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Longitudinal Associations Between Receiving E-cigarette Price Promotions and Subsequent E-cigarette Use Among U.S. Young Adult Cigarette Smokers

Maryam Elhabashy¹, Olivia A. Wackowski^{1,2}, Melissa Mercincavage³, Raul Cruz-Cano⁴,
Melissa H. Abadi⁵, Jenny E. Ozga⁶, Cassandra A. Stanton⁶, Julia Chen-Sankey^{1,2}

¹Center for Tobacco Studies, Rutgers Biomedical and Health Sciences, New Brunswick, NJ

²Rutgers School of Public Health, Rutgers University, Piscataway, NJ

³Department of Psychiatry, Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA

⁴School of Public Health, University of Maryland College Park, MD

⁵Pacific Institute for Research & Evaluation, Louisville, KY

⁶Behavioral Health and Health Policy, Westat, Rockville, MD

Abstract

INTRODUCTION.—E-cigarette price promotions (EPPs; i.e., marketed reductions in cost) may influence young adult cigarette smokers to try, dual use with, or completely transition to e-cigarettes. We assessed whether receiving EPPs was associated with subsequent e-cigarette use among this group.

METHODS.—Data were from Waves 4 (2016–2018) and 5 (2018–2019) of the nationally representative Population Assessment of Tobacco and Health (PATH) Study survey. Analysis

Corresponding author: Julia Chen-Sankey, PhD MPP, Rutgers Center for Tobacco Studies, 303 George St. Room 525, New Brunswick, NJ 08901, JC.Sankey@Rutgers.edu, Phone: 838-932-1855.

Author Contribution:

Conceptualization: Maryam Elhabashy; Julia Chen-Sankey

Data curation: Julia Chen-Sankey

Formal analysis: Maryam Elhabashy; Julia Chen-Sankey

Funding acquisition: Julia Chen-Sankey; Cassandra A. Stanton

Investigation: Maryam Elhabashy; Julia Chen-Sankey

Methodology: Maryam Elhabashy; Julia Chen-Sankey

Project administration: Julia Chen-Sankey; Cassandra A. Stanton

Resources: Julia Chen-Sankey; Cassandra A. Stanton

Software: Julia Chen-Sankey

Supervision: Julia Chen-Sankey; Cassandra A. Stanton

Validation: Julia Chen-Sankey

Visualization: Maryam Elhabashy; Julia Chen-Sankey

Roles/Writing - original draft: Maryam Elhabashy; Julia Chen-Sankey

Writing - review & editing: All authors

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was restricted to participants who were young adult (18–34 years) established, current cigarette smokers who did not use e-cigarettes at Wave 4 (baseline; n=2,664; Sample 1), and a subsample of those who tried to quit smoking completely in the past year at Wave 5 (follow-up; n=948; Sample 2). Multivariable logistic regressions were used to examine associations between receiving EPPs at baseline and past year use of e-cigarettes in general (Sample 1) and to help quit smoking (Sample 2) at follow-up, controlling for covariates.

RESULTS.—Overall, 4.1% and 4.9% of Sample 1 and 2 participants received EPPs, respectively; At follow-up, 33.4% of Sample 1 participants used e-cigarettes, and 12.0% of Sample 2 participants used e-cigarettes to quit smoking. Receiving EPPs was associated with subsequent past-year e-cigarette use in general (AOR=2.07; 95% CI=1.31 to 3.27), and past-year e-cigarette use to help with quitting smoking (AOR=3.20; 95% CI=1.48 to 6.90).

DISCUSSION.—EPPs may increase e-cigarette use among established, current smokers and may be used to quit smoking. Research is needed to understand how EPPs may be differentially associated with complete product transition versus dual/poly use among young adult smokers.

Keywords

E-cigarettes; Price Promotions; Cigarette Smoking; Smoking Cessation; Young Adults; Harm Reduction; PATH Study

1. Introduction

In 2020, the U.S. observed an increase in its annual cigarette sales for the first time in 20 years (FTC, 2021). Notably, between 2002 and 2018, the proportion of ever smokers who initiated cigarettes and transitioned to daily smoking in young adulthood more than doubled (Barrington-Trimis et al., 2020), and young adults appeared to initiate cigarette smoking at a higher rate than youth in the country (Perry et al., 2018). Given the severe health effects of long-term cigarette smoking (Doll et al., 2004; Taylor et al., 2002), the development of enhanced smoking prevention and cessation strategies is crucial for reducing cigarette smoking and its associated public health impacts among the young adult population.

Complete transition from using cigarettes to e-cigarettes may be a promising strategy to reduce the harm associated with cigarette smoking among adult smokers (National Academies of Sciences & Medicine, 2018). Exposure to e-cigarette marketing and promotion messages, including exposure to e-cigarette price promotions (EPPs; marketed reduced prices including discounts, coupons, and sales), may prompt e-cigarette use among this group (Liber et al., 2022). Recent studies have found that exposure to EPPs might prompt consumers' tobacco experimentation by making products more affordable, especially among price-sensitive populations such as young people (Margolis et al., 2018; Padon et al., 2018; Pokhrel et al., 2016). Such studies examined the associations between exposure to EPPs and e-cigarette use progression among mostly tobacco-naïve young people. However, little is known about these associations among established, current cigarette smokers. This is an important area of study because complete transition to e-cigarettes among this population could reduce harm, while dual or poly use with e-cigarettes could increase nicotine use and the risk of dependence (Coleman et al., 2022).

To address this research gap, the present study used two waves of the Population Assessment of Tobacco and Health (PATH) Study data to examine associations between receiving EPPs and subsequent e-cigarette use in general and in an attempt to quit smoking cigarettes among young adult established, current cigarette smokers who did not use e-cigarettes at the prior wave.

2. Materials and Methods

2.1 Study Sample

This study used a sample of nationally representative data from Wave 4 (December 2016 to January 2018) and Wave 5 (December 2018 to November 2019) of the PATH Study. These data, which included longitudinal cohorts of civilian adults in the U.S. (PATH Study Team, 2016), were accessed through the PATH Study's adult survey public-use files. This prospective analysis used two study samples among young adults (aged 18–34): (Sample 1) established, current cigarette smokers who did not use e-cigarettes at Wave 4 (n=2,664); and (Sample 2) a subsample of those who had attempted cigarette smoking cessation in the past year at Wave 5 (n=948). Established, current cigarette smokers were defined as those who reported smoking cigarettes “Some days” or “Every day,” and had smoked at least 100 cigarettes in their lifetime. Current e-cigarette users (defined as those who used e-cigarettes “Some days” or “Every day”) at Wave 4 were excluded from the samples. Smokers with past-year smoking cessation attempts were defined as those who had tried to quit smoking cigarettes completely in the past 12 months at Wave 5.

2.2 Variables

2.2.1 Predictor Variable—Receiving EPPs at Wave 4 was measured by the question, “In the past 12 months, have you received discounts or coupons for any of the following products? Choose all that apply.” Responses included various types of tobacco products (e.g., cigarettes, e-cigarettes, cigars, hookah, smokeless tobacco). Respondents were considered having received EPPs in the past year (Yes/No) if they chose “e-cigarettes” for this question (Chen-Sankey et al., 2021).

2.2.2 Response Variables—This study used two response variables. Past-year e-cigarette use (Yes/No) was measured using the question, “In the past 12 months, have you used an electronic nicotine product, even one or two times?” Past-year e-cigarette use to quit smoking cigarettes (Yes/No) was measured using the question, “Thinking back to the time you tried to quit cigarettes in the past 12 months, did you use a different tobacco product to help you quit? Choose all that apply” among those who tried to completely quit smoking cigarettes in the past year. Those who selected “e-cigarettes” were categorized as using e-cigarettes to try quitting smoking cigarettes (Chen-Sankey, Jeong, et al., 2022).

2.2.3 Covariates—The following sociodemographic characteristics at Wave 4 were used as covariates for this study: age, biological sex, race/ethnicity, annual household income, and highest educational attainment (Table 1). Additional covariates at Wave 4 included past-year attempt to quit smoking cigarettes (Yes/No), which was measured by the question, “In the past 12 months, have you tried to quit smoking cigarettes completely?” Time to smoke the

first cigarette after waking was measured by the question, “On the days that you smoke, how soon after you wake up do you typically smoke your first cigarette of the day?” (Baker et al., 2007). The responses were categorized as “ < 61 minutes,” “31–60 minutes,” “6–30 minutes,” and “ > 5 minutes.” Past-year cigarette price promotion receipt was measured by the same question as that for EPP receipt (Chen-Sankey et al., 2021; Choi et al., 2019). Current cigarette smoking frequency (Daily/Non-daily) was defined by the question, “Do you now smoke cigarettes?” with the options of “Every day” and “Some days.” Finally, tobacco advertising exposure was measured by the questions: “In the past 30 days, have you noticed [Tobacco Product Type] being advertised in any of the following places?” Respondents exposed to any type of tobacco advertising at any place were considered as having tobacco advertising exposure (Yes/No) (Chen-Sankey, Lopez, et al., 2022; Stanton et al., 2022).

2.3 Statistical Analysis

Statistical analyses for this study were performed with a statistical significance of 0.05 using Stata 17.0 (StataCorp, College Station, Texas). First, estimations were made for weighted frequencies of respondent characteristics at Wave 4 (baseline) by those who reported past-year e-cigarette use (Sample 1) and past-year e-cigarette use to try quitting smoking cigarettes (Sample 2) at Wave 5 (follow-up). Pearson Chi-square tests were used to examine bivariate associations between respondent characteristics at baseline and the two subsequent e-cigarette use behaviors at follow-up. Then, controlling for covariates, multivariable logistic regressions were used to examine associations between receiving EPPs at baseline and the two subsequent e-cigarette use behaviors at follow-up. To ensure that the balanced repeated replications method was adopted with a Fay adjustment of 0.3, this study applied the recommended Wave 5 adult-Wave 4 cohort single or all waves weights for analyzing merged Waves 4 and 5 longitudinal data (FDA, 2020). To minimize missing data, imputed sociodemographic variables and derived tobacco use variables were utilized when available (FDA, 2020). Missing data were minimal across all variables (<3%), and listwise deletion was used to treat missing values (Baum, 2009). Multicollinearity in regression analysis was examined using variance inflation factor (VIF) to ensure statistical reliability (O’Brien, 2007). This research involved the use of de-identified data, which is not considered human subject research under 45 CFR 46.102(d) and is deemed by Rutgers University as exempt from Institutional Review Board review.

3. Results

3.1 Respondent Characteristics

The samples used in the analysis (Table 1) were representative of the U.S. population of young adult established, current cigarette smokers who did not use e-cigarettes and those who tried to quit smoking cigarettes in the past year. Overall, 4.1% of all young adult smokers and 4.9% of those who tried to quit smoking cigarettes at follow-up had received EPPs in the past year at baseline; 33.4% of respondents used e-cigarettes in the past year at follow-up, and 12.0% of those who attempted to quit smoking cigarettes in the past year used e-cigarettes as a cessation aid.

3.2 Associations Between Receiving EPPs and Subsequent E-cigarette Use

Table 2 shows results from the multivariable logistic regressions that evaluated the associations between receiving EPPs and subsequent e-cigarette use in general and to quit smoking cigarettes in the past year. Specifically, receiving EPPs at baseline was associated with past-year e-cigarette use at follow-up among the overall sample of young adult cigarette smokers (adjusted OR (AOR)=2.07; 95% Confidence Interval (CI)=1.31 to 3.27). Additionally, receiving EPPs at baseline was associated with past-year e-cigarette use to quit smoking at follow-up among those who attempted to quit (AOR=3.20; 95% CI=1.48 to 6.90). The VIF values for the explanatory variables used in the models appear to be moderate, suggesting reliable statistical estimates (Kleinbaum et al., 2013).

4. Discussion

This is one of the first studies examining associations between receiving EPPs and subsequent e-cigarette use among a nationally representative sample of U.S. young adult established, current cigarette smokers who do not use e-cigarettes. Although only a small portion of this population reported past-year exposure to EPPs at baseline (2016–2018), this exposure was associated with subsequent past-year e-cigarette use in general as well as with past-year e-cigarette use to quit smoking cigarettes at follow-up (2018–2019). These associations were found after controlling for a series of potential covariates, including respondents' recent exposure to tobacco advertising and to cigarette price promotions.

Although we found an association with using e-cigarettes in cessation attempts, based on our study alone, it is unclear whether receiving EPPs would lead young adults to completely transition from using cigarettes to using e-cigarettes, potentially reducing harms associated with tobacco use (National Academies of Sciences & Medicine, 2018). While a certain short period of dual use may lead to eventual switching, extended dual or poly tobacco use behavior may cause more harm than exclusive cigarette smoking or e-cigarette use (Coleman et al., 2022). Dual use concerns may be underscored by the fact that, during the time of baseline data collection, many commonly used e-cigarette brands (e.g., JUUL, Vuse) (Cullen et al., 2018) were fully or partially owned by large tobacco industry companies (e.g., Altria) that also manufactured and marketed popular cigarette brands (e.g., Marlboro) and use price promotions to maintain product use and profits (Liber et al., 2022). Therefore, future research is recommended to examine the role of EPPs in complete product switching versus transitions to dual or poly-tobacco use to investigate its potential influence on harm among young adults who smoke cigarettes.

Future research should also examine how EPPs may interact with other e-cigarette marketing features (e.g., smoker-targeted claims, flavors, and human models) to influence young adult smokers' use of e-cigarettes. In prior work, non-tobacco-using young adults' noticing of price discounts in e-cigarette advertisements was only associated with increased e-cigarette product appeal when participants also noticed mint/fruit flavor descriptors in the same advertisements (Chen-Sankey, Jeong, et al., 2022). Therefore, it is important to understand how cigarette smokers' exposure to EPPs, in the context of simultaneous exposure to other marketing features, may contribute to e-cigarette use perceptions and behavior changes among established, current cigarette smokers.

This study has several limitations. First, due to the observational nature of this study, it may not have accounted for all of the confounders that explain the examined associations. Second, the PATH Study only included questions about receiving tobacco price promotions. Future research should examine seeing, receiving, and using tobacco price promotions to assess their differential influence. Lastly, our analysis did not examine whether study populations completely transitioned from smoking cigarettes at baseline to e-cigarettes at follow-up.

With the FDA authorizing the marketing of some e-cigarette products, it is important to develop an understanding of marketing strategies that may prompt e-cigarette use among young adult established, current cigarette smokers. If more research demonstrates that exposure to EPPs contributes to cigarette smokers' continued use of e-cigarettes to quit smoking, policymakers may need to consider this evidence for future e-cigarette product reviews. The influence of other price-related policies, such as taxation of e-cigarette products, may also need to be further examined to understand their potential impacts on product transitions.

5. Conclusions

This nationally representative survey study found significant associations between receiving EPPs at baseline (2016–2018) and subsequent use of e-cigarettes in general and to quit smoking cigarettes at follow-up (2018–2019) among young adult established, current cigarette smokers who did not use e-cigarettes at baseline. Future research is recommended to investigate whether receiving and using EPPs may influence the complete transition from using cigarettes to e-cigarettes among young adults who smoke cigarettes.

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Highlights:

- A U.S. national sample of young adult cigarette smokers who did not use e-cigs.
- Receiving e-cig price promotions was associated with e-cig use at 1-year follow-up.
- It was also associated with e-cig use to quit smoking cigarettes at 1-year follow-up.

Table 1.

Participant Characteristics at Wave 4 by Past-Year E-cigarette Use (to Quit Smoking Cigarettes) at Wave 5 (18–34 years) Among Young Adult Established, Current Smokers Who Did Not Use E-cigarettes at Wave 4 (18–34 years): Population Assessment of Tobacco and Health Study Youth Surveys Waves 4 (2016–2018) and 5 (2018–2019)¹

	Sample ²		Past-year E-cigarette Use at Wave 5		Sample ³		Past-year E-cigarette Use to Quit Smoking at Wave 5		P-value
	% (95% CI)	% (95% CI)	Yes	No	% (95% CI)	N=948	Yes	No	
	N=2,664		33.4%	66.6%			12.0%	88.0%	
E-cigarette Price Promotion Receipt									0.0001
Yes	4.1 (3.3, 5.1)	52.8 (43.2, 62.2)	47.2 (37.8, 56.8)		4.9 (3.3, 7.2)		30.0 (18.0, 45.5)	70.0 (54.5, 82.0)	0.0001
No	95.9 (94.9, 96.8)	32.6 (30.6, 34.7)	67.4 (65.3, 69.4)		95.1 (92.8, 97.7)		11.1 (9.2, 13.3)	88.9 (86.7, 90.8)	
Age									0.2167
18–24	18.2 (16.8, 19.7)	49.3 (45.6, 54.0)	50.7 (46.0, 55.4)		21.2 (18.5, 24.1)		15.5 (10.8, 21.8)	84.5 (78.2, 89.2)	
25–34	81.8 (80.3, 83.2)	32.1 (30.0, 34.4)	67.9 (65.6, 70.1)		78.8 (75.9, 81.5)		11.9 (9.5, 14.7)	88.1 (85.3, 90.5)	
Biological Sex									0.4173
Female	56.7 (54.7, 58.7)	32.2 (29.2, 35.3)	67.8 (64.7, 70.8)		55.0 (51.4, 58.4)		11.2 (8.6, 14.4)	88.8 (85.6, 91.4)	
Male	43.3 (41.4, 45.4)	35.1 (31.9, 38.4)	64.9 (61.6, 68.1)		45.0 (41.5, 48.6)		13.0 (10.0, 16.9)	87.0 (83.2, 90.0)	
Race/ethnicity									0.0075
Non-Hispanic White	66.0 (63.6, 68.4)	35.6 (31.9, 38.3)	64.4 (61.7, 67.1)		64.5 (61.0, 67.8)		14.0 (11.1, 17.4)	86.0 (82.7, 88.9)	
Non-Hispanic Black	12.6 (10.8, 14.5)	25.7 (21.3, 30.6)	74.3 (69.4, 78.7)		12.5 (10.6, 14.8)		5.8 (2.6, 12.5)	94.2 (87.5, 97.4)	
Hispanic	15.2 (13.7, 16.7)	29.7 (24.5, 35.3)	70.3 (64.6, 75.5)		17.0 (14.2, 20.3)		8.1 (4.7, 13.6)	91.9 (86.4, 95.3)	
Non-Hispanic Other	6.2 (5.2, 7.6)	37.6 (29.5, 46.5)	62.4 (53.5, 70.5)		6.0 (4.4, 8.2)		16.7 (8.5, 29.9)	83.3 (70.1, 91.5)	
Highest Level of Education									0.0023
High School/GED	56.0 (53.5, 58.4)	28.5 (25.9, 31.2)	71.5 (68.8, 74.1)		51.6 (47.5, 55.6)		8.0 (5.6, 11.4)	92.0 (88.5, 94.4)	
>High School	44.0 (41.6, 46.5)	39.8 (36.7, 43.0)	60.2 (57.1, 63.3)		48.4 (44.4, 52.5)		16.3 (12.8, 20.5)	83.7 (79.5, 87.2)	
Annual Household Income									0.2657
<\$50,000	71.1 (68.4, 73.6)	32.9 (30.3, 35.5)	67.1 (64.5, 70.0)		69.3 (65.0, 73.4)		11.3 (8.9, 14.3)	88.7 (85.7, 91.1)	
\$50,000	28.9 (26.4, 31.6)	34.6 (30.7, 38.9)	65.4 (61.3, 69.3)		30.7 (26.6, 35.0)		14.0 (10.4, 18.7)	86.0 (81.3, 89.5)	
Cigarette Smoking Frequency									0.0004
Daily Smoking	72.1 (69.7, 74.5)	33.0 (30.5, 35.6)	67.0 (64.4, 69.5)		68.6 (64.7, 72.4)		14.9 (12.2, 18.0)	85.1 (82.0, 87.8)	
Non-Daily Smoking	27.9 (25.6, 30.3)	34.5 (29.8, 39.5)	65.5 (60.5, 70.2)		31.4 (27.6, 35.4)		5.8 (3.5, 9.4)	94.2 (90.6, 96.5)	

	Sample ²		Past-year E-cigarette Use at Wave 5		Sample ³		Past-year E-cigarette Use to Quit Smoking at Wave 5		P-value
	% (95% CI)		Yes	No	% (95% CI)		Yes	No	
	N=2,664		33.4%	66.6%	N=948		12.0%	88.0%	0.0023
Time to Smoke the First Cigarette After Waking									
>60 minutes	31.1 (28.9, 33.4)	34.7 (30.6, 39.1)	65.3 (60.9, 69.4)		35.1 (31.6, 38.8)		8.9 (5.9, 13.1)	91.1 (86.9, 94.1)	
31–60 minutes	17.9 (16.3, 19.6)	33.7 (29.2, 38.5)	66.3 (61.5, 70.8)		20.7 (17.8, 24.0)		14.9 (10.7, 20.4)	85.1 (79.6, 89.3)	
6–30 minutes	31.9 (29.8, 34.1)	33.0 (29.5, 36.7)	67.0 (63.3, 70.5)		28.9 (25.7, 32.5)		12.4 (8.9, 17.0)	87.6 (83.1, 91.1)	
5 minutes	19.1 (17.2, 21.1)	32.2 (28.0, 36.6)	67.8 (63.4, 71.9)		15.3 (12.6, 18.3)		14.5 (8.6, 23.3)	85.5 (76.7, 91.4)	0.1852
Past-Year Quitting Smoking Cigarettes									
Yes	35.1 (33.1, 37.2)	34.4 (30.8, 38.2)	65.6 (61.8, 69.2)		53.6 (50.1, 57.2)		10.6 (8.0, 13.9)	89.4 (86.1, 92.0)	
No	64.9 (62.8, 66.9)	33.1 (30.6, 35.7)	66.9 (64.3, 69.4)		46.4 (42.8, 49.9)		13.7 (10.6, 17.6)	86.3 (82.4, 89.4)	
Past-Month Tobacco Advertising Exposure									
Yes	56.6 (54.3, 58.9)	37.9 (35.4, 40.5)	62.1 (59.3, 64.7)		56.7 (52.7, 50.7)		15.6 (12.6, 19.1)	84.4 (80.9, 87.4)	0.0001
No	43.4 (41.1, 45.7)	27.6 (24.9, 30.5)	72.4 (69.5, 75.1)		43.3 (39.4, 47.3)		7.3 (5.3, 10.0)	92.7 (90.0, 94.8)	
Past-Year Cigarette Price Promotion Receipt									
Yes	42.7 (40.2, 45.3)	36.4 (33.2, 39.8)	63.6 (60.0, 66.8)		46.2 (41.5, 51.1)		14.8 (11.4, 18.9)	85.2 (81.1, 88.6)	0.0350
No	57.3 (54.7, 59.8)	31.2 (28.8, 33.7)	68.8 (66.3, 71.2)		53.8 (49.0, 58.5)		9.6 (7.2, 12.7)	90.4 (87.3, 92.7)	

¹ Percentages are weighted estimates

² Bolded text represents $p < 0.05$

³ P-value for testing group difference

Table 2.

The Associations Between Receiving E-cigarette Price Promotions at Wave 4 and Past-Year E-cigarette Use (to Quit Smoking Cigarettes) at Wave 5 Among Young Adult Established, Current Smokers Who Did Not Use E-cigarettes at Wave 4 (18–34 years): Population Assessment of Tobacco and Health Study Youth Surveys Waves 4 (2016–2018) and 5 (2018–2019)¹

	Past-year E-cigarette Use at Wave 5 ¹	Past-year E-cigarette Use to Quit Smoking at Wave 5 ²
	AOR (95% CI)	AOR (95% CI)
E-cigarette Price Promotion Receipt		
Yes	2.07 (1.31, 3.27)	3.20 (1.48, 6.90)
No	Reference	Reference
Age		
18–24	2.35 (1.87, 2.94)	3.20 (1.48, 6.90)
25–34	Reference	Reference
Biological Sex		
Female	1.03 (0.82, 1.30)	1.06 (0.66, 1.72)
Male	Reference	Reference
Race/ethnicity		
Non-Hispanic White	Reference	Reference
Non-Hispanic Black	0.65 (0.49, 0.86)	0.46 (0.16, 1.35)
Hispanic	0.82 (0.59, 1.12)	1.03 (0.49, 2.16)
Non-Hispanic Other	0.91 (0.63, 1.33)	1.52 (0.61, 3.81)
Highest Level of Education		
High School/GED	Reference	Reference
>High School	1.50 (1.21, 1.86)	2.44 (1.37, 4.33)
Annual Household Income		
<\$50,000	Reference	Reference
\$50,000	0.85 (0.66, 1.11)	0.60 (0.30, 1.20)
Cigarette Smoking Frequency		
Daily	Reference	Reference
Non-Daily	1.09 (0.81, 1.46)	0.47 (0.22, 1.00)
Time to Smoke the First Cigarette After Waking		
>60 minutes	0.96 (0.71, 1.30)	0.64 (0.25, 1.66)
31–60 minutes	1.00 (0.74, 1.35)	1.08 (0.51, 2.30)
5–30 minutes	0.96 (0.74, 1.25)	0.64 (0.30, 1.38)
5 minutes	Reference	Reference
Past-Year Quitting Smoking Cigarettes		
Yes	1.00 (0.80, 1.24)	0.91 (0.57, 1.46)
No	Reference	Reference
Past-Month Tobacco Advertising Exposure		
Yes	1.51 (1.27, 1.81)	1.77 (1.08, 2.90)
No	Reference	Reference

	Past-year E-cigarette Use at Wave 5 ¹	Past-year E-cigarette Use to Quit Smoking at Wave 5 ²
	AOR (95% CI)	AOR (95% CI)
Past-Year Cigarette Price Promotion Receipt		
Yes	1.05 (0.86, 1.28)	1.34 (0.74, 2.41)
No	Reference	Reference

¹ **Bolded text represents $p < 0.05$**

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