

Letters

RESEARCH LETTER

Association of e-Cigarette Vaping and Progression to Heavier Patterns of Cigarette Smoking

E-cigarette vaping is reported by 37% of US 10th-grade adolescents¹ and is associated with subsequent initiation of combustible cigarette smoking.² Whether individuals who vape and transition to combustible cigarettes are experimenting or progress to more frequent and heavy smoking is unknown. In addition, because some adolescents use e-cigarettes as a smoking cessation aid,³ adolescent smokers who vape could be more likely to reduce their smoking levels over time. Therefore, associations of vaping with subsequent smoking frequency and heaviness pattern among adolescents were examined.

Methods | Respondents were students in 10 public high schools in Los Angeles County, California, enrolled in a longitudinal study approved by the University of Southern California institutional review board and detailed elsewhere.² This analysis used data from surveys administered during fall (baseline for this report) and spring (6-month follow-up) of 10th grade (2014-2015).

Surveys included e-cigarette and combustible cigarette use questions from prior research,^{1,2} which were used to create variables for baseline vaping (never, prior [ever-vaper with no past 30-day vaping], infrequent [vaped 1-2 days during past 30 days], or frequent [vaped ≥ 3 days]), and baseline and follow-up past 30-day smoking frequency (nonsmoker, infrequent smoker [1-2 days], frequent smoker [≥ 3 days]) and heaviness (0, <1, 1, or ≥ 2 cigarettes per day on smoking days).

Generalized estimating equation ordinal (cumulative logit) logistic regression models were used to assess the association between baseline vaping and follow-up frequency or heaviness of smoking, with adjustment for baseline smoking frequency or heaviness using SAS (SAS Institute), version 9.3. The baseline vaping \times baseline smoking interaction term was then added to test differential associations of baseline vaping with follow-up smoking by baseline smoking status. Each model was retested after adjusting for age, sex, ethnicity, highest parental education, whether the student lived with both parents, ever use of alcohol or drugs, ever use of any combustible tobacco product, family history of smoking, depressive symptoms (Cronbach $\alpha = .94$), UPPS Impulsive Behavior Scale lack of premeditation ($\alpha = .94$) and sensation-seeking ($\alpha = .91$) subscales, delinquent behavior ($\alpha = .81$), peer smoking, smoking susceptibility ($\alpha = .87$), and smoking expectancies ($\alpha = .46$). Details on covariate measures are reported elsewhere.² Significance was .05 (2-tailed). See modeling details in Table 1.

Results | Among 4100 eligible students, 3396 (82.8%) provided assent and parental consent to enroll in the study. Data

were obtained from 3282 students (96.6%) at baseline and 3251 (95.0%) at follow-up. Students with complete vaping and smoking data at both time points constituted the analytic sample ($N = 3084$; 54.3% girls, 47.3% Hispanic, baseline mean age, 15.5 years).

The prevalence rates of past 30-day vaping and smoking were low overall. Smoking frequency at follow-up was proportionately greater with successively higher levels of baseline vaping: never-vapers (infrequent smokers: 0.9%; frequent smokers: 0.7%), prior vapers (4.1% and 3.3%, respectively), infrequent vapers (9.0% and 5.3%), and frequent vapers (11.6% and 19.9%; Table 2). Similar trends were found for smoking heaviness.

Adjusting for baseline smoking, each increment higher on the 4-level baseline vaping frequency continuum was associated with proportionally higher odds of smoking at a greater level of frequency (odds ratio [OR], 2.17; 95% CI, 1.95-2.42) and heaviness (OR, 2.19; 95% CI, 1.85-2.58) by follow-up; associations persisted in covariate-adjusted analyses (Table 1).

The positive association between baseline vaping and follow-up smoking frequency was stronger among baseline nonsmokers ($n = 2966$; OR, 2.51; 95% CI, 2.30-2.75) than baseline infrequent ($n = 63$; OR, 1.47; 95% CI, 0.98-2.23) and frequent ($n = 53$; OR, 1.06; 95% CI, 0.72-1.55) smokers ($P < .001$ for interaction; Table 1 and Table 2). Similar trends were found for smoking heaviness (Table 1).

Discussion | In this study of adolescents, vaping more frequently was associated with a higher risk of more frequent and heavy smoking 6 months later. Adolescent smoking patterns overrepresented by more frequent vapers in this study (ie, weekly smoking, >2 cigarettes per day) have been previously linked with high risk of nicotine dependence during adulthood.⁵ Although some youth use e-cigarettes for cessation purposes,³ vaping was not associated with smoking reductions in baseline smokers. However, because reason for vaping was not assessed, further investigation is required.

The role of nicotine and generalizability of these results to other locations and ages, longer follow-up periods, and non-self-report assessments are unknown and merit further inquiry. The transition from vaping to smoking may warrant particular attention in tobacco control policy.

Adam M. Leventhal, PhD
Matthew D. Stone, BA
Nafeesa Andrabi, BA
Jessica Barrington-Trimis, PhD
David R. Strong, PhD
Steve Sussman, PhD
Janet Audrain-McGovern, PhD