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Original investigation

Polytobacco Use and Nicotine Dependence Symptoms Among US Adults, 2012–2014

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Abstract

Introduction: The tobacco product landscape has changed substantially. Little is known about the recent pattern of polytobacco use (at least two tobacco products) among US adults and its relationship to nicotine dependence.

Methods: Using the 2012–2013 and 2013–2014 National Adult Tobacco Survey (NATS) data ($N = 135\,425$ adults), we analyzed the prevalence and correlates of polytobacco use among each of the six categories of current tobacco user (cigarettes, cigars, pipes, hookah, e-cigarettes, and smokeless tobacco). Based on five nicotine dependence symptom measures from the NATS, difference in the prevalence of dependence symptoms between polytobacco and sole-product users for each category of tobacco user was assessed using multivariable regression analyses.

Results: During 2012–2014, 25.1% of adults were current users of any tobacco product. Among them, 32.5% were poly users with the largest poly use category being dual use of cigarettes and e-cigarettes (30.2%). Poly use prevalence was the lowest among current cigarette smokers (38.7%), followed by current users of smokeless tobacco (52.4%), hookah (59.2%), cigars (69.3%), e-cigarettes (80.9%), and pipes (86.2%). Among each category of current tobacco user, the prevalence of dependence symptom was consistently greater in polytobacco users than sole users for every symptom measure. After controlling for frequency of use and demographic covariates, the difference in nicotine dependence between poly users and sole users was statistically significant and consistent across all symptom measures for each category of tobacco user.

Conclusions: Between 52% and 86% of noncigarette tobacco users and nearly 40% of cigarette smokers engaged in polytobacco use. Poly users showed greater nicotine dependence than sole-product tobacco users.

Implications: This study examines recent patterns of polytobacco use separately for US adult current cigarette smokers, cigar smokers, pipe smokers, hookah users, e-cigarette users, and smokeless tobacco users. By including more tobacco products, particularly e-cigarettes and hookah, this study provides more comprehensive insight into polytobacco use. This study is also unique in comparing nicotine dependence between polytobacco and sole-product users among each category of tobacco users. Our results indicate that polytobacco use is very common and is associated with greater likelihood of reporting nicotine dependence symptoms. Tobacco cessation policies and programs should be tailored to address polytobacco use.

Introduction

In the past decade, cigarette smoking prevalence has decreased substantially among US adults from 20.9% to 15.1% during 2005–2015.[1] Nonetheless, cigar smoking and smokeless tobacco use have remained steady,[2–4] and the use of emerging tobacco products such as e-cigarettes has increased rapidly.[5–7] While only 1.5% of high school students reported past 30-day use of e-cigarettes in 2011, this percentage skyrocketed to 16.0% in 2015.[8,9] Among adults, the prevalence of current use of e-cigarettes increased from 4.2% in 2012–2013 to 6.6% in 2013–2014.[10,11] In 2013–2014, 4.3% of adults reported current use of hookah.[11]

As a result of the rapidly changing tobacco product landscape, the pattern of polytobacco use (consuming at least two tobacco products) is likely changing. A study found that the prevalence of polytobacco use among past-year users (aged ≥12) of any tobacco products was essentially constant during 2002–2011 (23.9%–23.4%).[12] Earlier studies also showed that cigars were the most prevalent product concurrently used by adult current cigarette smokers in the United States during 1995–2002,[13] and one-half of all polytobacco users were dual users of cigarettes and cigars.[4] However, little is known about the recent pattern of polytobacco use in the United States. One exception was a study that used the 2013–2014 Population Assessment of Tobacco and Health (PATH) Study data and reported that 37.8% of adult current users of any tobacco products were polytobacco users, and the most prevalent poly use combination was dual use of cigarettes and e-cigarettes (22.5%).[14]

Most polytobacco use studies of US adults have examined the prevalence of polytobacco use among all adults[12–19] or current cigarette smokers.[13,15,17,18,20–24] Fewer studies have examined the prevalence of polytobacco use among current users of noncigarette products such as smokeless tobacco,[17,21,22] snuff,[20,24,25] chewing tobacco,[24] and cigars.[24] Among the above-mentioned studies, only a few have examined the sociodemographic correlates of polytobacco use among current cigarette smokers, smokeless tobacco users, or cigar smokers.[13,15,21–24] There is no research on the pattern and correlates of polytobacco use among current users of emerging tobacco products such as e-cigarettes.

Because different tobacco products contain different nicotine content, constituent ingredients, and toxin levels and their effects may be additive,[26] polytobacco users may be at greater risk of tobacco-related diseases and nicotine dependence than single product users.[27,28] Dependence, also referred to as addiction, is characterized by a perceived loss of control, including compulsive use and difficulty abstaining. Previous research on nicotine dependence and polytobacco use primarily focused on cigarette smokers using cigarette-focused dependence instruments.[29–31] One such study found that among youth past 30-day cigarette smokers, the likelihood of polytobacco use was greater for those with higher levels of nicotine dependence measured by four cigarette-focused items such as "How long can you go without smoking before you feel like you need a cigarettes?".[28] In contrast, another study found that among past 30-day cigarette smokers aged 12 and older, nicotine dependence as measured by time to smoke the first cigarette after waking and craving for cigarettes was associated with lower likelihood of polytobacco use.[12]

A few studies have developed measures to assess nicotine dependence for noncigarette tobacco users.[32–35] Research examining the relationship between polytobacco use and nicotine dependence using dependence measures relevant to all tobacco products is limited.[36–38] Based on a dependence measure "Wanting to use a tobacco product within the first five minutes after waking" and the 2012 and 2013 National Youth Tobacco Survey (NYTS) data, Harrell et al.[36] showed that among youth past 30-day users of any tobacco product (cigarettes, cigars, smokeless tobacco, e-cigarettes, hookah, snus, pipes, bidis, or kreteks), polytobacco users were more likely than exclusive cigarette smokers to be nicotine dependent. Using the 2012 NYTS data, Apelberg et al.[37] showed that among youth 30-day users of cigarettes, cigars, or smokeless tobacco, those who used multiple products were more likely than single product users to report four tobacco dependence symptoms including craving to use a tobacco product. Based on five tobacco-dependent symptom questions asked in the 2012–2013 National Adult Tobacco Survey, Rostron et al.[38] found evidence that daily polytobacco users of cigarettes with cigars and/or e-cigarettes reported greater dependence than daily sole cigarette smokers; however, their study was based on univariate analysis without adjusting for other confounding factors. There is little research comparing nicotine dependence between poly users and sole users among adult current noncigarette users in the United States.

This study aimed to (1) examine the recent pattern and correlates of polytobacco use and (2) compare the prevalence of nicotine dependence symptoms between polytobacco users and sole-product users separately for current cigarette smokers, cigar smokers, pipe smokers, hookah users, e-cigarette users, and smokeless tobacco users with a large, nationally representative survey data of US adults in 2012–2014. By including more tobacco products, particularly e-cigarettes and hookah, this study provides more comprehensive insight into polytobacco use and its relationship to nicotine dependence.

Materials and Methods

Data Source

The analyses in this study rely on the cross-sectional National Adult Tobacco Survey (NATS). The NATS is a stratified random-digit-dialed telephone survey of a nationally representative sample of noninstitutionalized adults aged 18 and older. It includes individual's cigarette smoking, other tobacco use, addiction, exposure to tobacco marketing and promotion, risk perceptions, and sociodemographic characteristics. It utilized a dual-frame, nonoverlapping sample design, with independent samples drawn from landline and cellular-only telephone frames (25.2%–30.1% of sampled adults). Further details about the survey methodology are available elsewhere.[11,39,40] To increase the sample size, especially for low-use tobacco products such as pipes,[10,11] we pooled the NATS data from the latest two waves in 2012–2013 and 2013–2014.

Tobacco Use

This study examined six tobacco products: (1) cigarettes, (2) cigars (including regular-sized cigars, cigarillos, and little filtered cigars), (3) pipes, (4) hookah (waterpipe), (5) e-cigarettes (electronic cigarettes), and (6) smokeless tobacco. Although the NATS included separate questions for snus and dissolvable tobacco, we followed other studies in aggregating them with chewing tobacco, snuff, and dip into the single category of "smokeless tobacco" due to their small sample sizes.[10,11]

We analyzed seven categories of current tobacco users. These categories are not mutually exclusive. (1) *Current cigarette smokers* were respondents who have smoked at least 100 cigarettes during their lifetime and now smoke cigarette every day or some days. Current users of noncigarette tobacco products were defined based on varying lifetime use thresholds and the past 30-day use criteria according to the following two NATS questions:[39,40] "Do

you now use the respective product every day, some days, rarely, or not at all?" and "Was the respective product that you used in the past 30 days flavored to taste like menthol, mint, clove, spice, candy, fruit, chocolate, or other sweets?" Starting in 2012, the NATS added the "rarely" option to the first question because cognitive testing studies indicated that some occasional users of noncigarette products did not consider "some days" or "not at all" to accurately reflect their use pattern.[10,41] Those who answered "every day," "some days," or "rarely" to the first question were asked the second question that contains three options: "yes," "no," and "did not use that product in the past 30 days." The nonresponse rate to this question is very low (<1%), and those who answered "yes" or "no" to this question were regarded as meeting the past 30-day use criteria for that product. Therefore, (2) and (3) *current cigar (pipe) smokers* were defined as those who have smoked cigars (pipes) at least 50 times during their lifetime and meet the past 30-day use criteria for cigars (pipes). (4) and (5) *Current hookah (e-cigarette) users* were respondents who have smoked hookah (e-cigarettes) at least once during their lifetime and meet the past 30-day use criteria for hookah (e-cigarettes). (6) *Current smokeless tobacco users* were respondents who have used chewing tobacco, snuff, or dip at least 20 times or have used snus or dissolvable tobacco at least once during their lifetime and who meet the past 30-day use criteria for smokeless tobacco. Note that these varying thresholds were selected in line with previous studies[10,11] to separate established users from experimenters and nonusers based on documented differences in patterns of tobacco product use.[4] Finally, (7) *current users of any tobacco products* referred to those who were current users of cigarettes, cigars, pipes, hookah, e-cigarettes, or smokeless tobacco.

Outcome Variables

Polytobacco use status was coded as a dichotomous variable including two categories: "polytobacco users" for those who are a current user of two or more tobacco products, and "sole users" for those who are a current user of one tobacco product only.

Nicotine dependence symptoms were assessed using the following five NATS questions that were asked of respondents who now use any tobacco product every day, some days, or rarely.

1. "Do you sometimes wake up at night in order to have a cigarette or other tobacco product (yes/no)?"
2. "During the past 30 days, have you had a strong craving to use tobacco products of any kind (yes/no)?"
3. "During the past 30 days, did you ever feel like you really needed to use a tobacco product (yes/no)?"
4. "During the past 30 days, was there a time when you wanted to use a tobacco product so much that you found it difficult to think of anything else (yes/no)?"
5. "How true is this statement for you that after not using tobacco for a while, I feel restless and irritable (not at all true/sometimes true/often true/always true)?"

These questions are related to craving and withdrawal symptoms, and have been analyzed by Rostron et al.[38] with the 2012–2013 NATS data. Several similar questions from other national surveys were also used to assess tobacco dependence among US adults and adolescents.[37,42] As done by Rostron et al.,[38] the last question was dichotomized to whether or not often/always feeling restless and irritable when not using tobacco for a while (yes/no), and will hereafter be called withdrawal symptom for simplicity.

Covariates

Covariates included survey year (2012–2013 and 2013–2014), sociodemographic characteristics, and frequency of tobacco use. Sociodemographic characteristics included gender, age (18–24, 25–29, 30–44, 45–64, and ≥65), race/ethnicity (non-Hispanic White, Hispanic, non-Hispanic Black, non-Hispanic Asian, and non-Hispanic Other), education (less than high school education, high school graduate, some college, and college graduate), annual household income (<$30 000, $30 000–$49 999, $50 000–$99 999, ≥$100 000, and unknown), and marital status (married [including living with a partner], widowed/divorced/separated, and single [including never married and not living with a partner]). Those who did not report household income were classified as "unknown" and included in the analyses because of their large size (22.8% of 135 425 sampled adults) and the concern that income may not be missing at random.

Frequency of tobacco use was coded as a dichotomous variable (daily vs. nondaily). For current cigarette smokers, nondaily use referred to now smoking cigarettes some days. For current cigar smokers, pipe smokers, hookah users, and e-cigarette users, nondaily use referred to now using that product some days or rarely. For current smokeless tobacco users, those who used at least one smokeless tobacco product every day were classified in the "daily" group; otherwise, they were classified in the "nondaily" group. For current users of any tobacco products, we classified those who used at least one tobacco product every day or those who used at least two tobacco products some days or rarely but answered "no" to the survey question: "Are there some days when you do not use any of these tobacco products?" as daily users, and the remainder as nondaily users.

Statistical Analysis

First, we estimated the prevalence of polytobacco use and examined the most popular combinations of products used by poly users among each category of current tobacco users. Second, we identified correlates of polytobacco use among each of the six categories of tobacco user—current cigarette smokers, cigar smokers, pipe smokers, hookah users, e-cigarette users, and smokeless tobacco users—by conducting multivariable logistic regression analyses. Third, within each of the six categories of current tobacco user, we calculated and compared the prevalence of nicotine dependence among polytobacco users and among sole users separately for each of the five dependence symptom measures. The statistical difference in nicotine dependence prevalence between polytobacco users and sole users was determined using a multivariable logistic regression model.

All analyses were estimated using the NATS national sample weights and taking into account the complex survey design information. Analyses were performed using SAS software (SAS Institute, Cary, NC). We considered estimates to be statistically significant if the two-tailed p value was <.05.

Study Sample

The pooled NATS data contained 135 425 respondents. After excluding 4440 respondents with incomplete information on the tobacco use questions and another 15 325 respondents with missing values for gender, age, race/ethnicity, education, or marital status, the final study sample for polytobacco use analyses comprised 115 660 adults (Table 1). For nicotine dependence analyses, the study sample comprised 15 495 cigarette smokers, 4276 cigar smokers, 765 pipe smokers, 2349 hookah users, 4583 e-cigarette users, and 3097

Table 1. Distribution of the Final Study Sample (N = 115 660) by Year, Sociodemographic Characteristics, and Tobacco Use Status: National Adult Tobacco Surveys, 2012–2014

Characteristics or tobacco use status	*N*	Column %
Year		
2012–2013	45 813	47.5
2013–2014	69 847	52.5
Gender		
Male	48 992	48.0
Female	66 668	52.0
Age		
18–24	7662	13.0
25–29	6087	8.5
30–44	20 258	25.9
45–64	43 585	34.5
65+	38 068	18.1
Race/Ethnicity		
Non-Hispanic White	88 082	65.5
Hispanic	9266	15.0
Non-Hispanic Black	9385	11.2
Non-Hispanic Asian	2704	2.8
Non-Hispanic Others	6223	5.5
Education		
Less than HS	9199	14.0
HS graduate	28 189	29.7
Some college	29 314	25.3
College graduate	48 958	30.9
Household income		
<$30 000	20 657	18.7
$30 000–$49 999	21 455	19.3
$50 000–$99 999	30 337	25.7
≥$100 000	19 866	16.2
Unknown	23 345	20.1
Marital status		
Married	64 152	57.0
Widowed/divorced/separated	31 044	19.9
Single	20 464	23.2
Use of any tobacco product		
Current users	22 627	25.1
Daily	15 031	16.5
Nondaily	7596	8.6
Nonusers	93 033	75.0
Cigarette smoking status		
Current smokers	16 156	18.0
Daily	12 274	13.6
Some day	3882	4.3
Nonsmokers	99 504	82.0
Cigar use status		
Current users	4411	5.2
Daily	600	0.7
Some day	999	1.2
Rarely	2812	3.3
Nonusers	111 249	94.8
Pipe use status		
Current users	795	0.8
Daily	143	0.1
Some day	188	0.2
Rarely	464	0.5
Nonusers	114 865	99.2
Hookah use status		
Current users	2377	3.5
Daily	41	0.1
Some day	326	0.5
Rarely	2010	3.0
Nonusers	113 283	96.5
E-cigarette use status		
Current users	4717	5.5
Daily	1025	1.1
Some day	1423	1.7
Rarely	2269	2.8
Nonusers	110 943	94.5
Smokeless tobacco use status		
Current users	3209	3.6
Daily	1634	1.7
Some day	712	0.9
Rarely	863	1.0
Nonusers	112 451	96.4

All the percentages are estimated from the weighted analysis.
HS = high school; N = unweighted sample size.

smokeless tobacco users after further excluding those with missing information for any of the five dependence symptom questions.

Results

Of the 115 660 adults, 52.0% were women, 13.0% were young adults aged 18–24, 65.5% were non-Hispanic Whites, 14.0% had less than high school education, 18.7% reported annual household income less than $30 000 and 20.1% did not report income, 57.0% were married, and 25.1% were current users of any tobacco products (Table 1). By product, current use of cigarettes was most prevalent (18.0%), followed by current use of e-cigarettes (5.5%), cigars (5.2%), smokeless tobacco (3.6%), hookah (3.5%), and pipes (0.8%). Daily use varied by tobacco product with the proportion ranging from 75.9% of current cigarette smokers to only 1.7% of current hookah users.

Prevalence of Polytobacco Use

Among current users of any tobacco products, the overall prevalence of polytobacco use was 32.5% (data not shown). Across different products, the prevalence of polytobacco use was the lowest among current cigarette smokers (38.7%), followed by current users of smokeless tobacco (52.4%), hookah (59.2%), cigars (69.3%), e-cigarettes (80.9%), and pipes (86.2%) (Table 2).

Among current users of any tobacco products, 70.3% of poly users used two products and 29.7% of poly users used at least three products, and the most common poly use combination was dual use of cigarettes and e-cigarettes (30.2%), followed by dual use of cigarettes and cigars (16.3%) (Table 3). Among current cigarette smokers, the most common poly use combination was dual use of cigarettes and e-cigarettes (35.3%). More broadly, 56.9% of poly use cigarette smokers concurrently used e-cigarettes with or without other tobacco products. Among current e-cigarette users, the most common poly use combination was dual use of e-cigarettes and cigarettes (55.0%). Notably, 88.5% of poly use e-cigarette users concurrently smoked cigarettes with or without other tobacco products. Similarly, 78.8%, 75.0%, 70.7%, and 67.1% of poly users among current users of cigars, smokeless tobacco, pipes, and hookah, respectively, concurrently smoked cigarettes with or without other tobacco products.

Correlates of Polytobacco Use

Multivariable logistic regression results showed that the prevalence of polytobacco use increased over time during 2012–2014 among

Table 2. Prevalence of Polytobacco Use and Characteristics Associated With Polytobacco Users Among Current Cigarette Smokers, Cigar Smokers, Pipe Smokers, Hookah Users, E-cigarette Users, and Smokeless Tobacco Users: Multivariable Logistic Regression Analysis

	Polytobacco use among current cigarette smokers (*N* = 16 156)			Polytobacco use among current cigar smokers (*N* = 4411)			Polytobacco use among current pipe smokers (*N* = 795)		
	N	%Poly	AOR (95% CI)	*N*	%Poly	AOR (95% CI)	*N*	%Poly	AOR (95% CI)
Overall	16 156	38.7	…	4411	69.3	…	795	86.2	…
Year									
2012–2013	6866	36.3	REF	1800	69.5	REF	335	89.4	REF
2013–2014	9290	41.2	**1.38 (1.25–1.52)**	2611	69.2	1.00 (0.83–1.21)	460	82.9	**0.56 (0.34–0.91)**
Gender									
Male	7995	45.5	**1.95 (1.77–2.15)**	3732	67.8	0.80 (0.60–1.08)	713	84.8	0.36 (0.10–1.32)
Female	8161	30.4	REF	679	77.3	REF	82	96.5	REF
Age									
18–24	1363	66.9	REF	667	82.3	REF	119	96.7	REF
25–29	1236	50.8	**0.50 (0.40–0.61)**	449	77.8	0.90 (0.61–1.34)	59	92.6	0.53 (0.12–2.62)
30–44	3702	40.4	**0.32 (0.27–0.38)**	1073	72.0	0.70 (0.49–1.00)	157	91.7	0.51 (0.14–1.81)
45–64	7038	28.1	**0.18 (0.15–0.22)**	1633	57.4	**0.33 (0.23–0.46)**	259	85.1	**0.24 (0.07–0.79)**
65+	2817	19.8	**0.11 (0.09–0.14)**	589	45.9	**0.18 (0.12–0.27)**	201	51.8	**0.06 (0.02–0.19)**
Race/Ethnicity									
Non-Hispanic White	11 411	40.8	REF	3158	68.9	REF	569	82.8	REF
Hispanic	1264	37.3	**0.71 (0.60–0.85)**	377	70.5	**0.67 (0.48–0.94)**	57	94.4	1.80 (0.51–6.37)
Non-Hispanic Black	1717	26.9	**0.55 (0.47–0.65)**	429	61.5	**0.40 (0.29–0.55)**	40	91.5	2.00 (0.48–8.26)
Non-Hispanic Asian	196	38.7	**0.65 (0.43–0.99)**	33	86.0	2.88 (0.97–8.56)	8	88.7	3.95 (0.22–71.91)
Non-Hispanic Other	1568	43.2	1.06 (0.90–1.25)	414	81.7	**1.51 (1.04–2.19)**	121	93.4	2.07 (0.92–4.65)
Education									
Less than HS	2207	32.6	REF	437	82.3	REF	103	92.7	REF
HS graduate	5397	40.8	**1.29 (1.11–1.50)**	1254	71.5	**0.52 (0.36–0.76)**	211	89.2	0.55 (0.24–1.27)
Some college	4760	41.4	**1.39 (1.19–1.63)**	1248	72.3	**0.61 (0.42–0.87)**	199	87.3	0.45 (0.20–1.01)
College graduate	3792	37.8	**1.33 (1.12–1.58)**	1472	53.7	**0.33 (0.23–0.48)**	282	75.8	**0.18 (0.08–0.40)**
Household income									
<$30 000	4620	35.0	REF	918	79.6	REF	200	90.4	REF
$30 000–$49 999	3623	39.0	0.97 (0.84–1.11)	864	75.3	0.90 (0.65–1.24)	158	83.3	0.70 (0.30–1.66)
$50 000–$99 999	3521	42.2	1.11 (0.97–1.28)	1074	63.8	**0.53 (0.39–0.72)**	215	87.3	1.51 (0.65–3.51)
≥$100 000	1393	45.6	1.19 (0.99–1.44)	832	52.9	**0.38 (0.27–0.54)**	95	84.7	1.27 (0.48–3.34)
Unknown	2999	36.8	**0.84 (0.72–0.97)**	723	73.5	**0.70 (0.50–0.98)**	127	82.0	0.51 (0.20–1.29)
Marital status									
Married	7384	36.5	REF	2249	60.0	REF	370	80.0	REF
W/D/S	5019	33.5	**1.23 (1.09–1.38)**	899	77.0	**2.30 (1.76–2.99)**	217	87.4	**2.58 (1.41–4.75)**
Single	3753	47.8	1.12 (0.99–1.27)	1263	78.5	**1.57 (1.20–2.05)**	208	95.0	**2.42 (1.01–5.80)**
Frequency of use									
Daily	12 274	38.8	**1.15 (1.03–1.29)**	600	61.6	**0.62 (0.46–0.83)**	143	68.7	**0.41 (0.23–0.72)**
Nondaily[a]	3882	38.5	REF	3811	70.5	REF	652	88.9	REF

Table 2. *Continued*

	Polytobacco use among current hookah users (*N* = 2377)			Polytobacco use among current e-cigarette user (*N* = 4717)			Polytobacco use among current ST users (*N* = 3209)		
	N	%Poly	AOR (95% CI)	*N*	%Poly	AOR (95% CI)	*N*	%Poly	AOR (95% CI)
Overall	2377	59.2	…	4717	80.9	…	3209	52.4	…
Year									
2012–2013	835	58.8	REF	1479	84.2	REF	1355	55.7	REF
2013–2014	1542	59.5	1.01 (0.80–1.28)	3238	79.0	**0.66 (0.52–0.83)**	1854	49.1	**0.70 (0.57–0.87)**
Gender									
Male	1460	67.6	**2.81 (2.21–3.56)**	2389	81.6	1.22 (0.98–1.50)	2985	52.3	1.20 (0.79–1.83)
Female	917	46.1	REF	2328	80.2	REF	224	55.0	REF
Age									
18–24	1340	54.8	REF	870	82.5	REF	558	70.8	REF
25–29	525	62.8	**1.94 (1.45–2.59)**	529	85.6	**1.51 (1.03–2.22)**	350	66.3	0.82 (0.56–1.20)
30–44	383	68.3	**2.20 (1.48–3.26)**	1203	80.4	1.28 (0.92–1.78)	918	55.6	**0.64 (0.45–0.90)**
45–64	111	74.4	**2.62 (1.35–5.08)**	1651	78.9	1.15 (0.83–1.60)	992	33.1	**0.26 (0.18–0.37)**
65+	18	94.0	4.80 (0.96–24.09)	464	73.7	0.80 (0.51–1.26)	391	16.7	**0.10 (0.06–0.17)**
Race/Ethnicity									
Non-Hispanic White	1427	62.9	REF	3512	80.9	REF	2551	51.3	REF
Hispanic	417	58.4	**0.67 (0.50–0.91)**	427	80.9	0.76 (0.53–1.07)	163	63.9	0.79 (0.48–1.30)
Non-Hispanic Black	224	47.7	**0.44 (0.30–0.66)**	255	82.0	0.82 (0.52–1.28)	137	32.1	**0.50 (0.30–0.84)**
Non-Hispanic Asian	105	29.8	**0.25 (0.14–0.44)**	82	70.9	0.74 (0.38–1.43)	18	78.3	2.34 (0.75–7.31)
Non-Hispanic Other	204	66.6	1.17 (0.76–1.81)	441	83.0	1.03 (0.71–1.51)	340	60.8	1.23 (0.84–1.79)
Education									
Less than HS	136	78.0	REF	437	84.5	REF	389	53.6	REF
HS graduate	712	65.3	0.59 (0.33–1.05)	1513	82.4	0.91 (0.61–1.35)	1106	55.1	0.83 (0.57–1.20)
Some college	756	57.4	**0.38 (0.22–0.68)**	1614	80.7	0.89 (0.60–1.32)	823	54.2	0.76 (0.52–1.13)
College graduate	773	44.2	**0.18 (0.10–0.32)**	1153	75.5	**0.55 (0.36–0.84)**	891	44.6	**0.48 (0.32–0.73)**
Household income									
<$30 000	376	67.7	REF	1055	84.3	REF	526	53.6	REF
$30 000–$49 999	525	64.8	0.82 (0.55–1.21)	1060	82.6	0.88 (0.64–1.21)	648	56.6	1.04 (0.73–1.48)
$50 000–$99 999	639	54.6	**0.48 (0.33–0.69)**	1187	80.5	0.78 (0.56–1.08)	920	51.5	0.93 (0.66–1.32)
≥$100 000	376	51.8	**0.47 (0.31–0.71)**	570	76.0	**0.62 (0.43–0.90)**	579	47.0	0.79 (0.52–1.21)
Unknown	461	58.0	**0.66 (0.44–0.98)**	845	78.8	0.74 (0.53–1.04)	536	53.4	0.99 (0.69–1.42)
Marital status									
Married	671	65.1	REF	2230	79.7	REF	1790	44.5	REF
W/D/S	155	76.4	1.55 (0.87–2.78)	1131	79.6	1.03 (0.80–1.34)	607	53.6	**1.88 (1.41–2.51)**
Single	1551	55.1	**0.73 (0.56–0.95)**	1356	83.6	1.19 (0.91–1.55)	812	67.0	**1.39 (1.05–1.84)**
Frequency of use									
Daily	41	92.8	**5.87 (1.27–27.16)**	1025	57.3	**0.20 (0.16–0.25)**	1634	31.5	**0.19 (0.16–0.24)**
Nondaily[a]	2336	58.6	REF	3692	86.8	REF	1575	71.4	REF

Ellipsis indicates not included in the model. Statistically significant AOR results are noted in bold.

AOR = adjusted odds ratio; CI = confidence interval; HS = high school; ST = smokeless tobacco; *N* = unweighted sample size for the denominator; W/D/S = widowed/divorced/separated; %Poly = prevalence of polytobacco use.

[a]For cigarette smokers, this category refers to some-day smokers; for other tobacco users, this category includes some-day and rare users.

Table 3. Combinations of Tobacco Products Used by Polytobacco Users Among Current Cigarette Smokers, Cigar Smokers, Pipe Smokers, Hookah Users, E-cigarette Users, and Smokeless Tobacco Users: National Adult Tobacco Survey, 2012–2014

	Poly users among current users of any tobacco products		Poly users among current cigarette smokers		Poly users among current cigar smokers		Poly users among current pipe smokers		Poly users among current hookah users		Poly users among current e-cigarette users		Poly users among current ST users	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
Overall	6675	100.0	5702	100.0	2799	100.0	607	100.0	1395	100.0	3765	100.0	1445	100.0
Use of two products	4943	70.3	4138	68.5	1585	53.0	235	30.5	595	40.5	2599	63.2	734	48.1
Cigarettes + cigars	1075	16.3	1075	19.1	1075	37.0								
Cigarettes + pipes	94	1.1	94	1.3			94	13.1						
Cigarettes + hookah	230	4.2	230	4.9					230	16.4				
Cigarettes + e-cigarettes	2319	30.2	2319	35.3							2319	55.0		
Cigarettes + ST	420	6.8	420	7.9									420	29.1
Cigars + pipes	102	0.1			102	2.1	102	11.1						
Cigars + hookah	132	2.2			132	5.0			132	8.6				
Cigars + e-cigarettes	66	0.9			66	2.1					66	1.7		
Cigars + ST	210	3.0			210	6.8							210	12.9
Hookah + e-cigarettes	166	3.0							166	11.7	166	5.5		
Other combinations of two products	129	1.8					39	6.3	67	3.8	48	1.1	104	6.0
Use of at least three products	1732	29.7	1564	31.5	1214	47.1	372	69.5	800	59.5	1166	36.8	711	52.0
Cigarettes + e-cigarettes + cigars	334	5.4	334	6.2	334	12.1					334	9.7		
Cigarettes + e-cigarettes + cigars + ≥1 Other*	312	5.8	312	6.7	312	13.1	82	15.5	196	15.0	312	10.5	148	12.2
Cigarettes + e-cigarettes + ≥1 Other*	411	7.3	411	8.6			45	8.2	252	19.1	411	13.3	179	12.8
Cigarettes + cigars + ≥1 Other*	433	7.3	433	8.6	433	16.6	147	26.9	155	12.5			245	17.0
Cigarettes + ≥2 Other*	74	1.2	74	1.5			39	7.1	61	4.1			52	3.9
Combinations of ≥3 noncigarette products	168	2.8			135	5.3	59	11.9	136	8.8	109	3.3	87	6.1
Reclassification of polytobacco use														
Poly use with e-cigarettes w/ or w/o other products			3376	56.9										
Poly use with only non-e-cigarette products			2326	43.1										
Poly use with cigarettes w/ or w/o other products					2154	78.8	407	70.7	894	67.1	3376	88.5	1044	75.0
Poly use with only other noncigarette products					645	21.2	200	29.3	501	32.9	389	11.5	401	25.0

*Other indicates pipes, hookah, and/or smokeless tobacco.

ST = smokeless tobacco.

current cigarette smokers but decreased over time among current users of pipes, e-cigarettes, and smokeless tobacco (Table 2). Variations in demographic profiles of poly users were observed across different tobacco users. Among current cigarette smokers, polytobacco users were more likely to be male, aged 18–24, more educated, widowed/divorced/separated, and to smoke cigarettes daily; but less likely to be Hispanic, non-Hispanic Black, or non-Hispanic Asian. Among current cigar smokers, polytobacco users were more likely non-Hispanic Other, widowed/divorced/separated or single; but less likely to be aged 45 and older, Hispanic, non-Hispanic Black, more educated, to have household income at least $50 000, and to smoke cigars daily. Among current pipe smokers, polytobacco users were more likely to be widowed/divorced/separated or single; but less likely to be aged 45 and older, college graduates, and to smoke pipes daily. Among current hookah users, polytobacco users were more likely to be male, aged 25–64, and to use hookah daily; but less likely to be Hispanic, non-Hispanic Black, non-Hispanic Asian, to have at least some college education, to have household income at least $50 000, and to be single. Among current e-cigarette users, polytobacco use was more likely among young adults aged 25–29; but less likely among college graduates, those with household income at least $100 000, and those who used e-cigarettes daily. Among current smokeless tobacco users, polytobacco users were more likely to be widowed/divorced/separated or single but less likely to be aged 30 and older, non-Hispanic Black, to be college graduates, and to use smokeless tobacco daily.

Nicotine Dependence Symptoms and Polytobacco Use

Table 4 shows the nicotine dependence prevalence estimates for polytobacco users and sole users among each of the six categories of tobacco user. Awakening at night for tobacco was reported by 18.9%, 4.2%, 3.2%, and 4.8% of current sole cigarette smokers, sole cigar smokers, sole e-cigarette users, and sole smokeless tobacco users. A similar prevalence pattern across these sole tobacco users was also found for the symptom measure "wanted to use tobacco so much that it was difficult to think of anything else." Recent strong craving to use tobacco was reported by 57.1%, 15.0%, 13.2%, 6.0%, 28.9%, and 46.8% of current sole users of cigarettes, cigars, pipes, hookah, e-cigarettes, and smokeless tobacco, respectively. The pattern and magnitude of the dependence prevalence for the symptom measure "felt really needed to use tobacco" across different sole tobacco users mirrored those for the craving symptom. The prevalence of withdrawal symptom was 35.4%, 5.9%, 12.6%, and 24.5% among current sole users of cigarettes, cigars, e-cigarettes, and smokeless tobacco, respectively.

Among each category of current tobacco user, the prevalence of dependence was consistently greater in polytobacco users than sole users for every symptom measure. Table 4 also shows that after controlling for frequency of use and other covariates, the difference in nicotine dependence between polytobacco users and sole users was not only statistically significant but also consistent across the five symptom outcomes regardless of which category of current tobacco user. For example, among current smokeless tobacco users, poly users were more likely than sole users to report each dependence symptom, with adjusted odds ratios ranging from 2.86 (95% CI: 2.29–3.57) for withdrawal symptom to 4.92 (95% CI: 3.32–7.30) for awakening at night. However, across different categories of current tobacco user, the magnitudes of the associations between polytobacco use and the five symptom measures varied, with adjusted odds ratios being the lowest among current cigarette smokers (between 1.37 and 1.72), and highest among current hookah users (between 11.79 and 20.79) and current pipe smokers (between 6.35 and 33.37).

Discussion

This study extends previous studies on polytobacco use among US adults by examining polytobacco use among six categories of current tobacco user and by including two emerging tobacco products—e-cigarettes and hookah. We found that during 2012–2014, the prevalence of polytobacco use among current cigarette smokers was 38.7%, much higher than the estimates (2.3%–16.3%) from previous studies that used data prior to 2011.[13,17,18,20–24] This could be explained by two reasons. First, those previous studies only included cigarettes and one other tobacco product, while we included six tobacco products. Including more tobacco products increases the estimate of polytobacco use prevalence. Second, e-cigarettes were not included in those previous studies. The availability of e-cigarettes, often marketed as reduced harm tobacco products,[43,44] might appeal to cigarette smokers and increase their polytobacco use in recent years. However, our estimates of 45.5% of male and 30.4% of female current cigarette smokers being polytobacco users are similar to those (46.5% and 26.4%, respectively) estimated by Lee et al.[15] who used the 2012 RTI NATS data and also included many forms of tobacco products. Probably for similar reasons, our estimated prevalence of polytobacco use among current cigar smokers (69.3%) is larger than that from a previous study (50.3% in 2010),[24] and our estimated prevalence of polytobacco use among current smokeless tobacco users (52.4%) is also larger than that from previous studies (ranging from 25.0% to 42.4%).[17,21,22]

Our estimate of 32.5% of current users of any tobacco products being polytobacco users is slightly smaller than that estimated by Kasza et al.[14] using the 2013–2014 PATH data (37.8%). This is probably because their study disaggregated cigars into separate products (traditional cigars, cigarillos, and filtered cigars) while we did not. Our findings are consistent with theirs that the most common polytobacco combination was dual use of cigarettes and e-cigarettes.[14]

To our knowledge, this is the first study to examine the prevalence and correlates of polytobacco use among current pipe smokers, hookah users, and e-cigarette users. Polytobacco use was very common (59.2%–86.2%) among them. The association of age with polytobacco use was negative among current pipe smokers, positive among current hookah users, but not statistically significant among e-cigarette users. While polytobacco use was more prevalent for males versus females and less prevalent for racial/ethnic minorities versus non-Hispanic Whites among current hookah users, gender and race/ethnicity were not significant predictors for polytobacco use among current pipe and e-cigarette users. Daily users were less likely to engage in polytobacco use among current pipe and e-cigarette users, but the opposite relation holds among current hookah users. These results highlight the variation in the profiles of poly users across current hookah, pipe, and e-cigarette users.

Very few e-cigarette users used e-cigarettes daily or used only e-cigarettes. Nearly 90% of poly use e-cigarette users concurrently smoked cigarettes with or without other tobacco products. A subanalysis of our data revealed that the majority of sole e-cigarette users (93.1% of daily users and 56.7% of nondaily users) were former cigarette smokers. Yet, sole e-cigarette users still showed lower prevalence of dependence symptoms compared with poly use

Table 4. Prevalence of Nicotine Dependence Among Polytobacco Users and Sole Users by Nicotine Dependence Symptom Measure and Current Tobacco User Category, and Adjusted[a] Association of Polytobacco Use With Nicotine Dependence: National Adult Tobacco Survey, 2012–2014

Dependence symptom outcome variable	Among current cigarette smokers (N = 15 495)	Among current cigar smokers (N = 4276)	Among current pipe smokers (N = 765)	Among current hookah users (N = 2349)	Among current e-cigarette users (N = 4583)	Among current smokeless tobacco users (N = 3097)
1. Sometimes wake up at night in order to have a cigarette or other tobacco product						
%ND in sole users	18.9 (18.3–19.4)	4.2 (3.4–5.1)	[b]	[b]	3.2 (2.5–3.9)	4.8 (4.1–5.6)
%ND in poly users	23.2 (22.4–24.0)	24.3 (23.2–25.5)	26.3 (23.7–28.9)	16.3 (14.9–17.7)	19.9 (18.9–20.9)	19.0 (17.5–20.4)
AOR[a]	**1.52 (1.34–1.72)**	**7.04 (4.70–10.56)**	**15.53 (3.64–66.31)**	**20.79 (8.63–50.08)**	**7.04 (4.41–11.24)**	**4.92 (3.32–7.30)**
2. Ever had a strong craving to use tobacco products of any kind during the past 30 days						
%ND in sole users	57.1 (56.4–57.8)	15.0 (13.6–16.3)	13.2 (10.1–16.4)	6.0 (5.0–7.0)	28.9 (26.9–30.8)	46.8 (45.3–48.4)
%ND in poly users	70.1 (69.3–70.9)	61.9 (60.7–63.2)	56.7 (53.9–59.5)	53.3 (51.5–55.0)	66.9 (65.9–68.0)	64.6 (63.0–66.3)
AOR[a]	**1.72 (1.55–1.91)**	**9.04 (7.06–11.56)**	**10.20 (5.40–19.30)**	**15.64 (10.43–23.47)**	**5.69 (4.56–7.10)**	**3.14 (2.46–4.02)**
3. Ever felt really needed to use a tobacco product during the past 30 days						
%ND in sole users	61.4 (60.7–62.1)	13.8 (12.5–15.1)	11.7 (8.7–14.6)	4.8 (4.0–5.7)	29.9 (27.9–31.8)	42.5 (41.0–44.1)
%ND in poly users	71.0 (70.2–71.8)	61.5 (60.3–62.7)	55.5 (52.7–58.3)	51.6 (50.0–53.3)	67.9 (66.9–69.0)	64.5 (62.8–66.1)
AOR[a]	**1.59 (1.43–1.77)**	**10.21 (7.94–13.11)**	**10.05 (5.34–18.91)**	**19.30 (12.84–29.02)**	**6.14 (4.83–7.75)**	**3.57 (2.81–4.54)**
4. Ever wanted to use a tobacco product so much that it was difficult to think of anything else during the past 30 days						
%ND in sole users	18.0 (17.5–18.6)	4.1 (3.2–5.0)	[b]	[b]	5.6 (4.7–6.5)	7.6 (6.8–8.5)
%ND in poly users	24.4 (23.6–25.2)	21.9 (20.8–23.0)	26.5 (24.0–29.0)	17.7 (16.3–19.0)	22.8 (21.8–23.7)	22.9 (21.5–24.4)
AOR[a]	**1.49 (1.32–1.68)**	**5.37 (3.38–8.51)**	**33.37 (6.88–161.80)**	**11.79 (5.69–33.42)**	**4.83 (3.35–6.96)**	**4.16 (3.05–5.67)**
5. Often/always feel irritable or restless when not using tobacco for a while						
%ND in sole users	35.4 (34.7–36.1)	5.9 (5.0–6.8)	[b]	[b]	12.6 (11.2–14.1)	24.5 (23.2–25.9)
%ND in poly users	42.5 (41.6–43.4)	38.3 (37.1–39.6)	39.7 (36.9–42.5)	26.9 (25.3–28.5)	38.7 (37.6–39.8)	40.5 (38.8–42.2)
AOR[a]	**1.37 (1.24–1.52)**	**9.00 (6.51–12.44)**	**6.35 (2.85–14.16)**	**20.49 (10.28–40.86)**	**4.76 (3.56–6.36)**	**2.86 (2.29–3.57)**

The numbers in parenthesis represent the 95% conference interval. Statistically significant AOR results are noted in bold.

AOR = adjusted ratio of the odds of nicotine dependence among poly users compared with the odds of nicotine dependence among sole users; N = unweighted sample size; %ND = prevalence of nicotine dependence.

[a]Estimated from the multivariable logistic regression model on nicotine dependence adjusting for frequency of use, gender, age, race/ethnicity, education, household income, marital status, and survey year. Complete regression results for each dependence outcome by current tobacco user category are shown in Supplementary Tables 1–5.

[b]Estimate was suppressed because its relative standard error was greater than 30%.

e-cigarette users and sole cigarette smokers. This evidence implies potential beneficial impact of successful switching from cigarette to e-cigarette smoking on reducing dependence symptoms. However, more research is needed to validate this hypothesis.

One of the NATS strengths is the inclusion of the "rarely" option to questions about current use of noncigarette tobacco products. We found that 83%–94% of ever cigar smokers, pipe smokers, hookah users, e-cigarette users, and smokeless tobacco users who answered "rarely" using the respective product reported using that product in the past 30 days. This indicates that some occasional users of these products did use the product recently but do not perceive themselves as "some days" users or nonusers. In our final study sample, one-quarter of current smokeless tobacco users and more than half of current cigar, pipe, hookah, and e-cigarette users fell into this category. Future research to examine the role that "rarely" noncigarette tobacco use plays in the onset and development of tobacco dependence would inform tobacco prevention and cessation efforts.

There are several limitations in this study. First, tobacco use and nicotine dependence were self-reported and may be subject to recall or measurement bias. Second, this study used cross-sectional data; therefore, it is not feasible to determine whether polytobacco use causes greater nicotine dependence symptoms or vice versa. Longitudinal studies on product-specific tobacco use trajectories of initiation, transition, and quitting are needed to understand the causal effect of polytobacco use on nicotine dependence. Third, this study focuses on current polytobacco use among current tobacco users and does not assess the effects of former polytobacco use on nicotine dependence symptoms. Finally, this study replied on a limited set of self-reported dependence symptom measures from the NATS. Investigating the validity and comparability of each symptom measure across different products is beyond the scope of this work. Recently, Strong et al.[34,35] developed a parsimonious set of dependence symptoms to measure nicotine dependence across users of different tobacco products; however, the best way to capture product-specific influences on nicotine dependence still remains to be determined.[35]

In conclusion, our results indicate that between 52% and 86% of noncigarette tobacco users and nearly 40% of cigarette smokers engaged in polytobacco use. Polytobacco users are significantly more likely to report dependence symptoms than sole-product tobacco users for each category of current tobacco user. This study provides baseline insight into the complex and multifaceted matrix of polytobacco use patterns and its relationship to nicotine dependence symptoms shortly before the US Food and Drug Administration (FDA) issued the "Deeming Rule" that extends its tobacco regulatory authority over tobacco products that were not previously regulated, such as e-cigarettes and hookah.[45] Consideration of polytobacco use should be part of FDA tobacco regulatory activities.

Supplementary Material

Supplementary data is available at *Nicotine & Tobacco Research* online.

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Declaration of Interests

None declared.

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