%) were nontobacco users, of which 321 reported never using any forms of tobacco, 185 were former smokers, 38 were former SLT users, and 206 were former dual users. Among current tobacco users ($n = 197$; 20.8% of the total sample) 68 smoked cigarettes, 105 used SLT, and 24 used both. In general, tobacco users were significantly younger (36.7 ± 8.8 vs. 39.7 ± 8.7 , $p < .001$) and had served fewer years in fire service (12.3 ± 8.0 vs. 14.7 ± 8.7 , $p < .001$) than their nontobacco using counterparts. With respect to general and behavioral health characteristics, tobacco users were more likely to engage in heavy ($\text{OR} = 2.2$, 95% CI = 1.39, 3.42) and binge drinking ($\text{OR} = 1.7$, 95% CI = 1.07, 2.68), and more likely to show signs of depressive symptoms ($\text{OR} = 2.0$, 95% CI = 1.29, 3.07) compared to nontobacco users.

Cigarette Use

There was a relatively small percentage of firefighters who were current cigarette smokers (9.8%) compared to never (40.5%), experimental (32.2%), and former smokers (17.5%; Table 2). Age-standardized smoking prevalence among male firefighters was substantially lower than the rates for U.S. adult males (13.2% vs. 21.5%; ref. ³¹) and males in the military (16.8% vs. 24.0%; ref. ¹⁹). Current smokers were significantly younger and served in the fire service fewer years than never-smokers (Table 2). They also had less income than their nonsmoking counterparts. There were no significant differences among smoking status categories on most of the anthropometric and dietary intake measurements when adjusted for age, ethnicity, and income. However, experimental smokers were less likely to be obese compared to never-smokers ($\text{OR} = 0.7$, 95% CI = 0.46, 0.98) based on BMI-defined obesity ($\text{BMI} \geq 30.0 \text{ kg/m}^2$). In addition, current smokers were nearly seven times more likely to be heavy drinkers ($\text{OR} = 6.6$, 95% CI = 3.6, 12.0), five times more likely to binge drink ($\text{OR} = 4.6$, 95% CI = 2.6, 8.1), half as likely to engage in vigorous physical activity ($\text{OR} = 0.5$, 95% CI = 0.3, 0.8), and almost three times as likely to have depressive symptom ($\text{OR} = 2.6$, 95% CI = 1.4, 4.8) compared to never smokers.

SLT Use

The overall unadjusted prevalence of current SLT use among firefighters was 13.7%. Age-standardized rates were relatively high when compared to that for U.S. adult males (10.5% vs. 6.2%; ref. ³²) and comparable to males in the military (17.4% vs. 22.4%; ref. ¹⁹). SLT users were younger and served fewer years in the fire service than other firefighters who never used SLT, $p < .01$ (Table 3). Level of use was 2.8 ($SD = 2.8$) tins per week, and 4.0 dips ($SD = 3.6$) per day. Approximately 26% of SLT users started after joining the fire service, and only 2% noted using SLT because of the restrictions about smoking in their departments. Adjusted analyses by SLT use status showed significant differences between never and other

Table 2. Demographic and Health/Health Behaviors Characteristics Among Smoking Status ($M \pm SD$; %)

	Smoking status			
	Never ($n = 384$)	Experimental ($n = 305$)	Former ($n = 165$)	Current ($n = 93$)
Demographic variables				
Age (years)	40.6 $\pm$ 8.8 ^a	38.4 $\pm$ 8.4 ^b	38.6 $\pm$ 8.6	36.4 $\pm$ 9.4 ^b
Education (% at least some college or college graduate)	91.4	91.1	88.4	88.0
Income (% >\$75,000)	79.3	74.3	75.2	62.8
Marital status (% married or living with partners)	77.6	76.5	78.7	74.7
Race (% White)	64.3	64.9	73.9	58.1
Years in fire service (years)	15.6 $\pm$ 8.8 ^a	13.5 $\pm$ 8.0 ^b	12.9 $\pm$ 8.4 ^b	12.5 $\pm$ 8.8
Shift type (% 24 hr)	83.1	83.8	86.5	91.8
Rank (%)				
Any firefighter	69.3	76.4	77.0	79.1
Any officer	30.7	23.6	23.0	20.9
Health/health behaviors				
Weight (kg)	90.8 $\pm$ 18.0	89.9 $\pm$ 16.6	92.9 $\pm$ 19.1	90.3 $\pm$ 14.7
BMI (kg/m ²)	28.9 $\pm$ 5.2	28.4 $\pm$ 4.7	29.6 $\pm$ 5.5	29.0 $\pm$ 4.2
WC (cm)	96.6 $\pm$ 13.9	96.8 $\pm$ 12.7	99.2 $\pm$ 14.7	98.8 $\pm$ 11.3
%Body fat	23.4 $\pm$ 9.1	22.9 $\pm$ 8.3	24.0 $\pm$ 9.4	24.3 $\pm$ 7.3
Obesity prevalence (%)				
BMI defined	33.2	23.5	30.7	31.9
WC defined	27.3	24.8	30.4	29.3
BF defined	40.1	32.0	41.9	37.4
Hypertensive	17.9	21.4	20.8	14.1
Depressive symptom	13.9	15.9	16.5	26.4
Heavy drinkers	34.3 ^a	48.2 ^b	43.6 ^b	78.0 ^c
Binge drinking	38.8 ^a	52.1 ^b	58.6 ^b	76.4 ^c
Engaged in vigorous physical activity	68.8	73.5	69.9	56.8
Meet NFPA MET standard	38.5 ^a	52.9 ^b	45.4	46.5
Dietary intake (kcal)				
Energy intake	2,728.8 $\pm$ 1,285.5	2,829.3 $\pm$ 1,152.7	2,740.0 $\pm$ 1,416.0	2,900.1 $\pm$ 1,053.8
Protein intake	19.1 $\pm$ 6.7	19.8 $\pm$ 6.0	19.3 $\pm$ 7.3	19.0 $\pm$ 5.5
Carbohydrate intake	45.1 $\pm$ 11.7	43.3 $\pm$ 10.5	42.9 $\pm$ 12.9	43.5 $\pm$ 9.6
Total fat intake	35.9 $\pm$ 9.4	37.0 $\pm$ 8.4	37.8 $\pm$ 10.3	37.6 $\pm$ 7.7

Different superscript letter denotes differences among tobacco use categories at $p < .01$. Health/health behaviors variables are controlled for age, ethnicity and income. BF = body fat; BMI = body mass index; MET = metabolic equivalent; NFPA = National Fire Protection Association; WC = waist circumference.

SLT use categories. Compared to those who never used SLT, current SLT users were as twice as likely to drink heavily ($OR = 2.1$, 95% $CI = 1.4, 3.1$), binge drink ($OR = 2.2$, 95% $CI = 1.5, 3.4$), and report depressive symptoms ($OR = 1.8$, 95% $CI = 1.1, 2.9$).

Dual Use

Among 197 firefighters who were current tobacco users, 12.2% ($n = 24$) used both cigarettes and SLT and therefore were defined as dual users (Table 4). Dual users were more likely to be racial/ethnic minorities when compared to both exclusive SLT users, ($OR = 31.9$; 95% $CI = 3.64, 280.3$) and smokers ($OR = 16.0$; 95% $CI = 1.9, 138.1$). Compared to SLT users, dual users were nearly seven times more likely to demonstrate depressive symptom ($OR = 6.9$, 95% $CI = 1.2, 39.5$). In addition, exclusive smokers were three times more likely than SLT users to drink heavily ($OR = 3.2$, 95% $CI = 1.6, 6.5$). However, there were no significant differences among dual users, exclusive smokers, and SLT user on any other measures intake when adjusted for ethnicity.

Discussion

This study is one of the first to examine tobacco use patterns and factors associated with its use in a large, national sample of

U.S. firefighters. Key findings included that: (a) behavioral health characteristics of tobacco users were relatively distinct from nontobacco users; (b) the prevalence of dual users was high among racial/ethnic minorities (62.5%); (c) SLT use rate was high while smoking prevalence was low compared to the U.S. general population; and (d) a large proportion of SLT users started after joining the fire service; and (e) there was a strong and consistent association between problem drinking behaviors and tobacco use.

The prevalence of cigarette smoking in firefighters was relatively low compared to general public (21.3%; ref. ³¹), with unadjusted rates of 7.2% for exclusive cigarette users and 9.7% for overall current smokers. In fact, it was lower than the United States that had the lowest smoking prevalence in the nation (Utah, 11.9%; ref. ¹⁸). Age-standardized rates of current smoking among firefighters (13.9% for exclusive cigarette users and 16.8% for overall cigarette users) were also significantly lower than the recent report of current smoking among males in the military (DoD-adjusted rate = 25.2%; ref. ¹⁹). Smoking prevalence was similar to a recent population-based study of firefighters in the Midwest (16.2%; ref. ⁸).

Prevalence of overall SLT use (13.7%) and exclusive SLT use (11.1%) among male firefighters were very high compared to U.S. adult males (6.2%; ref. ³²). Firefighters demonstrated similarly high SLT rates when compared to males in the DoD (17.4% for

Table 3. Demographic and Health/Health Behaviors Characteristics Among SLT Use Status ($M \pm SD$; %)

	SLT use status		
	Never ($n = 544$)	Former ($n = 274$)	Current ($n = 129$)
Demographic variables			
Age (years)	40.5 $\pm$ 9.0 ^a	37.4 $\pm$ 8.3 ^b	36.8 $\pm$ 8.1 ^b
Education (% at least some college or college graduate)	90.3	91.5	89.2
Income (% >\$75,000)	76.3	74.5	75.9
Marital status (% married or living with partners)	78.1	75.6	74.6
Race (% White)	60.4 ^a	75.5 ^b	68.5
Years in fire service (years)	15.2 $\pm$ 9.1 ^a	13.1 $\pm$ 7.9 ^b	12.1 $\pm$ 7.4 ^b
Shift type (% 2 hr)	85.4 ^a	87.6 ^a	75.8 ^b
Rank (%)			
Any firefighter	70.4	76.5	81.7
Any officer	29.6	23.5	18.3
Health/health behaviors			
Weight (kg)	90.8 $\pm$ 14.7	90.3 $\pm$ 18.0	90.8 $\pm$ 15.8
BMI (kg/m ²)	28.5 $\pm$ 4.2	28.4 $\pm$ 5.2	29.1 $\pm$ 4.5
WC (cm)	97.3 $\pm$ 11.3	97.0 $\pm$ 13.9	97.5 $\pm$ 12.1
%Body Fat	23.2 $\pm$ 7.3	23.0 $\pm$ 8.9	24.8 $\pm$ 7.9
Obesity prevalence (%)			
BMI defined	32.2	25.9	26.9
WC defined	28.3	26.8	24.6
BF defined	39.0	34.1	38.9
Hypertensive	19.9	18.3	16.9
Depressive symptom	14.4	18.0	21.8
Heavy drinkers	38.1 ^a	51.5 ^b	58.1 ^b
Binge drinking	44.0 ^a	55.2 ^b	66.4 ^c
Engaged in vigorous physical activity	68.4	72.2	66.4
Meet NFPA MET standard	38.2 ^a	56.2 ^b	51.2 ^b
Dietary intake (kcal)			
Energy intake	2,671.9 $\pm$ 1,004.4 ^a	2,975.9 $\pm$ 1,157.9 ^b	2,701.6 $\pm$ 1,064.2
Protein intake	19.6 $\pm$ 5.2	19.2 $\pm$ 6.0	20.4 $\pm$ 5.2
Carbohydrate intake	44.0 $\pm$ 9.3	42.9 $\pm$ 10.7	42.1 $\pm$ 9.8
Total fat intake	36.4 $\pm$ 7.4	37.9 $\pm$ 8.6	37.5 $\pm$ 7.9

Different superscript letter denotes differences among tobacco use categories at $p < .01$. Health/health behaviors variables are controlled for age and ethnicity. BF = body fat; BMI = body mass index; MET = metabolic equivalent; NFPA = National Fire Protection Association; WC = waist circumference.

overall SLT use and 14.0% for exclusive SLT use vs. 22.4% for the military; ref. ¹⁹). The SLT prevalence found in this study was similar to that found in a recent population-based study among male Midwestern firefighters (i.e., 18.4% and 13.3%; ref. ^{8,9}).

A substantial proportion of firefighters were dual users (adjusted rate = 3.1%), a rate which is almost five times higher than that found nationally (0.6%–0.8%; ref. ³³). The high rate of dual use found in this study was consistent with that reported by⁹ in sample of male career firefighters (2.6%). High prevalence of dual use among firefighters is alarming and reflects a potentially troubling pattern. Dual users have been found to be less likely to stop using tobacco or remain abstinent from tobacco use^{33,39,40} and are more likely to have had unsuccessful quit attempts.³⁹ In addition, several studies demonstrate that dual users have greater health risks (i.e., acute myocardial infarction, cancer) compared to other tobacco users^{12,41,42} and have similar or higher level of nicotine exposure,^{33,39} compared with cigarette smokers who never used SLT. This is particularly concerning given the high rates of some cancer and CVD-related deaths among firefighters.^{13–15}

Possible reasons for the high prevalence of SLT and dual use among male firefighters include the fact that the tobacco industry has engaged in target marketing to the fire service and other high-risk groups like the military. Given the cultural characteristics and

traditions shared by both the fire service and military,⁴³ it is possible that the types of target marketing used by tobacco companies with the military have been adapted for the fire service. For example, U.S. Smokeless Tobacco Company donated utility vehicles to fire departments through its Operation Ranger program.⁴⁴ In addition, magazine advertisements for Copenhagen and Skoal have featured pictures of firefighters engaged in emergency operations.⁴⁵

It is also possible that occupational factors such as concerns about the impact of smoking on firefighters' ability to perform their job, disease presumption laws, and the prohibition of cigarette smoking in fire house^{6,11} have contributed to the low rates of smoking, but led to high rates of SLT use. In addition, other professional factors including receiving education about the negative health effects of smoking and awareness about their increased risk of exposure to toxic products of combustions can play a role in the low smoking rates.⁶ These factors could alter tobacco use behaviors by providing an opportunity for some smokers to become dual users (i.e., using SLT use indoor and continue smoking outdoor) and undermine smoking cessation attempts (i.e., turning to SLT use as a cessation strategy). The present study found a large proportion of firefighters started using SLT after joining fire service (26%). Given high rate of SLT use and dual use of cigarettes, and SLT is associated with health risks of developing tobacco-related diseases and mortality, the fire

Table 4. Demographic and Health/Health Behaviors Characteristics Among Exclusive Users and Dual Users ($M \pm SD$; %)

	Tobacco use status		
	SLT users ($n = 105$)	Smokers ($n = 68$)	Dual users ($n = 24$)
Demographic variables			
Age (years)	36.8 $\pm$ 8.0	36.1 $\pm$ 9.8	36.9 $\pm$ 8.7
Education (% at least some college)	89.5	88.1	87.5
Income (% >\$75,000)	77.5	62.7	66.7
Marital status (% married or living with partners)	73.8	71.9	81.8
Race (% White)	76.2 ^a	66.2 ^a	37.5 ^b
Years in fire service (years)	12.1 $\pm$ 7.1	12.5 $\pm$ 8.9	12.5 $\pm$ 8.8
Shift type (% 24 hr)	72.3 ^a	91.9 ^b	90.9
Rank (%)			
Any firefighter	79.4	74.6	91.3
Any officer	20.6	25.4	8.7
Health/health behaviors			
Weight (kg)	89.7 $\pm$ 12.2	88.9 $\pm$ 14.8	89.9 $\pm$ 10.6
BMI (kg/m ²)	28.4 $\pm$ 3.9	28.5 $\pm$ 4.7	28.8 $\pm$ 3.1
WC (cm)	96.0 $\pm$ 9.9	97.8 $\pm$ 13.4	97.3 $\pm$ 7.7
%Body Fat	23.9 $\pm$ 6.3	23.1 $\pm$ 5.4	24.1 $\pm$ 5.4
Obesity prevalence			
BMI defined	26.7	33.3	25.0
WC defined	25.7	32.8	16.7
BF defined	39.6	36.4	37.5
Hypertensive	19.0	16.4	8.3
Depressive symptom	20.0	26.9	26.1
Heavy drinkers	53.3 ^a	79.1 ^b	78.3 ^b
Binge drinking	63.8	77.3	77.3
Engaged in vigorous physical activity	67.0	55.4	63.6
Meet NFPA MET standard	50.5	44.4	54.5
Dietary intake (kcal)			
Energy intake	2,701.4 $\pm$ 981.8	2,954.6 $\pm$ 1,177.6	2,847.7 $\pm$ 839.9
Protein intake	20.9 $\pm$ 5.5	20.2 $\pm$ 5.9	18.2 $\pm$ 5.1
Carbohydrate intake	41.6 $\pm$ 8.8	41.8 $\pm$ 9.2	45.7 $\pm$ 10.1
Total Fat intake	37.5 $\pm$ 7.6	38.1 $\pm$ 7.5	36.2 $\pm$ 7.2

Different superscript letter denotes differences among tobacco use category at $p < .01$. Health/health behaviors variables are controlled for ethnicity. BF = body fat; BMI = body mass index; MET = metabolic equivalent; NFPA = National Fire Protection Association; SLT = smokeless tobacco; WC = waist circumference.

service culture that promotes SLT and dual tobacco use needs to be better understood. In addition, future research should focus on SLT cessation and treatment delivery and should examine the influence of tobacco industry on fire service's tobacco use.

Regarding tobacco-related sociodemographic characteristics among firefighters, the younger age distribution among tobacco users in this cohort is in line with previous studies.^{9,39,46,47} However, indicators of social disadvantage, such as income or education, were not found to be strongly associated with tobacco use in our sample, which contradictory to several studies.^{46,48} Our findings also demonstrated that dual users tended to be minorities rather than Caucasian, as previous studies suggested.^{33,39,49,50} Future research should examine dual use pattern among minorities and interventions tailored for dual users in this particular group are needed.

Unhealthy lifestyle characteristics such as heavy alcohol consumption and binge drinking were strongly associated with tobacco use in this study.^{9,12,46,49} A strong relationship between alcohol and tobacco use has been demonstrated in both civilian and military settings.^{12,51–53} Both smokers and SLT users also expressed greater depressive symptoms compared to nontobacco users, which is consistent with findings of previous studies.^{46,54} Although several studies reported an association between weight status with cigarettes and SLT use,^{46,55,56} suggesting that smokers tend to be underweight while

SLT users were likely to overweight, our results did not show any associations. Due to our cross-sectional design, future longitudinal studies should be carried out in order to explore the relationship between weight status to tobacco use.

There are several limitations to the current study. First, this study was based on cross-sectional data, which limited our ability to examine tobacco use and its impacts longitudinally. In addition, we were not able to determine whether smoking preceded or followed SLT use. Second, participants who used other forms of tobacco such as cigar, e-cigarette, or hookah were excluded. Future research should address the prevalence for these products to better determine the extent of their use and explore characteristics of poly-tobacco users. Third, the large number of statistical comparisons could have led to the greater probability of Type I errors; however, we adjusted our significance level to $p < .01$ to reduce the likelihood of this type of error. Last, but not least, there was no biochemical verification of tobacco use status. However, strong evidence exists for the validity of self-reported tobacco use in population-based surveys⁵⁷ and firefighters (i.e., we reported a false negative rate of only 1.3% among career firefighters in a previous study examining the relationship between self-reported and biochemically verified smoking status; ref. ^{8,9}).

Our study has several important strengths. It was conducted in the first large, national sample of U.S. firefighters. The findings also

demonstrated public health implications in terms of intervention strategies for SLT and dual use. Future research is needed to examine health and occupational factors that support SLT and dual use and evaluate occupationally tailored interventions to help firefighters quit using tobacco successfully. Given the exceptionally high levels of SLT and dual use and fire fighters' unique job characters, fire service organizations should address and focus more on SLT cessation programs and tailor the intervention programs for this occupational group since firefighters might use SLT as smoking cessation strategy and/or to follow fire service smoke-free regulations.

In conclusion, the prevalence of cigarette smoking is relatively low in the U.S. fire service; conversely, the prevalence of both SLT use and dual use is exceptionally high. Given the high prevalence of SLT and dual use found in this study and the health effects of using cigarettes and SLT, tobacco cessation treatment should be tailored to fit the fire service culture as well as explore the role of nicotine dependence in these users. SLT intervention programs should be specifically tailored and developed for this occupational group, particularly given the high rate of initiation upon joining the fire service.

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Declaration of Interests

None declared.

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