

Correlates of tobacco product reuptake and relapse among youth and adults in the USA: findings from the PATH Study Waves 1–3 (2013–2016)

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ABSTRACT

Objective This study examines sociodemographic and tobacco use correlates of reuptake and relapse to tobacco use across a variety of tobacco products (cigarettes, electronic nicotine delivery systems, cigars, hookah and smokeless tobacco) among the US population.

Design Data were drawn from the first three waves (2013–2016) of the Population Assessment of Tobacco and Health Study, a nationally representative, longitudinal cohort study of US youth (ages 12–17) and adults (ages 18+). Reuptake (past 30-day use among previous tobacco users) and relapse (current use among former established users; adults only) were examined among previous users of at least one type of tobacco product at Wave 1 (W1) or Wave 2 (W2) (n=19 120 adults, n=3039 youth). Generalised estimating equations were used to evaluate the association between demographic and tobacco use characteristics at baseline, with reuptake/relapse at follow-up, over two 1-year periods (W1–W2 and W2–Wave 3).

Results Any tobacco product reuptake occurred in 7.8% of adult previous users and 30.3% of youth previous users. Correlates of any tobacco reuptake included being male, non-Hispanic black and bisexual in adults, but race and sexual orientation were not consistent findings in youth. Among recent former users, relapse rates were greater (32.9%). Shorter time since last use and greater levels of tobacco dependence showed the strongest association with any tobacco relapse.

Discussion Continued clinical and public health efforts to provide adults with tools to cope with tobacco dependence symptoms, especially within the first year or two after quitting, could help prevent relapse.

INTRODUCTION

The majority of cigarette smokers who make at least one serious quit attempt relapse back to cigarette smoking, usually within the first week of quitting.^{1–3} This relapse could be due to the addictive nature of nicotine and negative nicotine withdrawal symptoms when stopping use,⁴ exposure to conditioned cues associated with the automated behaviour of tobacco product use,⁵ a desire to reinforce the subjective satisfaction derived from the product,⁶ and/or other social influences or stressors.^{6,7} Relapse

among cigarette smokers has been studied extensively.^{8–13} The cycle between use, discontinued use and relapse can repeat multiple times throughout a tobacco user's lifetime. Despite great progress in psychosocial and pharmacotherapy interventions, long-term abstinence rates for cigarette smokers tend to be 30% or less, making relapse the most likely outcome for addicted smokers who make a cessation attempt.³ Clinical data on relapse among cigarette smokers have revealed numerous factors associated with relapse, including sociodemographic characteristics (eg, age, race, socioeconomic status),^{8,9} cognitive and behavioural factors (eg, lack of self-efficacy),¹⁴ nicotine dependence/withdrawal,¹⁵ experiencing a smoking lapse¹⁶ and other comorbidities (eg, psychiatric illness, other substance use).¹⁷

Epidemiological studies of smoking relapse are less common and limited due to the cross-sectional nature of most population-based studies. Caraballo *et al*⁸ used 25 years of data from a community-based cohort study to assess cigarette smoking relapse. They found that 39% of former smokers (at baseline) relapsed at least once, but of those, 70% had quit again by the end of the study. Using data from the Tobacco Use Supplement to the Current Population Survey, Yi *et al*⁹ investigated sociodemographic factors related to cigarette smoking relapse and found that at least 15% of young adults, ages 18–29, experience smoking relapse (or move from being a former smoker to a current smoker) compared with 3%–8% of older adults, age 30 or older, who relapse to smoking. Researchers have also examined the role of other tobacco product use on cigarette relapse and found that e-cigarette and smokeless tobacco users were more likely to relapse to cigarette smoking than non-users of these products.^{18–20} Yet less is known about relapse with other tobacco products in the current tobacco marketplace. Non-cigarette tobacco product users exhibit different patterns of use²¹ and different levels of nicotine dependence.^{22,23} The lack of data on relapse for tobacco products other than cigarettes is a significant limitation of the current literature, since use of non-cigarette tobacco products has increased in recent years.^{24–27}

Understanding the sociodemographic and tobacco use factors associated with reuptake and

relapse to different tobacco products fills a large gap in the primarily cigarette-focused literature. Few studies have assessed the transition from any previous use back to past 30-day (P30D) use (hereafter referred to as product reuptake) or from former established use back to current use (ie, using every day or some days; hereafter referred to as product relapse).^{8 9 18} We have chosen to differentiate reuptake from relapse to allow exploration of behavioural changes that may or may not be indicative of a persistent pattern of use, especially among youth who may be experimenting with tobacco products. Using longitudinal data of the Population Assessment of Tobacco and Health (PATH) Study to assess within-person changes over time, this study evaluates the sociodemographic and tobacco use correlates of tobacco product reuptake among youth (ages 12–17) and adults (ages 18+), and tobacco product relapse among adults across several tobacco products available in the USA (cigarettes, electronic nicotine delivery systems (ENDS), cigars, hookah and smokeless tobacco). Knowing which sociodemographic and other tobacco use characteristics contribute to reuptake and relapse across a spectrum of tobacco products will enhance a targeted public health approach to preventing tobacco use relapse.

METHODS

Data source and participants

The PATH Study is an ongoing, nationally representative, longitudinal cohort study of youth and adults in the USA to gather information on tobacco use patterns and associated health behaviours. Data were collected from 12 September 2013 to 14 December 2014 (Wave 1 (W1)); from 23 October 2014 to 30 October 2015 (Wave 2 (W2)); and from 19 October 2015 to 23 October 2016 (Wave 3 (W3)). Further details regarding the PATH Study design and W1 methods are published elsewhere.²⁸ The overall weighted response rate was 78.4% for youth and 74.0% for adults at W1, 87.3% for youth and 83.2% for adults at W2, and 83.3% for youth and 78.4% for adults at W3. Details on interview procedures, questionnaires, sampling, weighting, response rates and accessing the data are described in the PATH Study Restricted Use Files User Guide at <https://doi.org/10.3886/Series606>. The study was conducted by Westat and approved by the Westat Institutional Review Board. All respondents ages 18 or older provided informed consent, with youth respondents ages 12–17 providing assent while each one's parent/legal guardian provided consent. Data in this paper were drawn from respondents in W1, W2 and W3 of the PATH Study

(25 384 adults at W1 or W2 and 12 993 youth at W1 or W2 (eg, among previous users of any tobacco product, youth who aged into adulthood at W2 were included in the youth analyses between W1 and W2 (n=624) and were included in the adult analyses between W2 and W3 (n=270). 'Shadow youth' or youth who turned 12 and entered the study at W2 (n=95) were included in the youth analyses between W2 and W3; see online supplementary table 1 for additional details)).

The analytic sample is subset to respondents who had ever used a tobacco product but are not P30D users of at least one type of tobacco product at baseline (n=18 988 adults; n=2 983 youth). W1 is considered as the baseline to W2 and W2 is the baseline to W3. The weighted estimates represent the civilian, non-institutionalised population of the USA at the time of W3 who were ages 9 or older at W1, through application of population and replicate weights that adjust for the complex study design characteristics (eg, oversampling at W1) and non-response at W1, W2 and W3.

Measures

Tobacco product use

Tobacco products were grouped into five types: cigarettes, ENDS (e-cigarettes at W1 and e-cigarettes, e-cigars, e-pipes and e-hookah at W2 and W3), cigars (traditional cigars, cigarillos and filtered cigars), hookah and smokeless tobacco (loose snus, moist snuff, dip, spit, chewing tobacco and snus pouches). Previous use, former established use (adults only) and recent former established use (adults only) are defined (see table 1) for each type of product and any tobacco use.

Outcomes

Reuptake was defined as the transition from previous use at baseline (W1 or W2) to P30D use at follow-up (W2 or W3). Relapse was defined as the transition from former established use (former established use cannot be defined from the youth interview) at baseline (W1 or W2) to current every day or some day use at follow-up (W2 or W3). Among adults, relapse was assessed among all former established users, and separately among recent (within the past 12 months) former users. See table 1 for definitions. For a visual depiction of how the reuptake definition compares to the relapse definition, see online supplementary figure 1.

Table 1 Definitions

Relapse Behaviors	Baseline Tobacco Use Group (W1 or W2)	Follow-up Outcome (W2 or W3)
Reuptake ¹ (Table 2 and online supplementary table 2)	Adults and Youth, <u>Previous Use</u> : For any tobacco and each tobacco product category ⁴ , had ever used the product (even once or twice) but not in the past 30 days.	Adults and Youth, <u>Reuptake</u> : Past 30-day use of the given tobacco product
Relapse ² (Table 3)	Adults only, <u>Former Established Use</u> : For cigarettes, had previously smoked at least 100 cigarettes in their lifetime, but had not smoked cigarettes in the past 30 days and not currently smoking every day or some days. For the other tobacco product categories, had previously used the product "fairly regularly" but not in the past 30 days, and not currently using every day or some days.	Adults only, <u>Relapse</u> : Current (every day/ some days) use of the given tobacco product
Relapse ³ (online supplementary table 3)	Adults only, <u>Recent Former Established Use</u> : For cigarettes, had previously smoked at least 100 cigarettes in their lifetime, had quit smoking in the past 12 months, had not smoked cigarettes in the past 30 days and not currently smoking every day or some days. For the other tobacco product categories, had previously used the product "fairly regularly," had quit in the last 12 months, and had not used the product in the past 30 days, and not currently using every day or some days.	Adults only, <u>Relapse</u> : Current (every day/ some days) use of the given tobacco product

¹The respondent could have been a previous user for varied amounts of time prior to reuptake, ranging from 31 days to 70+ years.

²The respondent could have been a former established user for varied amounts of time prior to relapse, ranging from 31 days to 70+ years.

³The respondent could only have become a former established user within the past 12 months, with previous use ranging from 31 days to 12 months.

⁴Tobacco product categories include cigarettes, ENDS (e-cigarettes at W1 and e-cigarettes, e-cigars, e-pipes, and e-hookah at W2 and W3), cigars (traditional cigars, cigarillos, and filtered cigars), hookah, and smokeless tobacco (loose snus, moist snuff, dip, spit, chewing tobacco, and snus pouches) W1, Wave 1; W2, Wave 2; W3, Wave 3.

Demographic characteristics

Demographic characteristics were assessed at the baseline wave and categorised as shown in the tables. Missing data on age, sex, race and Hispanic ethnicity were imputed at W1 as described in the PATH Study Restricted Use Files User Guide (imputed sex and race/ethnicity were carried forward to also represent these characteristics at W2; however, age at W2 was used since the time between interviews may not have yielded one additional year in all instances).²⁹

Tobacco use characteristics

Time since last use for each tobacco product among adult former established users was categorised as: between 30 days and 1 year, between more than 1 year up to 2 years or more than 2 years. Among adult recent former established users only, tobacco dependence was also assessed (using a 16-item measure validated across multiple types of tobacco use, see reference²³ for more details).

Statistical analyses

Generalised estimating equations (GEE) were used to evaluate the association between correlates assessed at baseline and reuptake/relapse to tobacco product use at follow-up, over two 1-year periods (W1–W2 and W2–W3). This statistical method allows for the inclusion of transitions from both periods in a single analysis while statistically controlling for interdependence among observations contributed by the same individuals.^{30 31} GEE logistic regression models specified unstructured covariance, within-person correlation matrices and the binomial distribution of the dependent variable using the logit link function. Analyses were weighted using the W3 ‘all-wave’ weights to produce nationally representative estimates, and variances were computed using the balanced repeated replication method³² with Fay’s adjustment set to 0.3 to increase estimate stability.³³ All analyses were conducted using SAS V.9.4 software (SAS Institute). See online supplementary material for the SAS macro code created to run weighted GEE analyses and calculate adjusted ORs (aORs) and CIs. Analyses were run on the W1–W3 Restricted Use Files to allow for exploration of more race/ethnicity categories and sexual orientation (<https://doi.org/10.3886/ICPSR36231.v18>). Demographic and tobacco use correlates were included in each model, adjusting for all correlates including wave among adults and youth separately.

RESULTS

Reuptake among previous users

Adults

Among adult previous users, the rate of P30D reuptake of any tobacco product use was 7.8% (95% CI 7.4 to 8.3; [table 2](#)) at 1-year follow-up. Rates of P30D reuptake for each type of tobacco product at follow-up were 5.2% (95% CI 4.9 to 5.6) for cigarettes, 16.0% (95% CI 15.2 to 16.8) for ENDS, 7.3% (95% CI 6.9 to 7.8) for cigars, 6.1% (95% CI 5.7 to 6.6) for hookah and 4.4% (95% CI 3.9 to 5.0) for smokeless tobacco.

Any tobacco

Adults ages 25–39, 40–54 or 55+ (aOR range: 0.1–0.5), those with a bachelor’s degree or higher (aOR 0.7, 95% CI 0.5 to 0.9), and household income of US\$25 000–US\$74 999 or \geq US\$75 000 per year (US\$25 000–US\$74 999: aOR 0.7, 95% CI 0.6 to 0.9; \geq US\$75 000: aOR 0.7, 95% CI 0.5 to 0.8) had lower odds of tobacco use reuptake than those ages 18–24, those without a high school diploma, and to those with household income less

than US\$25 000 per year, respectively. Male sex (aOR 1.5, 95% CI 1.3 to 1.8), non-Hispanic black race/ethnicity (aOR 1.4, 95% CI 1.1 to 1.7) and identifying as bisexual (aOR 1.5, 95% CI 1.0 to 2.0) all had higher odds of tobacco use reuptake than females, non-Hispanic white race/ethnicity and those who identified as straight/heterosexual, respectively, as shown in [table 2](#).

Cigarettes

Older adults (ages 25 or older; aOR range=0.2–0.5) and those with a bachelor’s degree or higher (aOR 0.7, 95% CI 0.5 to 0.9) had lower odds of cigarette use reuptake compared with those ages 18–24 and those without a high school diploma, respectively. Non-Hispanic black (aOR 1.5, 95% CI 1.2 to 1.9) and Hispanic (aOR 1.5, 95% CI 1.2 to 1.9) race/ethnicities and identifying as bisexual (aOR 1.6, 95% CI 1.1 to 2.2) had higher odds of cigarette use reuptake compared with those who are non-Hispanic white or identified as straight/heterosexual. Those who were P30D users of cigars (aOR 2.1, 95% CI 1.8 to 2.5), ENDS (aOR 3.6, 95% CI 2.9 to 4.5) or smokeless tobacco products (aOR 1.5, 95% CI 1.1 to 2.0) at baseline had higher odds of cigarette use reuptake compared with those who were not P30D users of these products, as shown in [table 2](#).

ENDS

Older adults (ages 25 or older; aOR range=0.4–0.7) and identifying as non-Hispanic black race/ethnicity (aOR 0.7, 95% CI 0.6 to 0.9) had lower odds of ENDS use reuptake compared with those ages 18–24 and to those who are non-Hispanic white. Those who identify as gay or lesbian (aOR 1.4, 95% CI 1.0 to 2.0) had higher odds of ENDS use reuptake compared with heterosexuals. P30D users of cigarettes (aOR 2.1, 95% CI 1.8 to 2.5), cigars (aOR 1.3, 95% CI 1.2 to 1.6) or hookah (aOR 1.8, 95% CI 1.5 to 2.2) at baseline had higher odds of ENDS use reuptake compared with those who were not P30D users of these products, as shown in [table 2](#).

Cigars

Older adults (ages 25 or older; aOR range=0.3–0.6) had lower odds of cigar use reuptake compared with those ages 18–24. Male sex (aOR 1.6, 95% CI 1.4 to 1.8), non-Hispanic black (aOR 1.9 95% CI 1.5 to 2.3) and Hispanic (aOR 1.3, 95% CI 1.1 to 1.5) race/ethnicities and those who identified as bisexual (aOR 1.5, 95% CI 1.1 to 2.0); had higher odds of cigar use reuptake compared with females, those who are non-Hispanic white, and those who identified as heterosexual/straight. P30D users of cigarettes (aOR 1.9, 95% CI 1.7 to 2.2), ENDS (aOR 1.2, 95% CI 1.1 to 1.4), hookah (aOR 1.5, 95% CI 1.2 to 1.9) or smokeless tobacco products (aOR 1.4, 95% CI 1.1 to 1.8) at baseline had higher odds of cigar use reuptake compared with those who were not P30D users of these products, as shown in [table 2](#).

Hookah

Older adults (ages 25 or older; aOR range: 0.3–0.4) and those with a bachelor’s degree or higher (aOR 0.7, 95% CI 0.5 to 0.9) had lower odds of hookah use reuptake compared with those ages 18–24 or those without a high school diploma. Non-Hispanic black (aOR 2.7, 95% CI 2.1 to 3.5), Hispanic (aOR 1.8, 95% CI 1.4 to 2.2) and non-Hispanic other race (aOR 1.9, 95% CI 1.5 to 2.6) as well as identifying as bisexual (aOR 1.7, 95% CI 1.2 to 2.2) or gay/lesbian (aOR 1.6, 95% CI 1.1 to 2.3) all had higher odds of hookah use reuptake compared with those who are non-Hispanic white or those who identified as

Table 2 Correlates of reuptake among previous users at baseline (adults 18+)

Correlates at baseline	P30D use at follow-up																							
	Any Tobacco				Cigarettes				ENDS				Cigars				Hookah				Smokeless			
	%	95% CI	aOR [†]	95% CI	%	95% CI	aOR [†]	95% CI	%	95% CI	aOR [†]	95% CI	%	95% CI	aOR [†]	95% CI	%	95% CI	aOR [†]	95% CI	%	95% CI	aOR [†]	95% CI
Overall	7.8	(7.4-8.3)	N/A	N/A	5.2	(4.9-5.6)	N/A	N/A	16	(15.2-16.8)	N/A	N/A	7.3	(6.9-7.8)	N/A	N/A	6.1	(5.7-6.6)	N/A	N/A	4.4	(3.9-5.0)	N/A	N/A
Demographic characteristics																								
Age group																								
18-24	25.5	(23.5-27.6)	--	--	19.4	(17.9-21.1)	--	--	21.3	(20.0-22.7)	--	--	16.5	(15.4-17.7)	--	--	11.3	(10.3-12.4)	--	--	10	(8.3-11.9)	--	--
25-39	12	(10.8-13.3)	0.5	(0.4-0.6)***	8.4	(7.7-9.3)	0.5	(0.5-0.6)***	15.9	(14.7-17.2)	0.7	(0.6-0.8)***	9.2	(8.3-10.2)	0.6	(0.5-0.7)***	4.7	(4.0-5.4)	0.4	(0.4-0.5)***	6.4	(5.4-7.4)	0.7	(0.5-1.0)*
40-54	6	(5.1-7.0)	0.2	(0.2-0.3)***	3.8	(3.2-4.6)	0.3	(0.2-0.3)***	14.1	(12.5-15.8)	0.6	(0.5-0.7)***	5.8	(5.1-6.5)	0.4	(0.3-0.5)***	3	(2.3-4.0)	0.3	(0.2-0.4)***	2.8	(2.0-3.8)	0.3	(0.2-0.5)***
55+	3.9	(3.2-4.7)	0.1	(0.1-0.2)***	2.4	(2.0-2.9)	0.2	(0.1-0.2)***	10	(8.3-11.9)	0.4	(0.3-0.5)***	3.4	(2.9-4.1)	0.3	(0.2-0.3)***	2.2	(1.3-3.5)	0.3	(0.1-0.4)***	2	(1.3-3.3)	0.2	(0.1-0.4)***
Sex																								
Female	6.7	(6.1-7.4)	--	--	4.9	(4.4-5.5)	--	--	15.5	(14.5-16.6)	--	--	6.3	(5.7-6.9)	--	--	5.8	(5.2-6.5)	--	--	2.4	(1.8-3.2)	--	--
Male	9.1	(8.3-9.9)	1.5	(1.3-1.8)***	5.5	(5.1-6.0)	1	(0.8-1.2)	16.5	(15.5-17.6)	1	(0.9-1.1)	7.8	(7.3-8.4)	1.6	(1.4-1.8)***	6.4	(5.7-7.0)	1.2	(1.0-1.4)	4.9	(4.3-5.6)	2.5	(1.8-3.5)***
Race/ethnicity																								
Non-Hispanic White	6.6	(6.0-7.1)	--	--	4.1	(3.7-4.5)	--	--	16.8	(15.8-17.8)	--	--	6.3	(5.8-6.8)	--	--	4.2	(3.7-4.8)	--	--	4.6	(4.0-5.2)	--	--
Non-Hispanic Black	11.9	(10.3-13.6)	1.4	(1.1-1.7)***	8.1	(6.9-9.4)	1.5	(1.2-1.9)***	14.1	(12.2-16.3)	0.7	(0.6-0.9)***	13.5	(11.8-15.3)	1.9	(1.5-2.3)***	12.9	(11.0-15.2)	2.7	(2.1-3.5)***	3.1	(1.9-5.0)	0.6	(0.4-1.1)
Non-Hispanic Other (includes two or more races)	8.7	(6.7-11.2)	1	(0.8-1.4)	6.4	(4.9-8.5)	1.2	(0.9-1.7)	14.1	(11.5-17.3)	0.8	(0.6-1.1)	6.9	(5.4-8.7)	0.9	(0.7-1.2)	7.3	(5.8-9.1)	1.9	(1.5-2.6)***	4.5	(2.9-6.9)	0.8	(0.5-1.4)
Hispanic	12.5	(11.1-14.1)	1.2	(0.9-1.4)	9.5	(8.1-11.0)	1.5	(1.2-1.9)***	15.5	(13.6-17.6)	0.9	(0.7-1.0)	10.4	(9.2-11.8)	1.3	(1.1-1.5)***	8.7	(7.7-9.9)	1.8	(1.4-2.2)***	4.5	(3.2-6.3)	0.7	(0.5-1.1)
Sexual orientation																								
Straight/Heterosexual	7.8	(7.3-8.3)	--	--	5.1	(4.7-5.5)	--	--	15.7	(14.9-16.6)	--	--	7.2	(6.8-7.6)	--	--	5.8	(5.3-6.3)	--	--	4.4	(3.8-5.0)	--	--
Gay or Lesbian	9.8	(6.7-14.1)	0.9	(0.6-1.4)	8.2	(5.6-11.8)	1.3	(0.9-1.9)	21.7	(16.8-27.6)	1.4	(1.0-2.0)*	8.1	(5.6-11.5)	0.9	(0.7-1.4)	10.6	(7.7-14.4)	1.6	(1.1-2.3)*	#	#	#	#
Bisexual	14.4	(10.6-19.2)	1.5	(1.0-2.0)*	13.7	(10.1-18.1)	1.6	(1.1-2.2)**	20.6	(17.0-24.8)	1.1	(0.8-1.5)	12.8	(10.0-16.2)	1.5	(1.1-2.0)**	10.5	(8.4-13.1)	1.7	(1.2-2.2)**	#	#	#	#
Something else	12.2	(7.7-18.7)	1	(0.6-1.8)	7.7	(4.6-12.7)	0.9	(0.5-1.6)	18.6	(12.5-26.8)	1.2	(0.7-1.9)	10	(6.3-15.7)	1.1	(0.6-1.8)	8.3	(5.2-12.9)	1.4	(0.9-2.2)	#	#	#	#
Educational attainment																								
Less than high school or some high school (no diploma) or GED	9.7	(8.1-11.5)	--	--	7.1	(6.0-8.3)	--	--	17.6	(15.8-19.6)	--	--	11.1	(10.0-12.4)	--	--	8.4	(7.0-10.1)	--	--	6.1	(4.8-7.8)	--	--
High school graduate—diploma	9.1	(7.8-10.5)	1	(0.8-1.3)	6.6	(5.7-7.6)	1	(0.8-1.3)	17.4	(15.8-19.1)	1	(0.9-1.2)	9.5	(8.3-10.8)	1	(0.8-1.2)	9.2	(8.1-10.4)	1.1	(0.9-1.4)	5.6	(4.4-7.1)	0.9	(0.6-1.3)
Some college (no degree) or associate degree	8.7	(7.9-9.5)	0.9	(0.7-1.1)	5.6	(5.0-6.2)	0.8	(0.6-1.0)	15.9	(14.8-17.0)	1	(0.8-1.1)	7.1	(6.5-7.7)	0.8	(0.7-0.9)**	6.7	(5.9-7.5)	0.9	(0.7-1.2)	4.6	(3.7-5.6)	0.8	(0.5-1.2)
Bachelor's degree or more	5.9	(5.3-6.6)	0.7	(0.5-0.9)*	3.4	(2.9-3.9)	0.7	(0.5-0.9)**	12.7	(11.0-14.6)	0.9	(0.7-1.1)	4.8	(4.2-5.5)	0.8	(0.7-1.1)	3	(2.5-3.7)	0.7	(0.5-0.9)**	2.6	(2.0-3.5)	0.5	(0.3-0.9)*
Annual household income																								
< \$25,000	12.2	(10.8-13.7)	--	--	9	(8.0-10.2)	--	--	17.3	(16.1-18.5)	--	--	11.9	(11.0-12.9)	--	--	9.1	(8.1-10.3)	--	--	6	(5.1-7.1)	--	--
\$25,000-\$74,999	7.2	(6.5-8.1)	0.7	(0.6-0.9)**	4.7	(4.1-5.3)	0.7	(0.6-0.9)**	16.1	(14.8-17.4)	1.1	(1.0-1.2)	6.4	(5.8-7.1)	0.7	(0.6-0.8)***	5.4	(4.7-6.1)	0.9	(0.7-1.1)	3.7	(3.0-4.6)	0.8	(0.6-1.1)
≥ \$75,000	6.2	(5.4-7.0)	0.7	(0.5-0.8)***	3.4	(2.9-4.1)	0.6	(0.5-0.8)**	12.7	(11.0-14.6)	0.9	(0.8-1.1)	4.8	(4.2-5.4)	0.7	(0.6-0.8)***	3.3	(2.7-4.0)	0.7	(0.5-0.8)**	3.8	(2.9-5.1)	1.1	(0.8-1.6)
Not reported	6.4	(4.9-8.3)	0.7	(0.5-1.0)*	4.6	(3.5-6.1)	0.8	(0.6-1.1)	17.5	(14.7-20.7)	1.1	(0.9-1.5)	8	(6.3-10.0)	0.9	(0.7-1.3)	7.1	(5.5-9.1)	0.9	(0.7-1.2)	5.2	(3.5-7.7)	1.2	(0.8-1.9)

Continued

Table 2 Continued

Correlates at baseline	Any Tobacco			Cigarettes			ENDS			P30D use at follow-up			Cigars			Hookah			Smokeless				
	%	95% CI	aOR [†]	95% CI	aOR [†]	95% CI	%	95% CI	aOR [†]	95% CI	%	95% CI	aOR [†]	95% CI	%	95% CI	aOR [†]	95% CI	%	95% CI	aOR [†]	95% CI	
Tobacco use correlates																							
Use of cigarettes																							
No P30D use	N/A	N/A	N/A	N/A	N/A	10.5	(9.4-11.7)	--	--	5	(4.6-5.4)	--	--	4.7	(4.2-5.3)	--	--	3.2	(2.5-3.9)	--	--		
P30D use	N/A	N/A	N/A	N/A	N/A	19.6	(18.5-20.7)	2.1	(1.8-2.5)***	12.6	(11.8-13.4)	1.9	(1.7-2.2)***	8.1	(7.4-8.9)	1.4	(1.2-1.6)***	6.5	(5.7-7.3)	1.3	(1.0-1.7)		
Use of ENDS																							
No P30D use	N/A	N/A	N/A	4.6	(4.2-5.0)	--	--	N/A	N/A	N/A	N/A	6.7	(6.2-7.1)	--	--	5.7	(5.2-6.2)	--	--	3.9	(3.4-4.5)	--	--
P30D use	N/A	N/A	N/A	24.2	(21.2-27.5)	3.6	(2.9-4.5)***	N/A	N/A	N/A	N/A	13.4	(12.2-14.7)	1.2	(1.1-1.4)**	8.5	(7.2-10.0)	1.1	(0.9-1.4)	7.7	(6.3-9.4)	1.2	(0.9-1.6)
Use of cigars																							
No P30D use	N/A	N/A	N/A	4.8	(4.4-5.2)	--	--	14.7	(13.8-15.6)	--	--	N/A	N/A	N/A	N/A	5.1	(4.6-5.6)	--	--	3.7	(3.2-4.4)	--	--
P30D use	N/A	N/A	N/A	15.5	(13.7-17.5)	2.1	(1.8-2.5)***	22.4	(20.5-24.3)	1.3	(1.2-1.6)***	N/A	N/A	N/A	N/A	11.1	(9.8-12.4)	1.5	(1.2-1.8)***	8.4	(6.9-10.2)	1.5	(1.1-2.1)*
Use of hookah																							
No P30D use	N/A	N/A	N/A	4.9	(4.6-5.3)	--	--	15	(14.2-15.8)	--	--	7	(6.5-7.4)	--	--	N/A	N/A	N/A	N/A	4.3	(3.7-4.9)	--	--
P30D use	N/A	N/A	N/A	22.7	(19.2-26.7)	1.2	(1.0-1.6)	27.8	(25.3-30.4)	1.8	(1.5-2.2)***	20	(17.3-23.0)	1.5	(1.2-1.9)***	N/A	N/A	N/A	N/A	10.9	(7.8-14.9)	1.2	(0.8-1.9)
Use of smokeless																							
No P30D use	N/A	N/A	N/A	5.1	(4.7-5.5)	--	--	15.8	(15.0-16.6)	--	--	7	(6.6-7.5)	--	--	6.1	(5.6-6.6)	--	--	N/A	N/A	N/A	N/A
P30D use	N/A	N/A	N/A	9	(7.3-11.1)	1.5	(1.1-2.0)**	20.1	(17.1-23.5)	1	(0.8-1.3)	11.9	(10.2-13.8)	1.4	(1.1-1.8)**	6.5	(4.9-8.5)	0.9	(0.7-1.3)	N/A	N/A	N/A	N/A

The percentages and ORs in the table are based on weighted data. Denominator N (unweighted number of observations) for aOR in Any tobacco = 14 707. Denominator N (unweighted number of observations) for aOR in Cigarettes = 16 356. Denominator N (unweighted number of observations) for aOR in ENDS = 12 124. Denominator N (unweighted number of observations) for aOR in Cigars = 18 606. Denominator N (unweighted number of observations) for aOR in Hookah = 12 946. Denominator N (unweighted number of observations) for aOR in Smokeless = 7612. Tobacco product types were categorised into five groups: cigarettes, ENDS (e-cigarettes at Wave 1, and e-cigarettes, e-cigs, e-pipes and e-hookah at Waves 2 and 3), cigars (traditional cigars, cigarillos, filtered cigars), hookah and smokeless tobacco (loose snus, moist snuff, dip, spit, chewing tobacco and snus pouches). P30D use is defined as ever use with no P30D use (or ever using the product, even one or two times, but not in the past 30 days). Previous use is defined as using the product at least once in the past 30 days. The outcome 'reuptake' is defined as P30D use at follow-up vs no P30D use at follow-up among previous users at baseline. Since no P30D use at follow-up among previous users at baseline are considered as correlates of 'reuptake' of the given tobacco product at follow-up. GEE logistic regression analyses were used to assess correlates of 'reuptake' of P30D use at follow-up among previous users at baseline over a 1-year period of time (ie, Wave 1-Wave 2 and Wave 2-Wave 3), including up to two change data points per individual and statistically controlling for the correlation among observations from the same individuals. All correlates reflect baseline measurement for each wave pair (eg, when evaluating change between Wave 1 and Wave 2, the age correlate reflects a person's age at Wave 1, and when evaluating change between Wave 2 and Wave 3, the age correlate reflects a person's age at Wave 2). *Analyses adjusted for age group, sex, race/ethnicity, sexual orientation, educational attainment, annual household income, each tobacco use correlate and wave. †Estimates with either a relative standard error greater than 30 or a corresponding denominator less than 50 have been suppressed. * p < 0.05, ** p < 0.01, *** p < 0.001 aOR, adjusted Odds Ratio; CI, confidence interval; ENDS, electronic nicotine delivery systems; GEE, generalised estimating equation; N/A, not applicable; P30D, past 30-day.

heterosexual/straight. P30D users of cigarettes (aOR 1.4, 95% CI 1.2 to 1.6) or cigars (aOR 1.5, 95% CI 1.2 to 1.8) at baseline had higher odds of hookah use reuptake compared with those who were not P30D users of these products, as shown in [table 2](#).

Smokeless tobacco

Adults ages 25 or older (aOR range: 0.2–0.7) and those with a bachelor's degree or higher (aOR 0.5, 95% CI 0.3 to 0.9) had lower odds of smokeless tobacco reuptake use compared with those ages 18–24 and those without a high school diploma, respectively. Male sex (aOR 2.5, 95% CI 1.8 to 3.5) and P30D use of cigars (aOR 1.5, 95% CI 1.1 to 2.1) had higher odds of smokeless tobacco use reuptake compared with females and those who were not P30D users of cigars, as shown in [table 2](#).

Youth

Among youth who were previous users of any tobacco product at baseline, the rate of P30D reuptake of any tobacco product use was 30.3% (online supplementary table 2) at follow-up. Rates of P30D reuptake for each type of tobacco product at follow-up ranged from just over 15% (smokeless tobacco) to almost 25% (cigars). Being an older youth (ages 15–17) was a significant predictor of reuptake of any tobacco and of all individual tobacco products except smokeless tobacco. See online supplementary table 2 for additional significant correlates of tobacco product reuptake in youth.

Relapse among former established users

Adults

Generally, the pattern of findings for relapse of any tobacco use among adult former established users ([table 3](#)) was fairly consistent with reuptake among adult previous tobacco users ([table 2](#)).

Among former established users of any tobacco product at baseline, 6.5% (95% CI 5.9 to 7.2; [table 3](#)) relapsed to use of any tobacco product at follow-up. Rates of relapse for each type of tobacco product at follow-up were 4.2% (95% CI 3.7% to 4.7%) for cigarettes, 17.6% (95% CI 15.4 to 19.9) for ENDS, 6.6% (95% CI 5.7 to 7.6) for cigars, 9.1% (95% CI 7.5 to 11.0) for hookah and 6.7% (95% CI 5.2 to 8.6) for smokeless tobacco.

Any tobacco

Adults ages 25 or older (aOR range: 0.1–0.4) were less likely to relapse than those ages 18–24, while males (aOR 1.7, 95% CI 1.3 to 2.2) were more likely than females to relapse (see [table 3](#)).

Cigarettes

Adults ages 40 or older (aOR range: 0.4–0.5) and those with larger income (aOR range: 0.6–0.7) were less likely to relapse than those ages 18–24 and those with a household income <US\$25,000, respectively. Use of cigars (aOR 1.5, 95% CI 1.1 to 2.1) or ENDS (aOR 1.9, 95% CI 1.3 to 2.8) at baseline was associated with greater odds of relapse. Time since last use of cigarettes was a significant predictor of cigarette relapse, with recent use (within the past year; aOR 13.0, 95% CI 8.8 to 19.2) as well as cigarette use 1–2 years ago (aOR 3.4, 95% CI 2.3 to 5.1) having higher odds of relapse to cigarette use compared with last use more than 2 years ago, as shown in [table 3](#).

Non-cigarette tobacco products

As shown in [table 3](#), use of cigarettes at baseline (aOR 2.1, 95% CI 1.4 to 3.4) was associated with higher odds of relapse to ENDS use than those who did not use cigarettes at baseline. Non-Hispanic black race/ethnicity (aOR 2.5, 95% CI 1.4 to 4.7)

was associated with higher odds of cigar relapse compared with non-Hispanic white race/ethnicity. For all products, other than ENDS, time since last use was a significant predictor of relapse to that product. Recent use (between 30 days and 1 year) was associated with higher odds of relapse (aOR range: 3.5 (hookah) to 11.0 (smokeless)) compared with last use 2 or more years ago. Among cigar and smokeless tobacco users, last use between 1 and 2 years ago was also associated with higher odds for relapse (aOR range: 3.3 (smokeless) to 5.0 (cigars)).

Relapse among recent former established users

Adults

Among recent former users of any tobacco product, the only significant predictor of relapse was tobacco dependence, with those with higher dependence scores having higher odds of relapse to any tobacco use (aOR 1.2, 95% CI 1.1 to 1.4; online supplementary table 3). After adjusting for correlates including tobacco dependence, those with an income \geq US\$75 000 per year (aOR 0.5, 95% CI 0.3 to 0.8) had lower odds of cigarette relapse than those with an income <US\$25 000 per year.

DISCUSSION

Over a 1-year period, less than 10% of adult users made the transition from previous product use to P30D use (reuptake) for any tobacco product (7.8%) or any individual product (reuptake ranged from 4.4% for smokeless tobacco to 7.3% for cigars) except ENDS. Among adult previous ENDS users, 16.0% were P30D ENDS users at the follow-up wave. Among youth, reuptake rates were much greater compared with adults (reuptake of any tobacco was 30.3%, with rates for individual products ranging from 15.6% for smokeless tobacco to 24.7% for cigars). This pattern is consistent with results evaluating reuptake over two waves of the PATH Study; ENDS had the highest reuptake rate of any P30D use (regardless of other products used) in youth and young adults (ages 18–24).^{34–38} ENDS products have also changed substantially from first generation devices that were not efficient at nicotine delivery,³⁹ to more advanced second generation devices and pod-mods (ie, JUUL), the latter of which increased its market share after the reporting period used for these analyses.⁴⁰ Therefore, these reuptake rates may signal continued experimentation of an evolving product or progression to regular use in youth and young adults.^{41 42}

The overall relapse rate reported in this study, 6.5%, is much lower than the rate found by Caraballo *et al*⁸ (~30%); however, it is difficult to compare findings from a 1-year period to those from a study that spanned 30 years. Our relapse definition focused on the transition back to current every day or some day use; however, using the outcome of P30D use would likely increase the number of relapse observations (ie, from 591 observations to 818 observations among former established cigarette users who did not use cigarettes in the past 30 days at baseline). While using a different outcome would likely change the overall relapse rate, we do not believe there would be substantial impact on the correlates of relapse as they were fairly similar across our current definitions of reuptake and relapse. Future research should explore the impact of different definitions (ie, including every day, some day or any P30D use at follow-up), as well as the role of intermittent product use patterns⁴³ on relapse rates.

Many demographic correlates of tobacco product reuptake were consistent with previously published correlates of tobacco product use.^{8 9 44–48} Consistent with Yi *et al*,⁹ the present study

Table 3 Correlates of 'Relapse' among former established users (adults 18+) with no P30D tobacco use at baseline

Correlates at baseline	Current (everyday/some day) use at follow-up																							
	Any tobacco				Cigarettes				ENDS				Cigars				Hookah				Smokeless			
	%	95% CI	aOR1	95% CI	%	95% CI	aOR1	95% CI	%	95% CI	aOR1	95% CI	%	95% CI	aOR1	95% CI	%	95% CI	aOR1	95% CI	%	95% CI	aOR1	95% CI
Demographic characteristics																								
Age group																								
18-24	30.2	(26.5-34.2)	--	--	24.2	(20.6-28.2)	--	--	19.3	(15.3-23.9)	--	--	12.9	(10.2-16.1)	--	--	NR	NR	NR	NR	16.9	(12.8-22.0)	--	--
25-39	14.5	(12.5-16.8)	0.4	(0.3-0.6)***	8.6	(7.3-10.0)	0.7	(0.5-1.0)	19.5	(16.1-23.5)	1.1	(0.7-1.5)	8.9	(7.0-11.4)	1	(0.6-1.5)	NR	NR	NR	NR	11.7	(8.7-15.4)	1	(0.6-1.8)
40-54	6.4	(5.2-7.9)	0.2	(0.1-0.2)***	4	(3.1-5.2)	0.5	(0.4-0.8)**	15	(11.0-20.1)	0.8	(0.5-1.4)	7.6	(5.4-10.5)	1	(0.5-1.7)	NR	NR	NR	NR	4.7	(3.1-7.1)	0.6	(0.3-1.2)
55+	3.1	(2.4-4.0)	0.1	(0.1-0.1)***	2	(1.5-2.7)	0.4	(0.2-0.6)***	13.5	(8.5-20.8)	0.7	(0.4-1.4)	2.4	(1.5-4.0)	0.5	(0.2-1.1)	NR	NR	NR	NR	#	#	#	#
Sex																								
Female	5.2	(4.4-6.2)	--	--	4.7	(3.9-5.5)	--	--	18.1	(15.3-21.3)	--	--	6.8	(5.0-9.1)	--	--	9.3	(6.8-12.5)	--	--	#	#	#	#
Male	7.7	(6.7-8.8)	1.7	(1.3-2.2)***	3.7	(3.2-4.4)	0.8	(0.6-1.1)	17.1	(14.0-20.7)	0.9	(0.6-1.3)	6.5	(5.4-7.9)	1.4	(0.8-2.3)	8.9	(7.0-11.3)	0.8	(0.5-1.3)	6.7	(5.1-8.7)	1	(0.3-3.1)
Race/ethnicity																								
Non-Hispanic White	5.9	(5.1-6.8)	--	--	3.6	(3.1-4.2)	--	--	17.7	(15.2-20.4)	--	--	5.4	(4.3-6.7)	--	--	8.3	(6.3-11.0)	--	--	7	(5.3-9.1)	--	--
Non-Hispanic Black	10.1	(7.6-13.2)	1.5	(1.1-2.2)*	6.6	(4.6-9.4)	1.4	(0.8-2.3)	17	(10.2-27.0)	0.9	(0.5-1.8)	13.8	(10.0-18.8)	2.5	(1.4-4.7)**	12.1	(5.6-24.3)	1.2	(0.4-3.5)	#	#	#	#
Non-Hispanic Other (includes two or more races)	6.4	(3.8-10.6)	0.8	(0.4-1.4)	4.7	(2.7-8.2)	0.9	(0.4-2.0)	14.2	(8.2-23.5)	0.9	(0.4-1.8)	4.7	(2.7-8.3)	0.9	(0.5-1.7)	9	(4.7-16.3)	1	(0.4-2.7)	#	#	#	#
Hispanic	9.6	(7.6-12.1)	0.9	(0.6-1.4)	7.1	(5.4-9.3)	1.4	(0.9-2.1)	20.1	(13.9-28.3)	1.4	(0.8-2.4)	6.6	(4.4-9.8)	0.9	(0.5-1.6)	10.6	(7.0-15.9)	1.2	(0.6-2.2)	#	#	#	#
Sexual orientation																								
Straight/Heterosexual	6.5	(5.9-7.2)	--	--	4	(3.6-4.6)	--	--	16.4	(14.1-19.0)	--	--	6.4	(5.4-7.5)	--	--	8.8	(7.1-10.9)	--	--	NR	NR	NR	NR
Gay or Lesbian	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	NR	NR	NR	NR
Bisexual	10.2	(6.5-15.8)	1.2	(0.8-1.9)	10	(6.3-15.6)	1.4	(0.8-2.4)	28.8	(19.1-40.8)	2	(1.0-3.9)	#	#	#	#	#	#	#	#	NR	NR	NR	NR
Something else	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	NR	NR	NR	NR
Educational attainment																								
Less than high school or some high school (no diploma) or GED	6.7	(4.9-9.2)	--	--	5.9	(4.3-8.1)	--	--	17.5	(13.3-22.8)	--	--	5.6	(3.7-8.4)	--	--	8.1	(4.6-13.7)	--	--	6.5	(4.4-9.3)	--	--
High school graduate—diploma	6.2	(4.9-7.9)	1.1	(0.6-1.8)	4.3	(3.4-5.6)	0.8	(0.5-1.3)	18.9	(13.1-26.5)	1.2	(0.7-2.2)	7.5	(5.5-10.3)	1.3	(0.8-2.3)	14.6	(9.9-21.0)	1.9	(0.9-4.3)	8	(5.2-12.0)	1.2	(0.6-2.3)
Some college (no degree) or associate degree	7.3	(6.2-8.7)	1	(0.6-1.6)	4.7	(3.9-5.5)	0.8	(0.5-1.3)	15.9	(12.9-19.5)	1	(0.7-1.6)	7.8	(5.9-10.2)	1.6	(0.9-2.8)	10.6	(7.7-14.4)	1.3	(0.6-2.7)	6.2	(4.1-9.3)	1.1	(0.6-2.0)
Bachelor's degree or more	5.8	(4.8-6.9)	0.9	(0.6-1.4)	2.6	(2.0-3.4)	0.6	(0.4-1.1)	20.5	(14.2-28.7)	1.6	(0.8-3.2)	4.2	(2.7-6.5)	1.4	(0.7-2.7)	3.9	(2.3-6.7)	0.5	(0.2-1.3)	6.4	(4.2-9.8)	1	(0.5-1.9)
Annual household income																								
< \$25000	8.8	(7.3-10.5)	--	--	7.2	(6.0-8.7)	--	--	16	(12.9-19.6)	--	--	8.4	(6.6-10.6)	--	--	11	(8.5-14.2)	--	--	8.1	(5.8-11.0)	--	--
\$25,000 - \$74,999	6.1	(5.1-7.4)	0.8	(0.6-1.0)	3.8	(3.1-4.6)	0.7	(0.5-0.9)*	18.6	(15.4-22.3)	1.3	(0.9-1.9)	5.6	(4.3-7.3)	0.9	(0.6-1.5)	8.5	(6.1-11.8)	0.8	(0.5-1.3)	5.8	(4.2-7.9)	0.8	(0.5-1.3)
≥ \$75000	6.4	(5.3-7.8)	0.7	(0.5-1.0)	2.7	(2.0-3.7)	0.6	(0.3-0.9)*	17.6	(12.8-23.6)	1.3	(0.7-2.2)	5.5	(3.5-8.6)	1.1	(0.6-2.2)	#	#	#	#	7.2	(4.5-11.4)	1.1	(0.6-2.1)
Not reported	3.1	(1.9-5.2)	0.5	(0.3-0.8)**	3	(1.8-4.8)	0.6	(0.4-1.0)	20.3	(12.2-31.8)	1.2	(0.6-2.5)	#	#	#	#	14.5	(7.8-25.3)	1.2	(0.5-2.8)	#	#	#	#
Tobacco use correlates																								
Use of cigarettes																								
No P30D use	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.7	(7.8-14.3)	--	--	4.6	(3.5-5.9)	--	--	8.1	(6.2-10.6)	--	--	5.8	(3.8-8.7)	--	--
P30D use	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20.6	(17.7-23.7)	2.1	(1.4-3.4)**	10.5	(8.8-12.4)	1.3	(0.9-2.1)	10	(7.5-13.2)	0.8	(0.5-1.3)	8.4	(6.9-10.2)	0.6	(0.4-1.0)
Use of ENDS																								
No P30D use	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.1	(4.5-8.4)	--	--
P30D use	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.9	(14.9-21.3)	1.5	(1.1-2.1)*	11	(7.9-15.0)	1.1	(0.7-1.8)	10.9	(7.1-16.2)	0.8	(0.4-1.7)	10	(6.9-14.3)	0.9	(0.5-1.7)

Continued

Table 3 Continued

Correlates at baseline	Current (everyday/some day) use at follow-up																													
	Any Tobacco					Cigarettes					ENDS					Cigars					Hookah					Smokeless				
	%	95% CI	aOR1	95% CI	%	95% CI	aOR1	95% CI	%	95% CI	aOR1	95% CI	%	95% CI	aOR1	95% CI	%	95% CI	aOR1	95% CI	%	95% CI	aOR1	95% CI	%	95% CI	aOR1	95% CI		
Use of cigars																														
No P30D use	N/A	N/A	N/A	N/A	4	(3.5–4.5)	--	--	16.8	(14.4–19.6)	--	--	N/A	N/A	N/A	N/A	N/A	N/A	8.5	(6.8–10.5)	--	--	5.9	(4.5–7.8)	--	--				
P30D use	N/A	N/A	N/A	N/A	10	(7.8–12.6)	1.9	(1.3–2.8)***	21.4	(16.2–27.8)	1.1	(0.7–1.8)	N/A	N/A	N/A	N/A	N/A	N/A	10.7	(7.5–15.1)	1	(0.5–1.8)	11.7	(7.9–17.0)	1.6	(0.8–3.2)				
Use of hookah																														
No P30D use	N/A	N/A	N/A	N/A	4	(3.6–4.5)	--	--	17.3	(15.2–19.7)	--	--	6.3	(5.4–7.4)	--	--	N/A	N/A	N/A	N/A	N/A	N/A	6.7	(5.2–8.6)	--	--				
P30D use	N/A	N/A	N/A	N/A	20.4	(14.5–28.0)	1.2	(0.7–1.9)	20.7	(13.1–31.2)	1.1	(0.6–2.0)	13.9	(9.2–20.5)	1.1	(0.6–2.0)	N/A	N/A	N/A	N/A	N/A	N/A	#	#	#	#				
Use of smokeless																														
No P30D use	N/A	N/A	N/A	N/A	4	(3.6–4.5)	--	--	17.4	(15.3–19.7)	--	--	6.2	(5.3–7.2)	--	--	8.8	(7.1–10.9)	--	--	#	#	N/A	N/A	N/A	N/A				
P30D use	N/A	N/A	N/A	N/A	6.7	(4.9–9.1)	1.4	(0.9–2.2)	19.9	(12.4–30.5)	1.2	(0.6–2.5)	11.6	(7.9–16.8)	1.7	(0.9–3.2)	#	#	#	#	#	#	N/A	N/A	N/A	N/A				
Time since last use																														
Between 30 days–1 year ago	N/A	N/A	N/A	N/A	25.7	(22.9–28.8)	13	(8.8–19.2)***	19.5	(17.0–22.3)	1.8	(0.8–4.3)	16.3	(13.4–19.7)	6.7	(3.7–12.3)***	14.6	(11.5–18.3)	3.5	(1.3–9.3)*	27.3	(22.5–32.8)	11	(5.2–23.5)***						
Between 1–2 years ago	N/A	N/A	N/A	N/A	8.5	(6.5–11.0)	3.4	(2.3–5.1)***	11.3	(7.5–16.7)	1.1	(0.4–3.1)	11.3	(8.5–14.9)	5	(2.5–9.8)***	9.7	(6.8–13.6)	2.3	(0.9–5.9)	9.4	(6.5–13.4)	3.3	(1.3–8.1)*						
More than 2 years ago	N/A	N/A	N/A	N/A	1.6	(1.2–2.0)	--	--	#	#	#	#	1.9	(1.2–3.0)	--	--	#	#	#	#	#	#	#	#	#	#	#	#	#	#

The percentages and ORs in the table are based on weighted data.
 Denominator N (unweighted number of observations) for aOR in 'Any tobacco' = 6109.
 Denominator N (unweighted number of observations) for aOR in 'Cigarettes' = 7032.
 Denominator N (unweighted number of observations) for aOR in 'ENDS' = 1229.
 Denominator N (unweighted number of observations) for aOR in 'Cigars' = 2393.
 Denominator N (unweighted number of observations) for aOR in 'Hookah' = 906.
 Denominator N (unweighted number of observations) for aOR in 'Smokeless' = 1836.
 Tobacco product types were categorised into five groups: e-cigarettes, e-cigs, e-pipes, and e-hookah at Waves 2 and 3; cigars (traditional cigars, cigarillos, filtered cigars), hookah and smokeless tobacco (loose snus, moist snuff, dip, spit, chewing tobacco and snus pouches).
 For each of the five tobacco products, and for any tobacco product, use is defined with respect to the given tobacco product in their lifetime, and currently does not use tobacco at all and has not used the product in the past 30 days.
 Current (every day/some day) use is defined as using every day or some days.
 Former established users is defined as having used a product fairly regularly (or smoked more than 100 cigarettes in their lifetime), and currently does not use tobacco at all and has not used the product in the past 30 days.
 P30D use is defined as use on at least one of the past 30 days.
 The outcome 'relapse' is defined as current (every day/some day) use at follow-up (vs no use at all) among former established users at baseline.
 Since no P30D use at baseline is defined with respect to each tobacco product, P30D use of 'other' tobacco products at baseline are considered as correlates of 'relapse' of the given tobacco product at follow-up.
 GEE logistic regression analyses were used to assess correlates of 'relapse' at follow-up among former established users at baseline over a 1 year period of time (ie, Wave 1-Wave 2 and Wave 2-Wave 3), including up to two change data points per individual and statistically controlling for the correlation among observations from the same individuals.
 All correlates reflect baseline measurement for each wave pair (eg, when evaluating change between Wave 1 and Wave 2, the age correlate reflects a person's age at Wave 1, and when evaluating change between Wave 2 and Wave 3, the age correlate reflects a person's age at Wave 2).
 Analyses adjusted for age, group, sex, race/ethnicity, sexual orientation, educational attainment, annual household income, each tobacco use correlate and wave.
 *Estimates with either a relative standard error greater than 30 or a corresponding denominator less than 50 have been suppressed.
 #p < 0.05; * p < 0.01; ** p < 0.001; *** p < 0.0001.
 aOR, adjusted Odds Ratio; ENDS, electronic nicotine delivery systems; GED, General Education Development (High School Equivalency Certificate); N/A, not applicable; NR, not reported; P30D, past 30 days.

found less reuptake in older adults compared with younger adult intermittent product use patterns, and higher levels of education were associated with a decreased likelihood of reuptake to current use of any tobacco and cigarettes. This is consistent with literature citing continued experimentation and initiation of tobacco product use among young adults.^{49–52} Furthermore, our results show that age is consistently correlated with tobacco product reuptake among youth as well, with high school students aged 15–17 years old, being more likely to reuptake tobacco products than those aged 12–14 (middle school to early high school students).^{53–54} In addition, this study expanded previous research findings to include sexual orientation which was a significant predictor (adults only) of tobacco reuptake, with sexual minorities (identifying as gay/lesbian or bisexual) having higher odds of reuptake to tobacco products except smokeless tobacco than those who identified as straight/heterosexual. In contrast to Yi *et al*,⁹ who found no racial/ethnic differences in reuptake rates, we found a significant race/ethnicity effect in adults such that previous non-Hispanic black users were more likely to reuptake any tobacco, specifically all combusted tobacco products, than previous non-Hispanic white users were. However, among youth, racial/ethnic minorities were less likely to reuptake any tobacco use, but race/ethnicity had no significant effect across individual products.

Moreover, our findings support previous research noting that other tobacco product use is associated with reuptake of not only cigarette smoking,^{18–20} but other tobacco product use as well. These findings are consistent with those in the report by Kasza *et al*⁵⁵ that evaluates correlates of tobacco product initiation. Since both initiation and reuptake are behaviours that involve starting (or restarting) tobacco use, it is not surprising that the pattern of correlates, in adults,⁵⁵ is similar to those seen here. Among former established users, time since last use had the largest magnitude of effect on subsequent relapse, especially among combusted products (ranging from a 4-fold increase in relapse among hookah smokers to a 13-fold increase among cigarette smokers; see table 3). We also explored the role of tobacco dependence in relapse among recent former established users (online supplementary table 3) and found tobacco dependence had a significant effect among any tobacco users. Tobacco dependence is a well-documented correlate of relapse to cigarette smoking,⁴ and although not statistically significant in ENDS and cigar relapse future research should continue to explore the role of dependence in other tobacco product relapse.

Limitations

The reduced sample size in models among former established and recent former established users, particularly when looking at smokeless tobacco use and sexual orientation, may have played a role in the reduced number of significant sociodemographic predictors. Additional limitations include the inability to incorporate all possible predictors of relapse in our models which we hope future research explores. Other possible predictors could include reasons for use, substance use, mental health symptoms, and parental and peer tobacco use. Furthermore, the present study focused on behavioural change over two 1-year periods; additional waves of the PATH Study can assess these behaviour transitions over longer periods, in which behaviour change may still be occurring.^{56–58} Lastly, the definition of ENDS was expanded at Wave 2 to include other electronic nicotine products (e-hookah, e-pipe) which could have impacted reuptake/relapse rates.

Summary and implications

The present study fills in gaps in the current literature to present correlates of tobacco product reuptake and relapse across multiple tobacco products among US youth and adults. Correlates of any tobacco reuptake include being male, non-Hispanic black and bisexual in adults, but findings for race and sexual orientation were less consistent in youth. When assessing tobacco product relapse among adult former established users, time since last use and tobacco dependence (among recent former established users) appeared to be the strongest predictors of current use at follow-up. Continued clinical and public health efforts to provide adults with tools to cope with tobacco dependence, especially within the first year or two after quitting, could help prevent relapse to both cigarette and non-cigarette tobacco products.

What this paper adds

- ▶ Understanding the sociodemographic and tobacco use factors associated with reuptake and relapse to different tobacco products fills a large gap in the primarily cigarette-focused literature. This study evaluates the sociodemographic and tobacco use correlates of tobacco product reuptake among youth (ages 12–17) and adults (ages 18+) and tobacco product relapse among adults across any tobacco and specific classes of tobacco products available in the USA.
- ▶ Over a 1-year period, reuptake was less than 8% for all products except ENDS (16%) among adults, and higher for youth (between 15% and 25% across products). Correlates of any tobacco reuptake included being male, non-Hispanic black and bisexual in adults, but race and sexual orientation were not consistent findings in youth. These correlates among adults are similar to those seen in tobacco product initiation.
- ▶ Among adults, relapse rates were similar to reuptake. Relapse rates were higher (15%–28% across products) when restricting our analyses to recent (within the past 12 months) former established users. Shorter time since last use and greater levels of tobacco dependence showed the strongest association with any tobacco relapse.
- ▶ Continued clinical and public health efforts to provide adults with tools to cope with tobacco dependence, especially within the first year or two after quitting, could help prevent relapse to both cigarette and non-cigarette tobacco products.

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