



Abstract

Background: The prevalence of past 30-day use of e-cigarettes among youth in the United States (US) has surpassed all other tobacco products in recent years, while cigarette smoking has declined. An association between e-cigarette use and subsequent onset of cigarette smoking has been observed; however, it is not clear whether this reflects a causal relationship. Guided by the 'common liability' theory, which postulates that the observed association between e-cigarette use and cigarette smoking is attributed to a 'common liability' to use tobacco products, the aim of the current study is to estimate the relationship between e-cigarette use and the onset of cigarette smoking among adolescents using a structural equation modeling approach.

Methods: The study population is non-institutionalized civilian adolescents 12–17 years of age living in the US, sampled in the longitudinal Population Assessment of Tobacco and Health (PATH) study. Information about ever use of a range of tobacco products, including e-cigarette and cigarette, was obtained via confidential selfreport. A structural equation modeling approach was used to estimate the relationship between ever use of e-cigarettes at wave 1 and the onset of ever smoking cigarettes at wave 2 after controlling for a latent construct representing a "common liability to use tobacco products."

Results: The measurement model for the "common liability to use tobacco products" fits data well (Root Mean Square Error of Approximation = 0.028, 90% CI = 0.024, 0.032; Comparative Fit Index = 0.921; Tucker Lewis Index = 0.889; all factor loadings > 0.4). The latent "common liability to use tobacco products" is a robust predictor for the onset of cigarette use (beta = 0.42; 95% confidence interval = 0.08, 0.76; p = 0.015). After accounting for a latent construct representing a "common liability to use tobacco products," ever use of e-cigarettes at wave 1 does not predict the onset of cigarette use at wave 2 (beta = 0.10, 95% confidence interval = -0.09, 0.29, p = 0.299). Conclusions: Findings from this study provide supportive evidence for a "common liability" underlying the observed association between e-cigarette use and the onset of cigarette smoking.

Introduction

- In the US, the prevalence of youth e-cigarette use increased sharply between 2011 and 2016, plateaued in 2017, and increased again in 2018, whereas underage cigarette smoking has been declining.
- A largest body of literature from individual-level observational studies has shown a consistent positive association linking e-cigarette use with a higher risk of cigarette smoking onset, even after adjusting for a range of variables known to be associated with cigarette smoking (e.g., Leventhal et al.; Miech et al.; Watkins et al.).¹⁻ However, it is unclear whether the observed association is attributed to an individual's liability to use tobacco products or reflects a causal relationship between e-vapor product use and subsequent cigarette smoking.
- Findings from ecological studies are inconsistent.
- To date, one experimental study found no effect of exposure to e-vapor product advertisements on appeal or susceptibility of cigarette smoking.⁴
- Liability denotes a latent (unobservable) quantitative trait that represents an individual's risk of having a condition.
- The "common liability" theory, which postulates that both e-cigarette use and combustible tobacco cigarette use are manifestations of the "liability" to use tobacco products of the individual; once this "common liability" is controlled for, there may be no causal relationship between e-cigarette use and cigarette smoking.⁵
- Guided by the "common liability" theory, the aim of this study is to estimate the prospective relationship between e-cigarette ever use and the onset of first cigarette smoking after controlling for a "common liability" to use tobacco in the US adolescents using a structural equation modeling approach.

Methods

- Study population: non-institutionalized civilian adolescents 12–17 years of age living in the US, sampled in the longitudinal Population Assessment of Tobacco and Health (PATH) study.⁶
- Analytic sample: never cigarette users at wave 1 assessment (n = 9,045)
- Assessment: audio computer assisted self-interviews (ACASI), with standardized multi-item modules on use of various tobacco products, including cigarettes, e-cigarettes, cigars, smokeless tobacco, snus, hookah, pipe, dissolvable tobacco, bidis, and kretek.
- Survey questions about ever use of these tobacco products are typically in the format of "Have you ever smoked/used ..., even one or two puffs/times?" - PATH also assessed lifetime history (i.e., ever use) of alcohol, cannabis, Ritalin® or Adderall®, painkillers/sedatives/tranquilizers, cocaine, stimulants, and other drugs, respectively.
- Sex and age categories (12–14 or 15–17 years at baseline) were included as covariates.
- Outcome variable: onset of ever cigarette smoking at wave 2, which is defined as smoking cigarettes (even one or two puffs) for the first time between wave 1 and wave 2 assessments among adolescents who had never smoked cigarettes at wave 1.

Analysis

- Measurement model for a latent construct for the common liability to use tobacco products using confirmatory factor analysis methods. - Observed variables for the latent construct: lifetime ever use of tobacco products assessed in PATH wave 1 youth survey. - Smokeless tobacco, snus, and dissolvable tobacco were combined to create an "oral tobacco" variable.
- All observed variables were treated as categorical variables.
- Structural equation model with
- A path from the latent construct to the onset of first cigarette smoking
- And a direct path from e-cigarette ever use to the onset of first cigarette smoking.
- If the direct path from e-cigarette to cigarette smoking is statistically robust, it provides evidence that e-cigarettes plays a role for cigarette smoking onset over and beyond the common liability to use tobacco products. If not, it suggests that the frequently observed association between e-cigarettes ever use and smoking is attributed to a common liability to use tobacco products.
- Fit indices include root mean square of approximation (RMSEA), comparative fit index (CFI), and Tucker-Lewis index (TLI). • Analysis weights were used to adjust for selection probability, nonresponse patterns, possible deficiencies in the sampling frame, and attrition. Balanced repeated
- replication method was used to generate standard errors and 95% confidence intervals (CI). • Analyses were conducted using Stata 15.0 (StataCorp, College Station, Texas, USA) and Mplus 8.1 (Muthén & Muthén, Los Angeles, CA, USA).

E-Cigarette Use and Onset of Cigarette Smoking Among Adolescents: An Empirical Test of the "Common Liability" Theory

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TABLE 1. Estimated occurrence (%) of lifetime ever use of tobacco products, factor loadings, and thresholds from confirmatory factor analysis. Data from PATH waves 1 and 2, 2013–2015. (Unweighted n = 9,045 12–17 Year Old never cigarette users^a).

Ever use of	Weighted %	Standardized factor loading
E-cigarette	3.7	0.76
Cigar	1.3	0.71
Pipe	0.3	0.88
Hookah	2.5	0.62
Oral tobacco ^b	1.2	0.63
Bidi	0.1	0.45
Kretek	0.1	0.68

^a Analytical sample consists of youths who had never smoked a puff of cigarette at wave 1 and followed up and remained youths at wave 2.

Oral tobacco includes smokeless tobacco, snus, and dissolvable tobacco products.

The measurement model fits data reasonably well (RMSEA = 0.019, 90% CI = 0.014, 0.024; CFI = 0.963; TLI = 0.945).

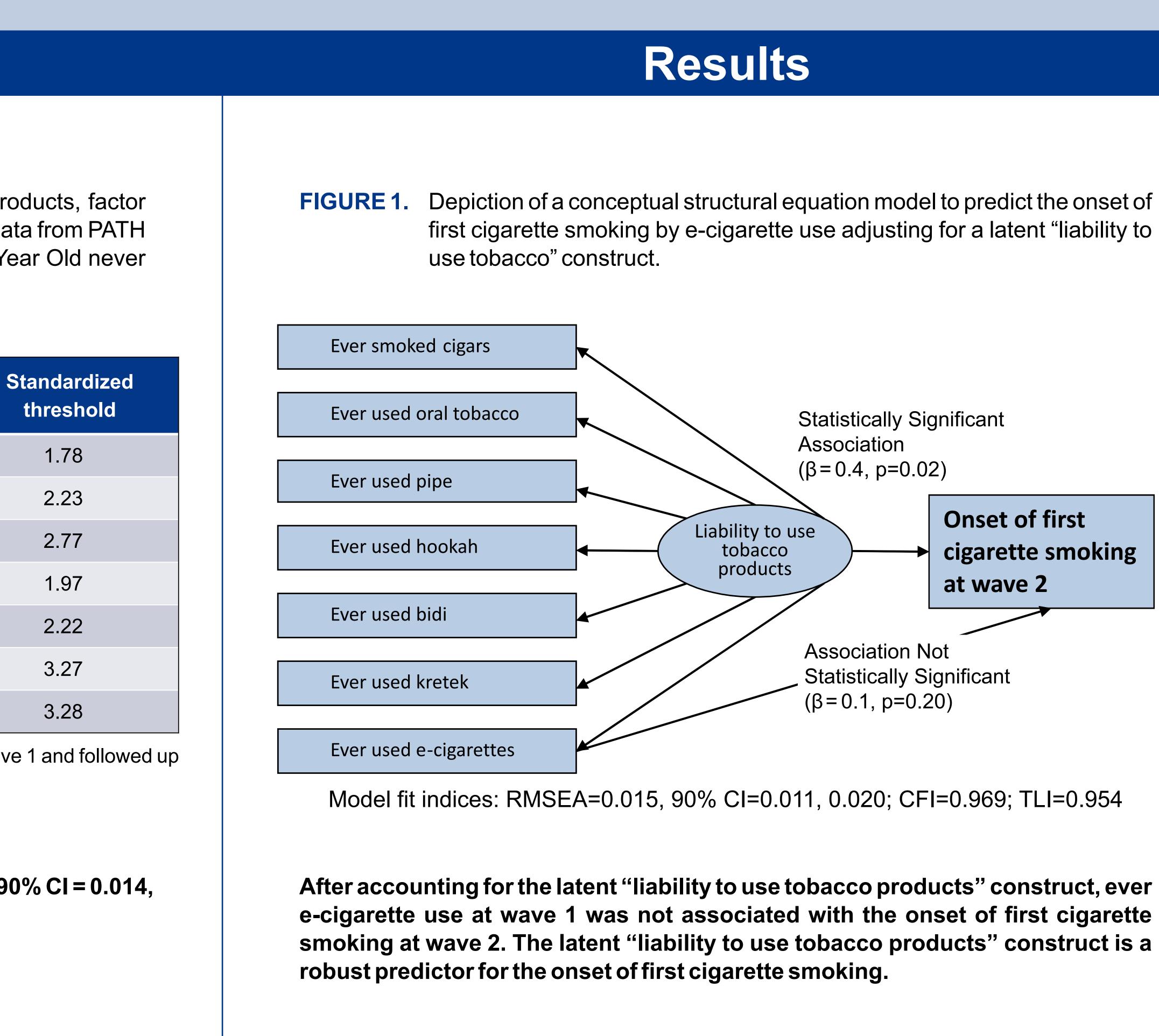
Limitations

- Observational study.
- The assessment was based on self-report information.
- The response level at the household screening is moderate.

Strengths

- Prospective design.
- Focus on the incidence of cigarette use without any interference of the persistence process.
- By using nationally representative data, our results are generalizable to the general US adolescent population.
- Use of ACASI and relatively low attrition enhances internal validity by reducing potential socially desirable responding and bias associated with attrition.

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Limitations & Strengths

threshold

1.78

2.23

2.77

1.97

2.22

3.27

3.28

onset of cigarette smoking.

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This poster may be accessed at www.altria.com/ALCS-Science

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5	 Including sex and age as covariates introduced little change in estimates, and statistical inference remained the same β=0.2; 95% CI= -0.03, 0.4; p=0.095; for the e-cigarette to cigarette onset path β=0.3; 95% CI= 0.04, 0.6; p=0.025; for the "liability to use tobacco" latent construct to cigarette onset path In order to further test the model with a latent construct for the liability for use of psychoactive substances (as was originally proposed by the "common liability theory"), we expanded the measurement model to include other substances measured in PATH (i.e., alcohol, cannabis, prescription Ritalin and Adderall, cocaine/crack, stimulants, and other drugs (heroin, inhalants, solvents, and hallucinogens).
	 The expanded measurement and structural equation models both have good fit (RSMEA<0.02, CFI and TLI>0.90).
	• Similar to results from the tobacco liability model, the e-cigarette-specific path is not statistically significant (β =0.1; 95% CI=-0.002, 0.3; p=0.053 without adjustment for sex and age; β =0.1; 95% CI=-0.002, 0.3; p=0.054 with adjustment for sex and age), and the latent "liability" construct is a robust predictor of cigarette smoking onset (β =0.4; 95% CI=0.3, 0.6; p<0.001 without adjusting for sex and age; β =0.4; 95% CI=0.3, 0.6; p<0.001 with adjusting for sex and age; β =0.4; 95% CI=0.3, 0.6; p<0.001 with adjusting for sex and age; β =0.4; 95% CI=0.3, 0.6; p<0.001 with adjusting for sex and age; β =0.4; 95% CI=0.3, 0.6; p<0.001 with adjusting for sex and age; β =0.4; 95% CI=0.3, 0.6; p<0.001 with adjusting for sex and age; β =0.4; 95% CI=0.3, 0.6; p<0.001 with adjusting for sex and age; β =0.4; 95% CI=0.3, 0.6; p<0.001 with adjusting for sex and age; β =0.4; 95% CI=0.3, 0.6; p<0.001 with adjusting for sex and age; β =0.4; 95% CI=0.3, 0.6; p<0.001 with adjusting for sex and age; β =0.4; 95% CI=0.3, 0.6; p<0.001 with adjusting for sex and age).
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Conclusion

Findings from this study provide supportive evidence for a "common liability" underlying the observed association between e-cigarette use and the

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