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## Susceptibility to tobacco product use among youth in wave 1 of the population Assessment of tobacco and health (PATH) study



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### ABSTRACT

The purpose of this study was to investigate susceptibility and ever use of tobacco products among adolescents and young adults in the US. Cross-sectional analysis of Wave 1 (2013–2014) adolescent (12–17 year-olds;  $n = 13,651$ ) and young adult (18–24 year-olds;  $n = 9112$ ) data from the nationally-representative Population Assessment of Tobacco and Health (PATH) Study was conducted. At 12 years, 5% were ever tobacco users and 36% were susceptible to use. Seventy percent were susceptible at age 17 years, and the same proportion were ever users at age 22 years. Susceptibility levels were comparable for cigarettes and e-cigarette (28.6% and 27.4%, respectively), followed by hookah (22.0%), pipes (17.5%), cigars (15.2%), and smokeless tobacco (9.7%). Non-Hispanic (NH) Black (Adjusted Odds Ratio [OR<sub>adj</sub>] = 1.36; 95% Confidence Limit [CL], 1.18–1.56) and Hispanic (OR<sub>adj</sub> = 1.34; 95% CL, 1.19–1.49) adolescent never-users were more likely to be susceptible to future use of a tobacco product than NH Whites. Susceptibility was higher with age (15–17 yrs. vs 12–14 yrs.: OR<sub>adj</sub> = 1.69; 95% CL, 1.55–1.85) and parental education (college graduates vs less than HS education: OR<sub>adj</sub> = 1.22, 95% CL, 1.08–1.39). Compared to exclusive users of hookah, cigars, or smokeless products, larger proportions of exclusive e-cigarette ever users were also susceptible to cigarette use. Among adolescents, lower levels of ever use of tobacco products are often counterbalanced by higher levels of susceptibility for future use, which may suggest delayed initiation in some groups. Ever users of a given tobacco product were more susceptible to use other tobacco products, putting them at risk for future multiple tobacco product use.

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### 1. Introduction

Although tobacco use remains the leading cause of preventable death in the United States (United States Department of Health and Human

Services, 2014), more products continue to be introduced (Zeller, 2014) including newer classes of products such as e-cigarettes. The recent decline in cigarette smoking uptake (Johnston et al., 2017) has been accompanied by upswings in adolescents' use of multiple tobacco products (Lee et al., 2015). Understanding which adolescents are most susceptible to tobacco use across multiple product types will help target prevention efforts.

Most cigarette smokers experiment and progress to becoming established users during an “initiation window” between the ages of 12

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and 24 years (Gilpin et al., 1999). Experimenting with other tobacco products may occur during a similar initiation window, with experimentation rates rising rapidly in adolescence before levelling off during young adulthood. Adolescent never smokers with susceptibility cognitions are twice as likely to start cigarette smoking compared to those without such cognitions (Choi et al., 2001; Nodora et al., 2014; Strong et al., 2015; Pierce et al., 1996), and this may apply to other tobacco products as well. Recent studies have reported that adolescents who used other tobacco products such as e-cigarettes (Barrington-Trimis et al., 2016) or waterpipes (Jiang et al., 2017) were susceptible to cigarette smoking.

Adolescent cigarette smoking in the U.S. increases with age (United States Department of Health and Human Services, 2014; Messer et al., 2008) is lower among those with highly-educated parents (United States Department of Health and Human Services, 1998; Perez-Stable et al., 2001), and is lower among African Americans, Hispanics, and Asian Americans compared to non-Hispanic Whites (Trinidad et al., 2009; Trinidad et al., 2011). Environmental factors such as cigarette marketing (Mackintosh et al., 2012), exposure to smoking in movies (Sargent et al., 2005), and friend/family smoking (Griesler Pc, 1998) also influence adolescent susceptibility to use cigarettes. Recent declines in adolescent cigarette smoking may reflect its selective use by lower socioeconomic status (SES) groups, while use of other tobacco products, particularly e-cigarettes and hookah, is increasing, especially among affluent and highly educated youth (Johnston et al., 2017; King et al., 2013; Wills et al., 2014; Choi and Forster, 2014). We expect these shifting patterns of use to be reflected through changing sociodemographic patterns of susceptibility to products among never users, although the overall susceptibility to any tobacco use may not have changed. Higher levels of susceptibility among subgroups of adolescent never smokers may indicate delayed initiation.

With the changing landscape of tobacco products, monitoring factors related to uptake is critical. This study will examine susceptibility and risk to use tobacco products among adolescents and young adults, highlighting sociodemographic differences. In addition, we will investigate whether users of one tobacco product are susceptible to the use of other tobacco products.

## 2. Methods

### 2.1. Data source

Data are from Wave 1 of the Population Assessment of Tobacco and Health (PATH) Study (September 2013–December 2014,  $N = 45,971$ ), a nationally-representative, longitudinal cohort study of non-institutionalized adult and youth residents of the U.S. ages 12 and older (Hyland et al., 2016). The PATH Study, conducted by Westat, used address-based, area-probability sampling. Following an in-person household screener, generally two adolescents aged 12–17 years and selected adults in the household were scheduled for interview. Further details regarding the PATH Study design and methods are previously published (Hyland et al., 2016) and in the User Guide to the PATH Study restricted use files (RUF) (United States Department of Health and Human Services, 2017). Audio-Computer Assisted Self-Interviews (ACASI) in English and Spanish collected information on tobacco-use patterns, knowledge, attitudes, beliefs and demographics. This analysis considers all adolescent respondents ( $N = 13,651$ ), their parents ( $N = 13,589$ ), and 18–24 year-old young adults ( $N = 9112$ ). Sampling weights are used to adjust for the study design (including sibling clustering) and nonresponse so as to provide population estimates (Hyland et al., 2016). Among selected youth aged 12–17, the weighted completion rate was 78.4%; among young adults aged 18–24, the rate was 75.1%. Informed consent was obtained from all respondents (for 12–17 year olds, it was parental consent and adolescent assent). The study was conducted by Westat and approved by the Westat Institutional Review Board.

### 2.2. Tobacco product use

All respondents were shown pictures for cigarettes, e-cigarettes, cigars (traditional cigars, cigarillos, and filtered cigars), pipes, hookah, smokeless tobacco, snus, dissolvables, bidis, and kreteks and asked a series of questions on each product type. With the exception of cigarettes, each picture included a brief description followed by the question, “have you seen or heard of <this product> before this study?” Those who responded positively were asked whether they had ever used or tried it, even 1 or 2 times (or a puff for cigarettes); a positive response categorized them as ever users. Youth ever users who reported using the product in the past 30 days were classified as current users. Young adult ever users were asked “Do you now <use product> every day, some days, not at all?”; those who did not report use were asked “In the past 30 days, have you <used product> even one or two <times>?”. Young adults who reported using every day, some days or in the past 30 days were classified as current users. Youth and young adult ever users who reported no use of the product in the past 30 days and young adults who did not report some day or everyday use were classified as non-current users.

In order to identify susceptibility to future use (Nodora et al., 2014; Strong et al., 2015; Pierce et al., 1996), we focused on identifying committed never users, those who are at lowest risk of future use, with all others defaulting to the susceptibility classification. Adolescents who had heard of <product> but never used it were asked: “Have you ever been curious about using <product>?”, and “Do you think you might try using <product> soon?” and “If one of your best friends were to offer you <product>, would you use it?” Each question had a 4-level response choice; ranging from “not at all curious” to “very curious,” or from “definitely not” to “definitely yes.” Only respondents with the strongest negative response to all three questions were classified as “committed never users” of that product. Missing data to the above questions are informative in that they do not indicate a clear commitment not to smoke, thus respondents with missing data are classified as susceptible to future use.

Based on these classifications, we created a tobacco product uptake continuum, in which each respondent aged 12–17 years was classified as either a committed never user, susceptible never user, non-current ever user, or current user (Pierce et al., 1996). As susceptibility was not measured for the young adult sample at Wave 1, respondents in this age group were classified as never users, non-current ever users, or current users.

### 2.3. Demographics

Standard sociodemographic measures were obtained from Youth Interviews (age, gender, and race/ethnicity). We used parental education level (obtained from brief Parent/Guardian Interview) as a proxy for socioeconomic status. Parents/Guardians were asked to indicate the highest level of education that they received from the following categories: less than high school, high school graduate, some college, and college graduate (4 years). Self-identification as Hispanic, regardless of other race/ethnic identifications, was classified as Hispanic. Among the remainder, those who reported a single race were classified as Non-Hispanic (NH) White, Non-Hispanic Black, Non-Hispanic Asian and Other. Because of small sample size, we classified American Indians/Alaska Natives, Pacific Islanders and those who reported more than one race as ‘Other’ races. Missing data on age, gender, race, Hispanic ethnicity, and adult education were imputed as described in the User Guide to the PATH Study RUF (United States Department of Health and Human Services, 2017).

### 2.4. Statistical analyses

All analyses were performed in 2015–2016 using SAS, version 9.3 (SAS Institute Inc. SAS® 9.3 System Options, 2011). All estimates were weighted. Variance estimates and  $p$ -values were calculated using the recommended Balanced Repeated Replication method with Fay's

adjustment and replicate weights supplied by Westat (Hyland et al., 2016). Data with cells of  $n < 50$  or a coefficient of variation  $> 30\%$  were suppressed. Modified Wilson 95% confidence limits (CL) for proportions and Wald 95% CLs for odds ratios (OR) were calculated on the weighted estimates. An area curve representing the tobacco product uptake continuum was smoothed with PROC LOESS, using local quadratic fitting, a scaling fraction of 0.1 and AIC<sub>c</sub> criterion (Hurvich et al., 1998) for smoothing parameter selection. A logistic regression model was fit examining racial/ethnic differences in susceptibility to using any tobacco product among 12–17-year-olds who had not previously used any tobacco product, with non-Hispanic Whites as reference. This model adjusted for age group, gender and parental education.

### 3. Results

#### 3.1. Susceptibility and use across tobacco products among 12–17 year-old U.S. adolescents

Table 1 gives the proportion of adolescents in various categories of the tobacco product uptake continuum for each product. Although adolescents were not asked if they had heard of cigarettes, the vast majority (89.4%,  $n = 12,177$ ) had heard of e-cigarettes, pipes (86.1%,  $n = 11,612$ ), and smokeless tobacco (75.8%,  $n = 10,122$ ), while about two-thirds had heard of hookah (61.5%,  $n = 8361$ ) and cigars (63.6%,  $n = 8653$ ), and about 8% had heard of either dissolvable tobacco products ( $n = 1053$ ) or bidis/kreteks ( $n = 1069$ ). Reported ever use (non-current ever use and current use) was highest for cigarettes (13.4%), followed by e-cigarettes (10.6%), cigars (7.6%), hookah (7.4%), and smokeless tobacco (4.8%). The proportion of susceptible never users was also highest for cigarettes (28.6%) followed by e-cigarettes (27.4%), hookah (22.0%), pipes (17.5%), cigars (15.2%), and smokeless tobacco (9.7%). We considered susceptible never users, non-current ever users, and current users to be at risk for future established (i.e., current, regular use) tobacco use in adulthood. The proportion at risk for each product type was: cigarettes (42.0%), e-cigarettes (38.1%), hookah (29.4%), cigars (22.9%), pipes (19.4%), and smokeless tobacco (14.5%). As these proportions add to far  $> 100\%$ , they also indicate that a significant proportion of adolescents are at risk for future use of multiple products.

#### 3.2. Susceptibility to use any tobacco product among adolescent never users

Among 12–17 year-old never users of any tobacco product ( $n = 10,751$ ), we used logistic regression to identify major predictors of susceptibility to use at least 1 tobacco product (Table 2). Older adolescents were more likely to be susceptible to tobacco use than younger adolescents ( $OR_{adj} = 1.69$ , 95%CL:1.55–1.85) and there was no difference between genders. Both NH Black ( $OR_{adj} = 1.36$ , 95%CL:1.18–1.56) and

Hispanic ( $OR_{adj} = 1.34$ , 95%CL:1.19–1.49) adolescents were significantly more likely than NH Whites to be susceptible to using tobacco products (susceptibility rates of 48%, 47% and 42% respectively). NH Asian adolescents appeared less likely to be susceptible than NH Whites, however, with the smaller sample of NH Asians, this association did not reach statistical significance. After controlling for other sociodemographic variables, children of college graduates appeared more likely to be susceptible than children of parents with less education ( $OR_{adj} = 1.22$ , 95%CL:1.08–1.39).

#### 3.3. Products associated with increased susceptibility and ever use among race/ethnicity groups

In Fig. 1, we investigate “ever use” (non-current ever use and current use) and “susceptibility” in NH Black, NH White, and Hispanic adolescents for the 5 products with the highest ever-use proportions among adolescents in this study (cigarettes, e-cigarettes, hookah, cigars, smokeless). A smaller proportion of NH Black adolescents compared to NH White adolescents had used cigarettes (9.8% vs 15.1%), e-cigarettes (6.8% vs 12.1%), hookah (4.8% vs 7.4%) and a smokeless tobacco product (1.4% vs 7.0%). Hispanics were less likely to have smoked cigarettes (12.4% vs 15.1%) or used a smokeless tobacco product (2.2% vs 7.0%) than NH Whites, but there were no differences in rates of e-cigarette, hookah or cigar use. However, the proportion of those at risk for future use (ever users and susceptible never users combined) did not differ substantially between NH Black and NH White adolescents for cigarettes (40.3% vs. 42.0%), hookah (27.5% vs. 28.6%) or cigars (23.3% vs. 25.5%); although the total proportion of NH Black at risk for future use of e-cigarettes (34.4% vs. 38.8%) and smokeless tobacco were lower (8.5% vs. 18.3%) than for NH Whites. Hispanics had a higher total proportion of those at risk for e-cigarette use than NH Blacks (39.8% vs. 34.4%); higher proportions for future use of hookah (34.0%) than both NH Blacks and NH Whites (27.5% vs. 28.6%); and lower proportions than NH Whites for smokeless tobacco (10.4% vs. 18.3%).

#### 3.4. Are Adolescents who have only used one tobacco product susceptible to using other products?

In this sample, 1275 adolescents had used only one tobacco product (44% of all ever-users). Of these, 36% had used only cigarettes, 24% e-cigarettes, 19% hookah, 10% cigars, 9% smokeless products and 2% any other product (Table 3). The majority of these single-product users were susceptible to using additional tobacco products. E-cigarette users were particularly susceptible to using other products: 73% were susceptible to cigarettes, 71% to hookah, 56% to cigars and 26% to a smokeless product. For those whose only tobacco product was a cigarette, the pattern was similar but somewhat lower: 62% were susceptible to using e-

**Table 1**

Awareness, susceptibility, and use of different tobacco products among adolescents (ages 12–17 years;  $N = 13,651$ ) in the PATH Study Wave 1.

	Never heard of <sup>b</sup>		Committed never user		At risk for use as adult							
					Susceptible never user		Non-current ever user		Current user		TOTAL at risk <sup>a</sup>	
	%	95% confidence limits <sup>b</sup>	%	95% confidence limits	%	95% confidence limits	%	95% confidence limits	%	95% confidence limits	%	95% confidence limits
Cigarettes			58.0	57.0–59.1	28.6	27.7–29.5	8.8	8.2–9.5	4.6	4.2–5.0	42.0	40.9–43.0
E-cigarettes	10.6	9.9–11.4	51.3	50.2–52.5	27.4	26.5–28.3	7.5	7.1–8.1	3.1	2.8–3.5	38.1	36.9–39.2
Cigars	36.4	35.4–37.3	40.8	39.8–41.7	15.2	14.5–16.0	5.2	4.8–5.6	2.4	2.2–2.8	22.9	22.1–23.7
Pipes	13.9	13.3–14.7	66.7	65.8–67.6	17.5	16.8–18.2	1.6	1.4–1.8	0.3	0.2–0.4	19.4	18.6–20.1
Hookah	38.5	37.1–40.0	32.1	31.1–33.0	22.0	21.0–23.0	5.8	5.3–6.3	1.6	1.4–2.0	29.4	28.2–30.7
Smokeless	24.2	23.3–25.2	61.3	60.2–62.4	9.7	9.2–10.3	3.2	2.8–3.6	1.6	1.3–1.9	14.5	13.7–15.3
Dissolvables	92.3	91.8–92.8	6.2	5.8–6.7	1.4	1.2–1.6	<sup>c</sup>		<sup>c</sup>		1.4	1.2–1.7
Bidi/kretek	92.1	91.6–92.6	5.5	5.1–6.0	1.8	1.6–2.0	0.5	0.4–0.6	0.1	0.1–0.2	2.3	2.1–2.6

Data are from Wave 1 of the Population Assessment of Tobacco and Health (PATH) Study (September 2013–December 2014).

<sup>a</sup> TOTAL at risk for use as adults = sum of susceptible never tobacco users, non-current ever users and current users

<sup>b</sup> “Never heard of” category is calculated by subtracting percentage of those who had heard of the product from 100.

<sup>c</sup> Suppressed (coefficient of variation  $> 30\%$  or cell size  $< 50$ )

**Table 2**

Logistic regression predicting susceptibility to any tobacco product among never-using adolescents (ages 12–17 years; n = 10,751).

		N <sup>a</sup>	% of sample	95% confidence limits	% susceptible	95% Confidence limits	Odds ratio	95% confidence limits
Age	Age 12–14	6250	57.4	56.4–58.3	38.4	37.1–39.7	Ref.	
	Age 15–17	4501	42.6	41.7–43.6	51.1	49.3–52.9	1.69	1.55–1.85
Sex	Male	5422	50.4	49.5–51.4	43.5	42.1–44.9	0.98	0.90–1.06
	Female	5329	49.6	48.6–50.5	44.1	42.7–45.7	Ref.	
Race/ethnicity	NH white	5107	53.6	52.6–54.5	41.5	39.9–43.2	Ref.	
	NH black	1538	14.4	13.8–15.1	48.3	45.4–51.2	1.36	1.18–1.56
	Hispanic	3132	22.4	21.6–23.2	46.7	44.9–48.5	1.34	1.19–1.49
	Asian American	318	5.2	4.8–5.6	36.8	31.5–42.4	0.78	0.61–1.01
	Other	656	4.5	4.1–4.9	50.1	45.8–54.4	1.46	1.20–1.77
Parental education	<HS grad	2184	17.2	16.1–18.5	43.5	41.5–45.6	Ref.	
	HS grad	2408	21.3	20.2–22.5	42.2	40.2–44.2	1.02	0.91–1.15
	Some college	2876	26.9	25.6–28.3	44.4	42.4–46.5	1.13	1.01–1.27
	College grad	3205	33.8	31.6–36.0	44.5	42.5–46.4	1.22	1.08–1.39
	No data	78	0.8	0.06–1.0	45.2	34.0–56.9	1.08	0.67–1.74

Data are from Wave 1 of the Population Assessment of Tobacco and Health (PATH) Study (September 2013–December 2014).

<sup>a</sup> N is the unweighted counts. All other numbers are from weighted analysis.

cigarettes, 60% to hookah, 44% to cigars, and 24% to a smokeless product. More than half of those whose only tobacco product was hookah were susceptible to both cigarettes and e-cigarettes.

**3.5. Age of initiation window for any tobacco product**

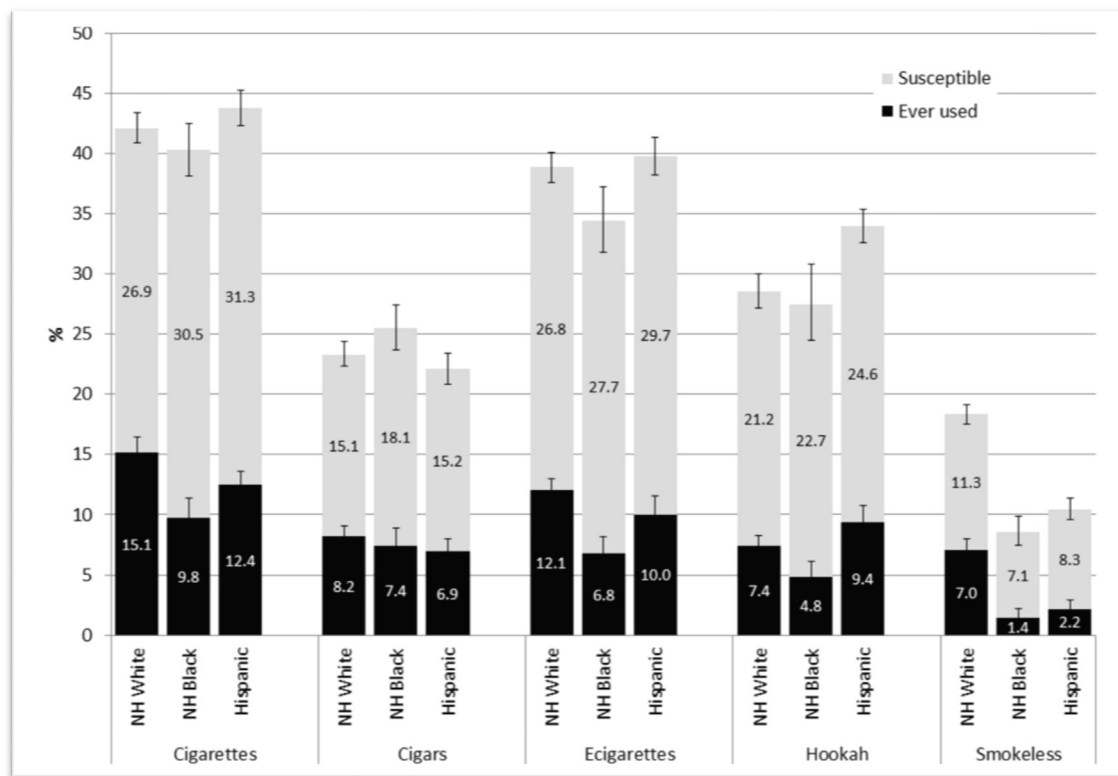
Fig. 2 presents the percentage of 12–24-year-olds at various levels of the tobacco product uptake continuum. About 5% of 12-year-olds have used any tobacco product; compared to 74% of 22-year-olds (including 47% who were current users).

The prevalence of current use of at least one tobacco product increased in the early adolescent years and plateaued at 47% around age 22 years. Thirty-six percent of 12-year-olds were at risk to using at least one product, compared to 72% of 17-year-olds. Of the 72% of 17-

year-olds at risk to use, 41% were ever users (non-current ever user or current users). Although this study did not measure susceptibility among young adults, ever use at age 22 was higher than susceptibility levels at age 17. Among young adults, the mean age of first use of any tobacco product was 15.7 years old (95% CL: 15.6–15.8) among NH Whites, 16.0 years old (95% CL: 15.8–16.2) among Hispanics, 16.2 years old (95% CL: 15.9–16.5) among NH Blacks, and 17.4 years old (95% CL: 17.0–17.8) among NH Asians.

**4. Discussion**

Although adolescent smoking has been declining consistently in recent years, our study reveals that more than half of 12–17 year-olds are susceptible to use or have used non-cigarette tobacco products. Ever use



**Fig. 1.** Percent of Adolescents (12–17 years; 13,651) At Risk\* (Susceptible and Ever Use\*\*) for Tobacco Products by Race/Ethnicity Group. \*Total at risk for use as adults = sum of susceptible never tobacco users, non-current ever users and current users. \*\*Ever used includes current users (within past 30 days) and non-current ever users (prior to past 30 days). Data are from Wave 1 of the Population Assessment of Tobacco and Health (PATH) Study (September 2013–December 2014).

**Table 3**  
Susceptibility to other tobacco products among adolescents (ages 12–17) who have used only one product (n = 1275).

Product used	N <sup>a</sup>	Used only this product		Susceptible to:											
				No other products		Cigarettes		E-cigarettes		Hookah		Cigars		Smokeless	
		%	CL	%	CL	%	CL	%	CL	%	CL	%	CL	%	CL
Cigarettes	461	35.7	32.8–38.8	25.1	21.3–29.2	NA		62.4	57.6–67.0	60.0	53.3–66.3	43.7	36.6–51.1	24.0	19.4–29.1
E-cigarettes	307	24.3	21.7–27.1	13.9	10.3–18.6	73.4	68.1–78.0	NA		71.2	64.0–77.5	56.2	49.2–62.9	25.8	20.6–31.7
Hookah	239	19.0	16.3–22.0	21.9	16.6–28.4	51.7	45.3–57.9	61.1	54.3–67.4	NA		40.1	32.5–48.2	17.8	12.0–25.5
Cigars	128	10.1	8.3–12.2	22.6	16.2–30.5	53.6	45.0–62.0	47.9	38.8–57.1	56.7	46.2–66.7	NA		14.4	8.8–22.6
Smokeless	113	9.0	7.3–11.0	31.0	23.2–40.1	55.4	46.2–64.2	51.3	42.0–60.5	47.8	33.3–62.5	47.7	36.6–59.4	NA	

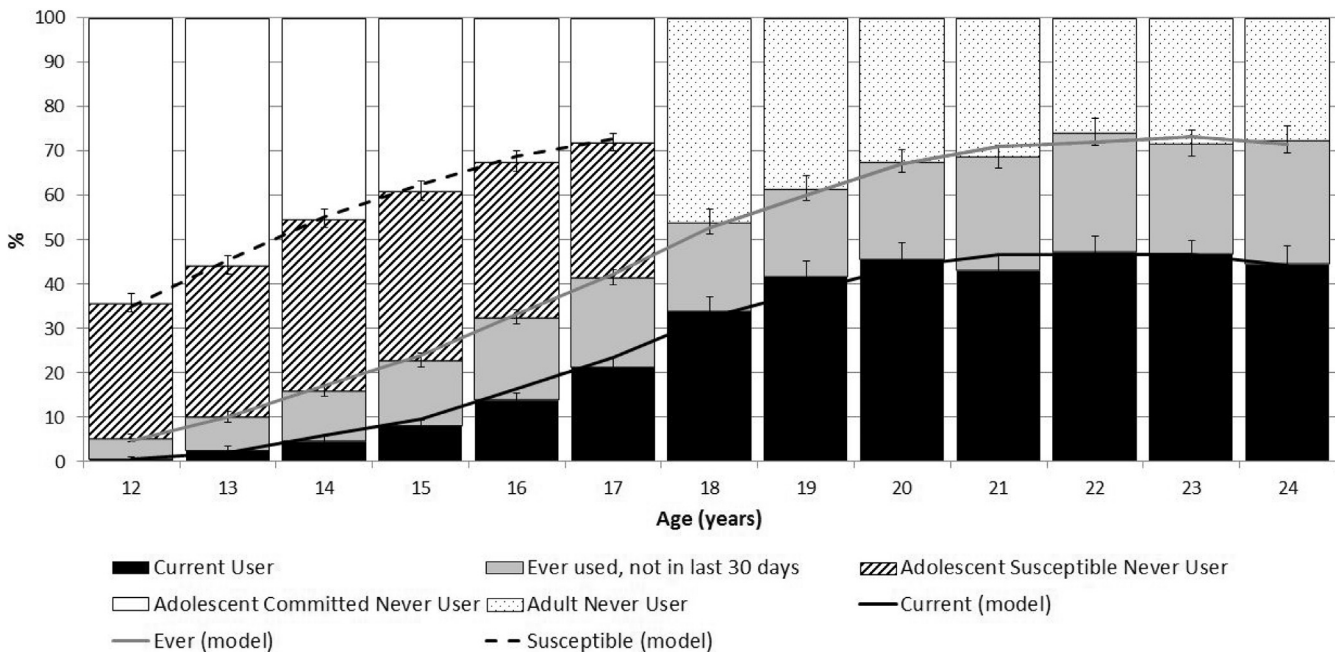
Data are from Wave 1 of the Population Assessment of Tobacco and Health (PATH) Study (September 2013–December 2014).

<sup>a</sup> N is the unweighted counts. All other numbers are from weighted analysis.

of at least one tobacco product type begins as young as age 12 years and continues through young adulthood: at age 22, 70% of young adults have at least tried one tobacco product and 40% are current users. Regardless of the type of product first used, the majority of users of any one product were susceptible to using another tobacco product. Adolescents who started with e-cigarettes had the highest level of susceptibility to cigarette smoking.

For the past two decades, Non-Hispanic Black and Hispanic adolescents have been less likely to take up tobacco use than Non-Hispanic Whites (United States Department of Health and Human Services, 1998). In this study, while ever use among adolescents followed this pattern, susceptibility among never users was higher among Non-Hispanic Blacks and Hispanics than in Non-Hispanic Whites; taken together, overall risk to be an adult tobacco user was generally no different across race/ethnic groups, with the exception of Hispanics having greater risk for hookah use as adults. While there is some indication that their initiation rates may be somewhat delayed (Trinidad et al., 2004a; Trinidad et al., 2004b), further study of environmental and psychosocial factors that influence this is required. Although our study had only a small sample of Non-Hispanic Asian adolescents, they did appear to have a lower rate of use of all tobacco products than other race-ethnic groups.

The well-known socioeconomic/education association with smoking behavior (Pierce et al., 1989; USDHHS, 2012) was not significant when susceptibility to use any tobacco product was added to the at risk measure for these adolescents. This is consistent with other research that has shown that adolescents who rated as not at the highest risk for cigarette smoking (e.g., intermediate rating for rebelliousness and sensation-seeking) are using e-cigarettes (Barrington-Trimis et al., 2015). Indeed, use of non-cigarette tobacco products for those who would not have tried cigarettes may lead to these individuals progressing to use cigarettes in the future (Meier et al., 2015). Our study found that only 14% of e-cigarette users were not susceptible to using other tobacco products, much lower than those who were ever users of cigarettes, cigars, hookahs, or smokeless products (22–31%). Further, susceptibility to using other tobacco products was higher among e-cigarette users compared to those who had used other tobacco products: adolescent e-cigarette users showed high susceptibility to use cigarettes (73%), hookah (71%), and cigars (56%). Although we cannot establish temporality based on these cross-sectional data, these findings are consistent with results from another national sample showing e-cigarette use as associated with experimentation with cigarette smoking in adolescents (Dutra, 2014).



**Fig. 2.** Percent of Population at Different Levels of Tobacco Product Uptake Continuum for Each Year of Age, With Smoothed Line from Model\*. Sample size (N): 13,651 (12–17 years), 9112 (18–24 years). Data are from Wave 1 of the Population Assessment of Tobacco and Health (PATH) Study (September 2013–December 2014). \* Model from PROC LOESS in SAS with local quadratic fitting, scaling fraction of 0.1 and AICC criterion for smoothing. **Current Users:** Youth ever users who reported using the product in the past 30 days were classified as current users. Young adult ever users were asked “Do you now <use product> every day, some days, not at all; those who did not report use were asked “In the past 30 days, have you <used product> even one or two <times>. Young adults who reported using every day, some days or in the past 30 days were classified as current users. **Non-Current Users:** Youth and young adult ever users who reported no use of the product in the past 30 days and young adults who did not report some day or everyday use were classified as non-current users.

While the 2016 Monitoring the Future Study reported that e-cigarettes had the highest 30 day prevalence rate of all tobacco products (Johnston et al., 2017), in the PATH Study, both current and ever use were higher for cigarettes, than e-cigarettes. However, we found that the vast majority (about 90%) of adolescents had heard of e-cigarettes, a level higher than that found for any other non-cigarette product, even though e-cigarettes have only been available for a few years. This high level of awareness by adolescents may translate into increased susceptibility to use e-cigarettes and potentially cigarettes or other tobacco products, a topic that has been investigated in a separate paper (Pierce et al., 2016). Future waves of the PATH Study will provide the longitudinal data necessary to solidify our understanding of adolescent susceptibility, receptivity to marketing, and uptake of tobacco products.

#### 4.1. Limitations and future directions

Due to small sample sizes, findings for Native Americans/Alaska Natives could not be analyzed separately and specific nationalities of Asian Americans and Hispanics was not presented. Future studies focusing on Asian American and Hispanic populations would inform our understanding of whether and how these patterns of susceptibility vary by subgroups, including age. In addition, examining subgroup differences within racial/ethnic groups in susceptibility and use of particular tobacco products may improve tailored prevention efforts in these populations.

In this report, smoking status was self-reported. Nevertheless, self-reported smoking status in population based surveys has not been associated with biased prevalence estimates (Wong et al., 2012; Park and Kim, 2009). For many of the comparisons presented here, we have relied on non-overlapping confidence intervals for our inference of statistical significance; when the gap between these confidence intervals is very small, it is possible that the formal statistical significance might not meet the 0.05 criterion.

Research on susceptibility and risk to use cigarettes has been largely conducted on adolescent populations, with little research on adults (Nodora et al., 2014; Strong et al., 2015; Pierce et al., 1996). However, some racial/ethnic groups are more likely to experiment and progress in use as young adults (Trinidad et al., 2004b; Geronimus et al., 1993; Myers et al., 2009). Our cross-sectional results suggest that susceptibility to tobacco use would likely be high in young adults. Future studies should explore susceptibility to tobacco products longitudinally, beyond adolescence and into the young adult years, particularly across racial/ethnic groups.

## 5. Conclusions

This is the first study to assess susceptibility to use multiple tobacco products in a national sample of U.S. youth. As susceptibility to smoking doubles the risk that an adolescent will be an adult smoker (Nodora et al., 2014; Strong et al., 2015; Pierce et al., 1996), if this generalizes to other tobacco use, then this study suggests that adolescent tobacco product use is likely to remain a public health concern in the near-term future. Of concern is that those who had used e-cigarettes were more susceptible to using other tobacco products, particularly cigarettes, than those who had used other tobacco products. Data suggest that the lower tobacco use rates among NH Black, Hispanic, and the higher educated may increase, a finding that requires further examination of factors that influence initiation, including both psychosocial risk factors and receptivity to tobacco industry marketing (National Cancer Institute, 2008).

## Disclaimer

The views and opinions expressed in this manuscript are those of the authors only and do not necessarily represent the views, official policy or position of the U.S. Department of Health and Human Services or any of its affiliated institutions or agencies.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <http://dx.doi.org/10.1016/j.jypmed.2017.05.010>.

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