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SHORT REPORT

ADDICTION SSA

Can PATH Study susceptibility measures predict e-cigarette and cigarette use among American youth 1 year later?

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Abstract

Aims: To investigate whether e-cigarette and cigarette susceptibility predict e-cigarette and cigarette use among American youth 1 year later.

Design and Setting: Longitudinal data from the Population Assessment of Tobacco and Health (PATH) Study—a four-stage, stratified probability cohort study of youth (12–17 years old) sampled from the United States civilian, non-institutionalized population. Multivariable logistic regression was used to estimate the association between initial product-specific susceptibility and subsequent cigarette smoking and e-cigarette use while controlling for sociodemographic characteristics, exposure to nicotine users, and behavioral risk factors.

Participants: The sample included 8841 adolescent never nicotine users at initial survey who participated in both wave 4 (2016–2017) and wave 4.5 (2017–2018) of PATH.

Measurements: We measured cigarette and e-cigarette susceptibility (defined as a lack of a firm commitment to not use cigarettes or e-cigarettes) among never nicotine users at baseline (wave 4) as well as cigarette and e-cigarette use at 12-month follow-up (wave 4.5).

Findings: Youth e-cigarette susceptibility was statistically significantly ($P < 0.05$) associated with e-cigarette use 1 year later, for both past 12-month (adjusted odds ratio [aOR], 2.99; 95% CI, 2.29–3.90) and past 30-day e-cigarette use (aOR, 2.73; 95% CI, 1.78–4.16), but not with cigarette smoking (aOR, 1.05; 95% CI, 0.64–1.73 for past 12-month smoking and aOR, 0.65; 95% CI, 0.29–1.45 for past 30-day smoking. Smoking susceptibility predicted subsequent smoking in the past 12 months (aOR, 1.82; 95% CI, 1.09–3.03) and past 30 days (aOR, 3.32; 95% CI (1.33–8.29), but not e-cigarette use in the past 12 months (aOR, 0.96; 95% CI, 0.77–1.19) or past 30 days (aOR, 1.11; 95% CI, 0.82–1.51).

Conclusion: E-cigarette and cigarette susceptibility measures appear to predict product-specific use among youth 1 year later.

KEYWORDS
Alcohol, brief interventions, complex interventions, drug use, evaluation, substance use

INTRODUCTION

In the last 2 decades, cigarette smoking has declined steadily among United States (US) adolescents [1, 2]. In 2020, 1.6% of middle school and 4.6% of high school students reported past-30-day use of cigarettes, compared with 12.8% and 34.8% in 1999 [3–5]. Although cigarette use has dropped, use of electronic- or e-cigarettes has increased substantially among adolescents [6, 7]. Since 2014,

e-cigarettes have become the most commonly used nicotine-containing product among American middle and high school students [8, 9]. From 2017 to 2018, current use (past 30-day use) of e-cigarettes increased from 11.7% to 20.8% among high school students and from 3.3% to 4.9% among middle school students [3]. The rates grew even higher in 2019, with 27.5% of high school and 10.5% of middle school students having used e-cigarettes in the past 30 days [10]. E-cigarette use fell significantly in 2020 to 19.6% of high school and 4.7% of middle school students [11]. Rates as high as those in the United States are less common in other countries. For example, the prevalence of current e-cigarette use among 11–18 year olds in the United Kingdom (UK) was 4.1% in 2021 [12].

The concept of cigarette susceptibility, defined as the lack of a firm commitment to not use cigarettes, was introduced in 1995 [13]. Research has validated susceptibility as an independent predictor of smoking onset among adolescents [14–17]. Of late, studies examining e-cigarette susceptibility with the same construct have emerged. Using both cross-sectional [18, 19] and longitudinal data [20–22], these studies have reported a significant positive association between e-cigarette susceptibility and subsequent use. However, little is known about the predictability of product-specific susceptibility with subsequent use of that nicotine-containing product, controlling for susceptibility to other products. Only one study [20] included both cigarette and e-cigarette susceptibilities. It found that cigarette susceptibility predicted e-cigarette use, but e-cigarette susceptibility did not predict future smoking.

Our study, investigating product-specific susceptibility and subsequent product use, examines if e-cigarette and cigarette susceptibility predict e-cigarette and cigarette use among American youth 1 year later. Using longitudinal data from the Population Assessment of Tobacco and Health (PATH) Study, we assess whether product-specific susceptibility is a significant independent predictor of initiation, controlling for sociodemographic characteristics, exposure to nicotine users, and behavioral risk factors. We include alcohol and marijuana use among our behavioral risk factors.

METHODS

PATH is a nationally representative, longitudinal cohort study of adults and youth in the United States. Computer-assisted personal interviewing is used to collect self-reported data on nicotine product use and related health behaviors. A full description of the PATH design and methods is available [23]. Our sample included youth (12–17 years old) who participated in both wave 4 (2016–2017) and wave 4.5 (2017–2018) of PATH. The weighted wave 4.5 response rate for the wave 1 cohort (2013–2014) was 74.6% and the weighted wave 4.5 response rate for the wave 4 cohort was 89.1%. We examined a subsample of youth who had never used any nicotine-containing product by wave 4 (n = 8841), including life-time use of cigarettes, e-cigarettes, cigars, pipe, hookah, snus, smokeless tobacco, bidis, kreteks, and dissolvable tobacco.

Measures

The principal independent variables of interest are cigarette and e-cigarette susceptibility. Other covariates include sociodemographic characteristics, exposure to nicotine users, and behavioral risk factors of adolescent never nicotine users in wave 4. The dependent variables, smoking and e-cigarette use behaviors, are evaluated by respondents' reports in wave 4.5 of whether they had smoked or used e-cigarettes at all during the past 12 months (any use) and during the past 30 days (current use).

Susceptibility

In PATH, participants were asked four survey questions on potential use of cigarettes and e-cigarettes: "Have you ever been curious about using [product]?", "Do you think that you will try a [product] soon?", "If one of your best friends were to offer you a [product], would you [use] it?", and "Do you think you will use a [product] in the next year?" Based on previous literature [13, 14], we constructed a binary variable of susceptibility. Participants answering "not at all curious" to the first question and "definitely not" to the last three were considered not susceptible to cigarettes or e-cigarettes; the rest were regarded as susceptible.

Sociodemographic characteristics

Sociodemographic variables included age (12–14 years old vs 15–17 years old), sex (male vs female), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, and non-Hispanic other), highest parental education (high school/GED or less, some college, and college or above), household income (<$50 000, $50 000–$100 000, and >$100 000), and school grades (greater than or equal to mostly B's vs not).

Exposure to nicotine users

Family nicotine use (vs none) was evaluated by asking if anyone living with the respondent uses any nicotine-containing products(s). Youth exposure to secondhand smoke (vs no) was determined by asking respondents if they had been around others who were smoking, including at home, in a car, at school, or outdoors, for at least a total of an hour during the past 7 days. Best friends' nicotine use (0 vs 1) is scored 1 if participants answered a positive number to any of the questions asking "How many of your best friends use (product)?" The nicotine-containing products include cigarettes, e-cigarettes, cigarillos, snus, and smokeless tobacco.

Behavioral risk factors

Behavioral risk factors included any past 12-month use (vs none) of alcohol and marijuana.

TABLE 1 Wave 4 never nicotine product users' weighted rates of use of e-cigarettes and cigarettes in Wave 4.5 by product-specific susceptibility measures, among US youth in the PATH study (n = 8841)

	Product use[a], wave 4.5			
	Electronic cigarettes n (weighted %)		*Cigarettes n (weighted %)*	
Susceptibility responses, wave 4	*Any use (n = 628)*	*Current use (n = 277)*	*Any use (n = 151)*	*Current use (n = 60)*
Ever been curious about using [product]?				
Yes	279 (19.3)	123 (8.6)	66 (4.1)	27 (1.7)
No	314 (5.5)	150 (2.4)	85 (1.2)	33 (0.4)
P-value	<0.001[b]	<0.001	<0.001	<0.001
Think you will try a [product] soon?				
Yes	183 (25.9)	89 (12.6)	35 (5.2)	15 (2.4)
No	437 (6.3)	184 (2.6)	116 (1.5)	45 (0.5)
P-value	<0.001	<0.001	<0.001	<0.001
Would you use a [product] if one of your best friends offered you one?				
Yes	261 (22.6)	135 (11.8)	47 (4.6)	20 (2.2)
No	357 (5.6)	138 (2.1)	104 (1.4)	40 (0.5)
P-value	<0.001	<0.001	<0.001	<0.001
Think you will use a [product] in the next year?				
Yes	225 (25.8)	117 (13.4)	44 (6.11)	17 (2.46)
No	395 (5.9)	156 (2.3)	107 (1.35)	43 (0.52)
P-value	<0.001	<0.001	<0.001	<0.001
Binary measure: susceptible to any of the four questions				
Yes	360 (18.5)	164 (8.4)	80 (3.6)	33 (1.5)
No	260 (4.6)	109 (1.9)	71 (1.1)	27 (0.4)
P-value	<0.001	<0.001	<0.001	<0.001

[a]Any use: past 12-month use. Current use: past 30-day use.
[b]Pearson's χ^2 test of independence was performed to assess the association.

TABLE 2 Descriptive statistics of never nicotine product users among US youth in the PATH study, by product susceptibility (n = 8841)

	Electronic cigarettes			*Cigarettes*		
	Susceptible (n = 2059, 25.3%) Weighted % (95% CI)	*Unsusceptible (n = 6032, 74.7%) Weighted % (95% CI)*	*P-value[a]*	*Susceptible (n = 2252, 25.4%) Weighted % (95% CI)*	*Unsusceptible (n = 6575, 74.6%) Weighted % (95% CI)*	*P-value*
Age, y			0.309			0.972
12–14	22.8 (21.5,24.2)	77.2 (75.8,78.6)		23.8 (22.4,25.2)	76.3 (74.8,77.6)	
15–17	30.1 (28.1,32.1)	70.0 (67.9,72.0)		28.8 (27.2,30.3)	71.3 (69.7,72.8)	
Sex			0.249			0.123
Male	25.3 (23.6,27.0)	74.8 (73.0,76.4)		24.3 (23.0,25.8)	75.7 (74.3,77.0)	
Female	25.4 (23.8,27.0)	74.6 (73.0,76.0)		26.5 (25.1,27.9)	73.5 (72.1,74.9)	
Race/ethnicity			<0.001*			<0.001*
NH White	23.9* (22.3,25.6)*	76.1* (74.4,77.7)*		24.5* (23.0,26.1)*	75.5* (73.9,77.0)*	
NH Black	27.8* (24.7,31.2)*	72.2* (68.8,75.3)*		25.5* (22.9,28.4)*	74.5* (71.6,77.1)*	
Hispanic	27.0* (24.8,29.3)*	73.0* (70.7,75.2)*		26.9* (24.8,29.1)*	73.1* (70.9,75.2)*	
Other	25.8* (22.3,29.6)*	74.2* (70.5,77.7)*		26.1* (23.2,29.3)*	73.9* (70.7,76.8)*	
Parents education			0.069			0.250
High school/GED or less	24.6 (22.9,26.5)	75.4 (73.6,77.1)		25.1 (23.3,27.0)	74.9 (73.0,76.7)	
Some college	25.5 (23.7,27.4)	74.5 (72.7,76.3)		25.6 (23.8,27.4)	74.4 (72.6,76.2)	
College or higher	25.3 (24.1,26.7)	74.7 (73.4,76.9)		25.4 (23.6,27.3)	74.6 (72.7,76.4)	

(Continues)

TABLE 2 (Continued)

	Electronic cigarettes			*Cigarettes*		
	Susceptible (n = 2059, 25.3%) Weighted % (95% CI)	***Unsusceptible (n = 6032, 74.7%) Weighted % (95% CI)***	***P-value[a]***	***Susceptible (n = 2252, 25.4%) Weighted % (95% CI)***	***Unsusceptible (n = 6575, 74.6%) Weighted % (95% CI)***	***P-value***
Household income			0.745			0.438
<50 k	25.6 (23.8,27.4)	74.4 (72.6,76.2)		25.9 (24.3,27.7)	74.1 (72.3,75.7)	
50 k to 100 k	26.2 (23.8,28.8)	73.8 (71.2,76.2)		24.9 (22.4,27.4)	75.2 (72.6,77.6)	
>100 k	25.4 (23.2,27.8)	74.6 (72.2,76.8)		26.1 (24.2,28.2)	73.9 (71.8,75.8)	
Grades ≥ mostly B's			0.211			0.132
Yes	24.9 (23.4,26.5)	75.1 (73.5,76.6)		24.8 (23.5,26.1)	75.2 (73.9,76.6)	
No	26.8 (24.6,29.1)	73.2 (70.9,75.4)		27.2 (25.0,29.6)	72.8 (70.4,75.0)	
Family nicotine use			0.013*			0.006*
Yes	30.9* (28.7,33.2)*	69.1* (66.8,71.3)*		31.4* (29.4,33.4)*	68.6* (66.6,70.6)*	
No	23.2* (21.8,24.6)*	76.8* (75.4,78.2)*		23.3* (22.0,24.5)*	76.8* (75.5,78.0)*	
Secondhand smoke			<0.001*			<0.001*
Yes	34.3* (31.9,36.7)*	65.7* (63.3,68.1)*		34.5* (32.3,36.7)*	65.5* (63.3,67.7)*	
No	22.2* (20.8,23.7)*	77.8* (76.3,79.2)*		22.4* (21.1,23.8)*	77.6* (76.3,78.9)*	
Best friends' nicotine use			<0.001*			<0.001*
Yes	47.9* (45.3,50.5)*	52.1* (49.6,54.7)*		41.9* (39.4,44.4)*	58.1* (55.6,60.6)*	
No	19.2* (18.1,20.5) *	80.8* (79.6,81.9)*		21.2* (20.2,22.3) *	78.8* (77.7,79.8)*	
Past 12-month marijuana use			0.031*			0.808
Yes	54.9* (46.2,63.4) *	45.1* (36.6,53.8)*		40.5 (31.2,50.5)	59.5 (49.5,68.8)	
No	24.5* (23.3,25.8)*	75.5* (74.2,76.7)*		24.9 (23.8,26.0)	75.1 (74.0,76.2)	
Past 12-month alcohol use			<0.001*			<0.001*
Yes	47.9* (45.0,50.9)*	52.1* (49.1,55.0)*		45.2* (42.4,48.0) *	54.8* (52.0,57.6)*	
No	20.5* (19.3,21.8)*	79.5* (78.2,80.7)*		21.6* (20.5,22.7) *	78.4* (77.3,79.6)*	

[a]Multivariable logistic regression was performed with sample weights, in which electronic cigarette or cigarette susceptibility (yes vs no) was the outcome variable, and covariates included age, sex, race/ethnicity, parents' education, household income, school grades, family tobacco use, secondhand smoke, best friends' tobacco use, and past 12-month use of marijuana and alcohol.
*Statistically significant at $P < 0.05$.

Analysis

All of the analyses were conducted using Stata version 16 (StataCorp, College Station, TX). We performed a complete case analysis via multivariable logistic regressions to examine the association between product-specific susceptibility measures at baseline (wave 4) and product consumption a year later (wave 4.5), controlling for sociodemographic characteristics, exposure to nicotine users, and behavioral risk factors. E-cigarette susceptibility has the most missing values, at 8.5%. Logistic regressions on missing values imply they are missing at random. We incorporated sample weights via the *svy* command in Stata to produce nationally representative results. The analysis was not pre-registered, and the results should be considered exploratory.

We also calculated the variance inflation factor (VIF) to assess potential multicollinearity among our control variables. The VIF score is 1.35, implying limited multicollinearity. Pearson's χ^2 test was performed in Table 1 to compare distributions of categorical variables.

RESULTS

Table 1 shows strong univariate associations between cigarette and e-cigarette susceptibility questions and subsequent smoking and e-cigarette use behaviors. Considering the binary measure of susceptibility (last four rows of the table), 18.5% of participants who were susceptible to e-cigarettes in PATH wave 4 used e-cigarettes in the subsequent 12 months, whereas only 4.6% who were not susceptible did so ($P < 0.001$). A higher percentage of those who were susceptible to e-cigarettes used e-cigarettes in the past 30 days as well (8.4% vs 1.9%, $P < 0.001$). We report similar results for cigarette smoking.

TABLE 3 Weighted association of binary susceptibility measures with subsequent e-cigarette and cigarette use among US youth in the PATH study (n = 8841)

	Wave 4.5 outcomes[a]							
	Electronic cigarettes				*Cigarettes*			
Wave 4 variables	*Any use aOR (95% CI)*	*P-value*	*Current use aOR (95% CI)*	*P-value*	*Any use aOR (95% CI)*	*P-value*	*Current use aOR (95% CI)*	*P-value*
Susceptibility measure								
Susceptible to e-cigarettes (vs no)	2.99* (2.29–3.90)*	<0.001*	2.73* (1.78–4.16)*	<0.001*	1.05 (0.64–1.73)	0.839	0.65 (0.29–1.45)	0.291
Susceptible to cigarettes (vs no)	0.96 (0.77–1.19)	0.707	1.11 (0.82–1.51)	0.500	1.82* (1.09–3.03)*	0.022*	3.32* (1.33–8.29)*	0.011*
Covariates								
Age (12–14 vs 15–17)	1.29* (1.04–1.62)*	0.024*	1.19 (0.88–1.60)	0.248	1.40 (0.87–2.24)	0.164	1.90 (0.87–4.15)	0.105
Female (vs male)	0.99 (0.79–1.25)	0.959	1.27 (0.96–1.69)	0.089	0.97 (0.64–1.49)	0.905	0.98 (0.51–1.86)	0.940
Race/ethnicity (Ref: NH White)								
NH black	0.34* (0.22–0.51)*	<0.001*	0.27* (0.13–0.56)*	0.001*	0.27* (0.09–0.83)*	0.023*	0.18* (0.04–0.89)*	0.035*
Hispanic	0.75 (0.56–1.02)	0.067	0.75 (0.52–1.09)	0.130	0.76 (0.45–1.30)	0.317	0.57 (0.23–1.41)	0.223
Parents education (Ref: high school/GED or less)								
Some college	1.07 (0.79–1.46)	0.656	1.04 (0.65–1.68)	0.860	0.96 (0.51–1.80)	0.906	1.57 (0.69–3.59)	0.283
College or higher	1.50* (1.09–2.07)*	0.014*	1.31 (0.83–2.06)	0.240	0.92 (0.48–1.76)	0.802	0.88 (0.33–2.33)	0.796
Household income (Ref: < 50 k)								
50 k to 100 k	1.12 (0.82–1.54)	0.471	1.35 (0.87–2.10)	0.182	1.04 (0.59–1.83)	0.885	1.10 (0.54–2.27)	0.786
> 100 k	1.32 (0.99–1.76)	0.057	1.70* (1.06–2.72)*	0.027*	0.83 (0.45–1.54)	0.558	0.67 (0.24–1.87)	0.437
Grades ≥ mostly B's (vs no)	0.70* (0.54–0.91)*	0.008*	0.69 (0.45–1.05)	0.085	0.46* (0.29–0.75)*	0.002*	0.32* (0.15–0.68)*	0.003*
Family nicotine use (vs no)	1.72* (1.39–2.13)*	<0.001*	1.32 (0.93–1.87)	0.122	1.75* (1.13–2.70)*	0.012*	1.89 (0.92–3.90)	0.083
Secondhand smoke (vs no)	1.00 (0.79,1.28)	0.977	1.08 (0.75–1.56)	0.674	1.41 (0.81–2.45)	0.219	1.17 (0.52–2.63)	0.695
Best friends' nicotine use (vs no)	2.51* (1.94–3.25)*	<0.001*	1.99* (1.39–2.83)*	<0.001*	2.43* (1.57–3.78)*	<0.001*	3.27* (1.56–6.88)*	0.002*
Past 12-month alcohol use (vs no)	2.43* (1.98–2.98)*	<0.001*	2.35* (1.70–3.25)*	<0.001*	1.60 (0.93–2.73)	0.083	1.38 (0.61–3.13)	0.442
Past 12-month marijuana use (vs no)	1.59 (0.87–2.89)	0.128	2.23* (1.10–4.52)*	0.027*	4.93* (2.16–11.21)*	<0.001*	3.23 (0.94–11.19)	0.063

[a]Any use: past 12-month use. Current use: past 30-day use.
*Statistically significant at $P < 0.05$.

Compared with non-susceptible adolescents, a higher proportion of adolescents susceptible to cigarettes reported smoking later, both in the 12 months following wave 4 (3.6% vs 1.1%, $P < 0.001$) and in the past 30 days (1.5% vs 0.4%, $P < 0.001$).

Table 2 presents the relationships between other covariates and susceptibility measures. Among adolescent never nicotine users, higher proportions of the older group (15–17) are susceptible to e-cigarettes ($P < 0.001$), based on Pearson's χ^2 test. We also report that higher proportions of youth are susceptible to e-cigarettes if they have family members who use nicotine ($P < 0.001$), are exposed to secondhand smoke ($P < 0.001$), have best friend(s) who used nicotine-containing products ($P < 0.001$), or have past 12-month marijuana ($P < 0.001$) and alcohol ($P < 0.001$) use. Similarly, higher proportions of never nicotine users are susceptible to cigarettes if they are older ($P < 0.001$), of the female sex ($P = 0.018$), have family members who use nicotine products ($P < 0.001$), are exposed to secondhand smoke ($P < 0.001$), have best friend(s) who used nicotine-containing products ($P < 0.001$), or have past 12-month marijuana ($P < 0.001$) and alcohol ($P < 0.001$) use. Multivariable logistic regressions reveal that significant factors affecting e-cigarette and cigarette susceptibility include race, family nicotine product use, secondhand smoke, best friends' nicotine product use, and marijuana and alcohol consumption.

Table 3 reports weighted associations in adjusted odds ratios (aORs) of binary susceptibility measures with subsequent e-cigarette and cigarette use, controlling for our list of covariates. The aORs were 2.99 (95% CI, 2.29–3.90) between e-cigarette susceptibility and any use of e-cigarettes in the next 12 months, and 2.73 (95% CI, 1.78–4.16) for subsequent current (past 30-day) e-cigarette use, whereas the aORs for cigarette susceptibility were not significant. The aORs for cigarette susceptibility and subsequent cigarette smoking were 1.82 (95% CI, 1.09–3.03) for past 12-month smoking and 3.32 (95% CI, 1.33–8.29) for current smoking. E-cigarette susceptibility was not statistically significantly associated with subsequent cigarette use.

For sensitivity analysis, we tested the weighted association between continuous susceptibility measures with subsequent product use (reported in Supporting information Table S1 and Table 2) and the unweighted association between the binary susceptibility measures and subsequent product use, reported in Supporting information Table S2. The results in both cases are similar to our main findings.

DISCUSSION

This study examined e-cigarette and cigarette susceptibility among adolescent never nicotine users as predictors of e-cigarette and cigarette use within the next year. Our results agree with previous literature that susceptibility measures are significant independent predictors of future e-cigarette and cigarette use (any use and current use). E-cigarettes susceptibility is associated with subsequent any use and current use of e-cigarettes. Cigarette susceptibility is associated with any use and current use of cigarettes 1 year later. Our study contributes to the literature by examining more recent data (2016–2018) and controlling for important risky behaviors among never nicotine users, including marijuana and alcohol use.

In addition, by including both e-cigarette and cigarette susceptibility in our models, we investigated the predictability of product-specific susceptibility measures. We found that e-cigarette susceptibility was significantly associated with future e-cigarette use behaviors, but not with cigarette smoking behaviors. Similarly, smoking susceptibility was a significant predictor for subsequent cigarette smoking, but not for e-cigarette use. Especially given all of our control variables, these findings imply that product-specific susceptibility is an independent risk factor for the future use of that specific product only. As such, we conclude that future studies of the association between e-cigarette use and smoking should include a cigarette-specific susceptibility measure as an independent risk factor.

Limitations

Our analysis examined, and hence only applies to, how susceptibility measures predict youth never nicotine users' subsequent product use. Other studies have found that the predictability of susceptibility measures varies by study sample. For example, the association of susceptibility and product initiation is stronger among never nicotine users [24, 25], compared to those who have used other nicotine products. More research is needed to further examine how study sample influences susceptibility's association with product use.

We were unable to include in our study one risk factor included in many other studies [25–28]: a psychosocial measure of risk-taking propensity. PATH includes questions on sensation seeking, but poses them only to new participants in each wave. As such we could not get a wave 4 sensation seeking measure for all respondents. Given our inclusion of other psychoactive substance use, however, this omission would be unlikely to affect our conclusion.

Another limitation is the reliability and validity of the self-reported data from PATH. Tourangeau *et al.* [29] re-interviewed a subset of adults and youth from wave 4 of PATH and then followed self-report responses with saliva samples. They concluded that the self-report data on nicotine/tobacco use are both reliable and valid. More generally, Bachman *et al.* [30] reviewed a substantial body of evidence regarding multiple surveys of youth self-reporting of drug use, including nicotine/tobacco use, and found that the evidence supports the validity of the self-reported data.

We excluded from our analysis individuals who aged out of the wave 4.5 follow-up adolescent survey by having turned 18. PATH wave 4.5 is a special survey of 12- to 17-year-olds only. We believe that these 18 year olds should not be substantially different from respondents who finished both surveys, therefore, making it unlikely that their exclusion would change our results.

CONCLUSION

E-cigarette and cigarette susceptibility measures are statistically significantly associated with e-cigarette and cigarette use a year later, respectively. These susceptibility measures predict product-specific use, where e-cigarette susceptibility predicts future e-cigarette use, but not cigarette use and cigarette susceptibility predicts future cigarette smoking, but not e-cigarette use. When available, as in PATH, susceptibility questions should be included in prospective studies examining the determinants of youth substance use.

DECLARATION OF INTERESTS

None.

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None.

AUTHOR CONTRIBUTIONS

Ruoyan Sun: Conceptualization-Equal; Validation-Equal. **David Mendez:** Conceptualization. **Kenneth Warner:** Conceptualization; Validation-Equal; Writing - review & editing-Equal.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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