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Home e-cigarette rules and youth's vulnerability to initiate and sustain e-cigarette use

Anne Buu, PhD^a, Joon Kyung Nam, MPH^a, Meng Yang, MPH^b, Wei-Chung Su, PhD^c, Hsien-Chang Lin, PhD^{b,*}

^aDepartment of Health Promotion and Behavioral Sciences, University of Texas Health Science Center, 7000 Fannin St., Houston, TX 77030, USA

^bDepartment of Applied Health Science, School of Public Health, Indiana University-Bloomington, 1025 E. 7th Street, SPH 116, Bloomington, IN 47405, USA

^cDepartment of Epidemiology, Human Genetics & Environmental Sciences, University of Texas Health Science Center, 1200 Pressler St., Houston, TX 77030, USA

Abstract

Existing studies of the impact of home rules on youth's vulnerability to e-cigarette use were based on cross-sectional data, youth or parent reports alone, as well as youth's perceptions and susceptibility. This study capitalizes on the restricted-use data of the Population Assessment of Tobacco and Health (PATH) Study to examine the longitudinal association between home rules for e-cigarette use and youth's vulnerability including initiation of use and regular use two years later. Secondary analysis was conducted on 1,203 parent-youth pairs who participated in both Wave 4 (2016-2018) and Wave 5 (2018-2019) assessment of the PATH Study and while the youth were age 12-16 at Wave 4. Linear and logistic regressions were performed to examine the associations between having a strict home rule for e-cigarette use at Wave 4 and the youth's outcomes including perceived social norms, expectancies, susceptibility, initiation of use, and regular use of e-cigarettes at Wave 5, controlling for parent and youth factors. The results show that having a strict home rule for e-cigarette use was associated with youth's heightened level of perceived injunctive norms ($\beta=0.22$, $p<0.01$), higher expectancy of harmfulness ($\beta=0.28$, $p<0.01$) and lower odds for regular e-cigarette use (OR=0.36, $p<0.05$). In conclusion, the findings of this study support the potential protective effects of implementing a strict home rule for e-cigarette use. Future intervention efforts may promote parents' awareness of the potential protective effects

*Corresponding author: Hsien-Chang Lin, PhD, 1025 E 7th St. SPH 116, Bloomington, IN 47405, USA. Tel.: +1 (812) 855-6197. linhsi@indiana.edu.

Contributors

Dr. Buu conceived the study, provided leadership for the team, secured the grant funding, and drafted the manuscript. Yang conducted literature review, edited the manuscript, and provided critical feedback. Nam conducted literature review, edited the manuscript, and provided critical feedback. Dr. Su conducted literature review, edited the manuscript, and provided critical feedback. Dr. Lin conceived the study, secured the grant funding, conducted statistical analysis, edited the manuscript, and provided critical feedback. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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Conflict of interests

The authors have no competing interests or conflicts to declare.

of a strict home e-cigarette rule on youth's normative belief, harm expectancy, and behavior of e-cigarette use.

Keywords

home rule; e-cigarette use; social norms; expectancies; susceptibility

1. Introduction

Youth's exposure to secondhand e-cigarette aerosol has been a public health concern. The prevalence of exposure to secondhand aerosol from e-cigarettes in an indoor or outdoor *public place* among middle and high school students significantly increased from 26% in 2017 to 33% in 2018, based on cross-sectional data from the National Youth Tobacco Survey (NYTS) (Dai, 2020). Studies have shown that the exposure to secondhand e-cigarette aerosol may pose a risk of exposure to potentially harmful toxicants (Farsalinos et al., 2015; Su et al., 2021; Su, Wong, & Buu, 2021). Dai's study (Dai, 2020) found that exposure to secondhand e-cigarette aerosol has been shown to be associated with adverse tobacco use outcomes; students with such exposure tended to have higher odds of susceptibility to use e-cigarettes and cigarettes (i.e., an openness to future use). Notably, the prevalence of e-cigarette use among U.S. youth significantly increased from 2011 (1.5%) to 2018 (20.8%) (Cullen et al., 2018). Importantly, another study conducting secondary analysis on the NYTS data indicated that youth living with a household member who used e-cigarettes reported more than a threefold higher prevalence of secondhand aerosol exposure in public places than youth with either no tobacco user in their household or those with a household member who used other forms of tobacco (Agaku, Perks, Odani, & Glover-Kudon, 2020). Given this finding and the fact that youth spend more time at home than in public places, the potential impact of youth's exposure to e-cigarette use in *private homes* should not be overlooked.

Living with a smoker/e-cigarette user and whether having an e-cigarette use rule in private homes could be linked to the level of children's exposure to secondhand tobacco smoke/aerosol and potentially children's tobacco use outcomes. According to the ecological systems theory (Bronfenbrenner, 1979), adolescent development is influenced by multiple levels of the surrounding environment with the most immediate influence coming from parents. By setting a home rule for e-cigarette use, parents could initiate an interaction with other influences such as peers and teen culture and thus may impact their teenage children's social norm, e-cigarette use expectancy, susceptibility, initiation, and progression to regular use. Based on the 2018 Minnesota Adult Tobacco Survey, 82% of current smokers who lived with children had smoke-free home rules, whereas only 29% of e-cigarette using adults who lived with children reported e-cigarette-free home rules (Helgertz, Claire, & Kingsbury, 2020). In fact, one study found that children living with e-cigarette users were exposed to nicotine (measured by urinary cotinine) at levels comparable to children living with cigarette smokers (Tackett et al., 2021). Furthermore, a study used data from the 2016 Florida Youth Tobacco Survey found that living with an e-cigarette user and living in a home that allows tobacco use were both associated with increased odds of youth's susceptibility to e-cigarette and cigarette use (Bayly et al., 2019). These findings confirmed the importance

of investigating the impact of exposure to e-cigarette use and having an e-cigarette use rule in private homes on youth's e-cigarette use and susceptibility.

Nevertheless, these existing studies of the impact of home rules on youth's vulnerability to initiate and sustain e-cigarette use have important limitations. First, the findings of these studies (Bayly et al., 2019; Helgertz et al, 2020; Tackett et al., 2021) were based on cross-sectional data so the temporal relationship cannot be established. Second, youth reports and parent reports were examined in separate studies (see Bayly et al., 2019; Helgertz et al, 2020), making it impossible to examine the association between parental rules/ characteristics and youth behavioral outcomes without reporting bias from the same source. Third, previous studies (e.g., Bayly et al., 2019) focused on youth's perceptions of social norms, harmfulness, and susceptibility rather than progression to onset of use or regular use that are more likely to lead to negative health consequences. The Population Assessment of Tobacco and Health (PATH) Study conducted longitudinal surveys on representative samples of adults and youth in the United States. This present study conducted secondary analysis on the restricted-use data of PATH Study, which allows the linkage between the parent report and youth report from the same household, to examine the longitudinal association between home e-cigarette use rules and youth's vulnerability to initiate and sustain e-cigarette use including perceived social norms, expectancies, susceptibility, initiation of use, and regular use two years later.

2. Methods

2.1 Data and Study Sample

The PATH Study is a longitudinal survey study conducted by the National Institutes of Health and Food and Drug Administration in the United States to comprehensively assess tobacco and e-cigarette use related issues among a representative adult sample and a representative youth sample (United States Department of Health Human Services, 2022). The PATH Study sampled households that had adults, and then sampled youth (aged 12-17) within the sampled households (United States Department of Health Human Services, 2022). The present study conducted secondary analysis on the Wave 4 (December 2016 – January 2018) and Wave 5 (December 2018 – November 2019) data from the Wave 4 cohort. The inclusion criteria of the present study were: (1) youth participants with a parent participating in the adult survey so they can form parent-youth pairs; (2) participation in both Wave 4 and Wave 5 assessments; (3) youth who were 14-17 years old at Wave 5 (corresponding to ages 12-16 at Wave 4). These criteria resulted in 1,203 parent-youth pairs (weighted N=2,958,027) who represented the general households with at least a parent and an adolescent child. The data from these 1,203 pairs were used for the analysis with perceived social norms, expectancies, and susceptibility as outcomes. For the analysis with initiation of e-cigarette use as the outcome, the sample was reduced to 1,059 pairs (weighted N=2,597,659) with the youth who had never used e-cigarettes at Wave 4. For the analysis involving regular e-cigarette use as the outcome, the sample was limited to 302 pairs (weighted N=768,293) with the youth who had ever used e-cigarettes at Wave 5. The use of the restricted-use PATH Study data was deemed exempt from review by the Institutional Review Board of the corresponding author's institution.

2.2 Measures and Variables

2.2.1 Outcomes: youth's vulnerability to initiate and sustain e-cigarette use at Wave 5: Multiple youth's outcomes were included in analysis: perceived social norms, expectancies, susceptibility, initiation of use, and regular use. The perceived descriptive norm was assessed by the survey question "how many of your best friend use e-cigarettes" on an ordinal scale of 1 (none) to 5 (all). The perceived injunctive norm was assessed by the survey question "people who are important to you: their views on using e-cigarettes" on the scale of 1 (very positive) to 5 (very negative). The e-cigarette expectancy of harmfulness to health was assessed by the survey item "harmfulness of e-cigarettes or other electronic nicotine products to health" on the scale from 1 (not at all harmful) to 5 (extremely harmful). The e-cigarette expectancy of addiction liability was assessed by the survey item "likeliness of someone addicted to e-cigarettes or other electronic nicotine products" on the scale from 1 (very unlikely) to 5 (very likely). Further, the PATH Study inquired about e-cigarette susceptibility using three questions each of which was responded on an ordinal scale of 1 (very curious/definitely yes) to 4 (not at all curious/definitely not): (1) Have you ever been curious about using e-cigarettes? (2) Do you think you will try an e-cigarette soon? (3) If one of your best friends were to offer you an e-cigarette, would you use it? In our analysis, a binary variable for susceptibility was coded as the case if a participant answered "very curious/definitely yes" to any of the 3 questions (Chen-Sankey, Kong, & Choi, 2019). Moreover, the youth who had never used e-cigarettes at Wave 4 but reported ever use at Wave 5 was defined as the case for e-cigarette use initiation. The youth who reported they "ever used e-cigarette fairly regularly" at Wave 5 was defined as the case for regular e-cigarette use (the control was the youth who simply reported ever using e-cigarettes at Wave 5), which is in line with the literature (e.g., Coleman et al., 2019; Rodu & Plurphanswat, 2018; Pérez et al., 2020; Nicksic et al., 2019).

2.2.2 Main predictor: having a home rule for e-cigarette use at Wave 4: The PATH Study question concerning "rules about using e-cigarettes or other electronic nicotine products inside home" self-reported by parents provided three choices: (1) it is not allowed anywhere or at any time inside my home; (2) it is allowed in some places or at some time inside my home; and (3) it is allowed anywhere and at any time inside my home. Our preliminary analysis did not find any difference with respect to the covariates between having a partial rule and no rule, and therefore we aggregated them and treated the home rule as a binary variable (i.e., with a strict rule or not) in all analysis.

2.2.3 Covariates: characteristics of parents and youth at Wave 4: Based on previous studies that investigated household restrictions for smoking (Shavers et al., 2006; Bolte et al., 2009), the following parents' sociodemographic characteristics were included in the analysis: age (in years), gender (female as the reference), race/ethnicity (non-Hispanic white; non-Hispanic black; Hispanic; and other), education (less than high school, high school graduate/GED, college no degree/associate degree, and bachelor's or advanced degree), employment (not currently working; part-time job; and full-time job), and home ownership (own; rent; and other). Parents' current tobacco use status (defined as using every day or some day in past 30 days) was also included, which was indicated by two binary variables: current e-cigarette use; and current use of other tobacco products

(including cigarettes, traditional cigars, cigarillos, filtered cigars, pipe tobacco, hookah, snus pouches, other smokeless tobacco, and dissolvable tobacco.) In addition, parents' perceived harmfulness of e-cigarettes was included and measured by ordinal categorical variables including not at all harmful, slightly harmful, somewhat harmful, very harmful, and extremely harmful. Further, youth's characteristics were included, such as age (in years), gender, and Grade Point Average (A, B, C, and D and below).

2.3 Statistical Analysis

Descriptive statistics, means with standard deviations or frequencies with percentages, were calculated for continuous/ordinal variables or categorical variables, respectively. Two-sample t tests and Chi-square tests were used to examine differences between the groups with and without a strict rule for e-cigarette use at home on the two types of variables, respectively. Further, linear regression (for continuous outcomes) or logistic regression (for binary outcomes) was adopted to investigate the longitudinal association between Wave 4 home e-cigarette use rules and youth's vulnerability to initiate and sustain e-cigarette use at Wave 5, controlling for parental factors, and youth factors. Note that the associations of having a strict home e-cigarette use rule with Wave 5 e-cigarette susceptibility and initiation were examined on only those who were never e-cigarette users at Wave 4 (i.e., those who were at risk for Wave 5 susceptibility and initiation); and the association between having a strict home e-cigarette use rule and regular e-cigarette use status were examined on only those who were ever e-cigarette users at Wave 5. All parameters were estimated with Wave 5 "all-wave" survey sample weights and the balanced repeated replication method (Fay=0.3) was used to calculate the standard errors. All analyses were conducted using Stata 17.

3. Results

Table 1 shows the descriptive statistics of parent factors, youth factors, and youth e-cigarette outcomes by the home e-cigarette use rule groups (with hypothesis testing results for group differences) and for the entire sample. The parent sample at Wave 4 was characterized by the mean age of 41; 69% females; 58% non-Hispanic white, 17% non-Hispanic black, and 20% Hispanic; 65% had a college/associate or higher degree; 58% with full-time jobs; and 55% with home ownership. The youth sample at Wave 4 had the mean age of 14, and 46% females. There were 76% households that had a strict home rule for e-cigarette use. The parents with a strict rule tended to be older, Hispanic, employed, and homeowners. They also perceived e-cigarette use as more harmful. A lower proportion of them used e-cigarettes (3% vs. 21%) or other tobacco products (31% vs. 70%). Furthermore, youth in the households with a strict e-cigarette use rule tended to have a higher GPA, perceive a higher injunctive norm (i.e., disapproval of use by others), and expect e-cigarette use to lead to harmfulness and addiction.

Table 2 depicts the results of linear regressions that examined the effects of home e-cigarette use rules on youth's perceived social norms and e-cigarette use expectancies two years later, controlling for parents' and youth's characteristics. A strict home rule for e-cigarette use was significantly associated with a higher level of perceived disapproval of e-cigarette use by others (i.e., injunctive norm) ($\beta=0.22$, $p<0.01$) and higher expectancy

of harmfulness resulting from e-cigarette use ($\beta=0.28, p<0.01$). Yet, it did not have a significant effect on youth's descriptive norm (i.e., best friends' e-cigarette use) or expectancy of addiction resulting from e-cigarette use. Some of the parents' characteristics were associated with youth's perceived social norms. Youth with non-Hispanic black or Hispanic parents perceived that fewer best friends were e-cigarette users, compared to those with non-Hispanic white parents. Youth with parents who were employed, less educated, and current users of other tobacco products tended to perceive greater approval of using e-cigarettes by others. Some of the youth's characteristics were also associated with youth's social norms and e-cigarette use expectancies. Older youth tended to perceive more best friends as e-cigarette users and expect e-cigarette use to be less harmful. Female youth were more likely to perceive more best friends to be e-cigarette users and perceive e-cigarette use to be better approved by others and yet expected e-cigarette use to be more harmful.

Table 3 shows the results of logistic regressions that examined the effects of home e-cigarette use rules on youth's likelihood to be susceptible to e-cigarette use, initiate e-cigarette use, and involve in regular e-cigarette use, controlling for parents' and youth's characteristics. Youth living in households with a strict rule for e-cigarette use were less likely to be involved in regular e-cigarette use (odds ratio [OR]=0.36, 95% CI: 0.16, 0.85, $p<0.05$). The strict home rule, however, was not significantly associated with youth's susceptibility and initiation. In comparison to youth with non-Hispanic white parents, those with non-Hispanic black parents were less likely to be susceptible to e-cigarette use and initiate e-cigarette use. Youth with parents who worked full-time were more likely to be susceptible to e-cigarette use compared to those with parents who were not currently working. In terms of youth characteristics, female youth had higher odds to be susceptible to e-cigarette use. Youth with lower GPA were more likely to initiate e-cigarette use.

4. Discussion

This secondary analysis study capitalizes on the restricted-use data of PATH Study that makes it possible to examine the longitudinal association between home rules for e-cigarette use and youth's vulnerability to initiate and sustain e-cigarette use including perceived social norms, expectancies, susceptibility, initiation of use, and regular use two years later. The results show that a strict home rule for e-cigarette use was associated with youth's heightened level of perceived injunctive norms (i.e., disapproval of e-cigarette use by important people), higher expectancy of harmfulness resulting from e-cigarette use, and lower odds for involving in regular e-cigarette use, adjusting for the effects of parents' and youth's characteristics.

Although our findings indicated some positive associations between strict home rules for e-cigarette use and youth's e-cigarette use outcomes, such rules specifically for e-cigarette use in the home may still be under-implemented. A previous study found that parents who were dual users of cigarettes and e-cigarettes were more likely to have a smoke-free home (64%) than a e-cigarette-free home (26%) (Drehmer et al., 2019). These findings of survey studies imply that parents may perceive e-cigarette use in the home as less pernicious to their youth's health. Indeed, a recent study comparing three types of caregivers (cigarette-exclusive, e-cigarette-exclusive, and non-users) and their children showed that e-cigarette

users rated e-cigarette products as less harmful than the other two groups and reported greater child secondhand exposure than caregivers using cigarettes (Tackett et al., 2021). In fact, evidence supporting potential health effects of secondhand exposure to aerosol from e-cigarette products have been emerging, such as considerable nicotine levels in youth's bodies (Quintana et al., 2021; Tackett et al., 2021), asthma symptoms (Alnajem et al., 2020), acute ocular and nasal irritation, as well as persistent throat-respiratory symptoms (Amalia et al., 2021; Tzortzi et al., 2020; Tzortzi et al., 2018). Nevertheless, according to a systematic review and meta-analysis of 18 randomized controlled trials that aimed to reduce/stop parental smoking for children's benefit, quit rates (approximately 23%) in the intervention group across trials indicated that most parents still continued to smoke even after being fully aware of the risk of secondhand exposure (Rosen et al., 2012), which might be applicable to parental e-cigarette use. Taken together, educational interventions that can enhance parents' understanding of the harmfulness of secondhand e-cigarette aerosol as well as the potential protective effect of home rules for e-cigarette use are warranted.

The findings of this study supported the potential protective effects of home rules for e-cigarette use through influencing youth's perceived social norms and perceived harmfulness of e-cigarette use, even after adjusting for parental tobacco use. Interestingly, a strict home rule for e-cigarette use was associated with youth's perceived injunctive norm but not their perception of the descriptive norm. This implies that a home rule is probably not sufficient to prevent youth from hanging out with e-cigarette using peers. Yet, it still provides layers of protection through heightening their awareness of disapproval of e-cigarette use by people important to them, as well as their expectancy of the harmfulness associated with e-cigarette use.

Notably, unlike youth's expectancy of harmfulness associated with e-cigarette use, we did not find that a strict home rule for e-cigarette use was associated with youth's expectancy of addiction, possibly due to their lack of full awareness of the nicotine content and its addictive potential (Gorukanti et al., 2017; Owotomo, Maslowsky, & Loukas, 2018). Another interesting finding is that having home e-cigarette use rules was significantly associated with youth's involvement in regular e-cigarette use but not associated with their susceptibility and initiation of e-cigarette use. This implies that implementing a strict rule for e-cigarette use at home may not fully prevent youth from being curious about or even experimenting with these tobacco products. Yet, it may protect them from further progress into regular use. Additional studies are needed to confirm these results.

Our findings show significant associations between some of the covariates and youth's normative belief and expectancy of e-cigarette use. These findings may reflect the higher prevalence of e-cigarette use among non-Hispanic white, older, and female youth in the U.S. (Bold et al., 2018; Kong et al., 2017; Wang et al., 2021). Additionally, this study found that parents' tobacco use was negatively associated with youth's perceived disapproval of e-cigarette use by people important to them (i.e., injunctive norm). While anti-e-cigarette campaigns have focused on young people (Hair et al., 2021), these findings stress the importance of parental involvement in combating the youth e-cigarette epidemic.

Some limitations of this secondary analysis study are important to note. First, the PATH Study is an observational study so the results are potentially impacted by uncontrolled confounding factors. Second, parental tobacco use and youth e-cigarette use examined in this study are both based on self-reported survey data without being validated by biomarkers. Third, the high percentage of female parents (69%) in our study sample of parent-youth pairs unavoidably introduces biases from parents' reports, especially given that discrepancies in parental reports on a home smoking ban among two-parent households have been found in national surveys (Zhang et al., 2012). Thus, the generalizability of findings to all households is not warranted. Finally, although we implemented a longitudinal design for this study, causality cannot be guaranteed. There may be some reverse causation such as the home e-cigarette use rule may be a marker of parental e-cigarette use.

Despite the aforementioned limitations, this study has many strengths including the longitudinal design, national representative samples, the capacity to link parent reports and youth reports in the same study, and a comprehensive examination of youth's vulnerability to initiate and sustain e-cigarette use. The findings of this study support the potential protective effects of implementing a strict home rule for e-cigarette use, including heightening youth's awareness of disapproval of e-cigarette use by people important to them and their perceived harmfulness of e-cigarette use, as well as preventing them from progression into regular use. Future intervention efforts may promote parents' awareness of the potential protective effects of a strict home e-cigarette rule on youth's normative belief, harm expectancy, and behavior of e-cigarette use.

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Highlights

- Having a home e-cigarette rule was associated with youth e-cigarette use, such as:
 - 1) Heightened level of perceived injunctive norms toward e-cigarette use
 - 2) Higher e-cigarette expectancy of harmfulness
 - 3) Lower odds for regular e-cigarette use
- There may be protective effects of implementing a strict home e-cigarette rule.

Table 1:

Descriptive statistics of study sample

	N (%) or Mean (SD)			P-value
	Home e-cigarette rule: partial or no rule n=278 (23.69%)	Home e-cigarette rule: strict n=925 (76.31%)	Overall N=1,203	
1. Parent factor (Wave 4):				
Age	39.46 (8.38)	40.95 (9.85)	40.62 (9.56)	0.0255
Gender				
Male	70 (26.20%)	288 (32.06%)	358 (30.67%)	0.072
Female	208 (73.80%)	636 (67.94%)	844 (69.33%)	
Race/ethnicity				
Non-Hispanic White	174 (67.19%)	462 (54.52%)	636 (57.52%)	0.001
Non-Hispanic Black	56 (18.50%)	150 (16.28%)	206 (16.80%)	
Hispanic	32 (10.05%)	250 (22.45%)	282 (19.52%)	
Other	13 (4.26%)	56 (6.75%)	69 (6.16%)	
Education				<0.001
Less than high school	33 (10.82%)	118 (11.03%)	151 (10.98%)	
High school graduate/GED	79 (28.64%)	226 (22.96%)	305 (25.42%)	
College no degree/Associate degree	126 (45.20%)	325 (27.52%)	451 (37.39%)	
Bachelor's/Advanced	39 (15.34%)	254 (31.03%)	293 (27.33%)	
Employment				
Not currently working	86 (29.92%)	213 (21.88%)	299 (23.79%)	0.049
Part time job	44 (16.43%)	173 (19.06%)	217 (18.43%)	
Full time job	148 (53.65%)	535 (59.07%)	683 (57.78%)	
Own or rent home				
Own	126 (47.11%)	513 (57.53%)	639 (55.05%)	0.0336
Rent	132 (45.58%)	353 (36.53%)	485 (38.68%)	
Other	20 (7.31%)	56 (5.94%)	76 (6.27%)	
Use e-cigarettes				
No	220 (79.39%)	901 (97.32%)	1,121 (93.08)	<0.001
Yes	58 (20.61%)	24 (2.68%)	82 (6.93%)	
Use other tobacco products				
No	82 (29.81%)	632 (68.78%)	714 (59.55%)	<0.001
Yes	196 (70.19%)	293 (31.22%)	489 (40.45%)	
Perceived e-cigarette harmfulness				<0.001
Not at all harmful	12 (4.29%)	4 (0.38%)	16 (1.31%)	
Slightly harmful	45 (16.84%)	45 (5.32%)	90 (8.04%)	
Somewhat harmful	101 (36.47%)	221 (24.33%)	322 (27.19%)	
Very harmful	61 (22.93%)	350 (38.07%)	411 (34.49%)	
Extremely harmful	55 (19.46%)	299 (31.91%)	354 (28.97%)	
2. Youth factor (Wave 4)				

	N (%) or Mean (SD)			P-value
	Home e-cigarette rule: partial or no rule n=278 (23.69%)	Home e-cigarette rule: strict n=925 (76.31%)	Overall N=1,203	
Age	13.52 (1.15)	13.55 (1.09)	13.55 (1.11)	0.7539
Gender				
Male	149 (55.03%)	491 (53.20%)	640 (53.64%)	0.63
Female	128 (44.97%)	432 (46.80%)	560 (46.36%)	
GPA				<0.001
A	136 (48.54%)	554 (61.38%)	690 (58.35%)	
B	83 (31.35%)	266 (28.47%)	349 (29.15%)	
C	47 (16.18%)	81 (7.83%)	128 (9.81%)	
D and below	10 (3.93%)	20 (2.32%)	30 (2.70%)	
3. Youth e-cigarette outcomes (Wave 5)				
Perceived social norm: Descriptive	1.98 (1.16)	1.81 (1.06)	1.85 (1.08)	0.058
Perceived social norm: Injunctive	3.70 (1.05)	4.16 (1.00)	4.05 (1.03)	<0.001
E-cigarette use expectancy:				
Harmfulness	3.70 (1.07)	4.04 (1.03)	3.96 (1.05)	<0.001
E-cigarette use expectancy:				
Addiction	4.03 (1.06)	4.19 (1.01)	4.15 (1.02)	0.0348
E-cigarette use susceptibility ^a				
Yes	59 (36.35%)	219 (33.02%)	278 (33.72%)	0.453
No	110 (63.65%)	438 (66.98%)	548 (66.28%)	
E-cigarette use initiation ^a				
Yes	55 (24.88%)	172 (21.91%)	227 (22.55%)	0.382
No	168 (75.12%)	655 (78.09%)	823 (77.45%)	
Regular e-cigarette use ^b				
Yes	28 (35.19%)	54 (24.63%)	82 (27.72%)	0.113
No	59 (64.81%)	161 (75.37%)	220 (72.28%)	

*
 $p < 0.05$

**
 $p > 0.01$

 $p > 0.001$

^a Among participants who were never e-cigarette users at Wave 4 and provided susceptibility and initiation information at Wave 5 (i.e., those who were at risk for Wave 5 susceptibility)

^b Among participants who were ever e-cigarette users at Wave 5

n's are unweighted; percentages, means, and SDs are weighted

Table 2:

Associations of having a strict house e-cigarette rule with youth's later perceived social norms and e-cigarette use expectancies from weighted linear regressions

	Perceived social norm: Descriptive		Perceived social norm: Injunctive		E-cigarette use expectancy: Harmfulness		E-cigarette use expectancy: Addiction	
	β	(SE)	β	(SE)	β	(SE)	β	(SE)
1. Home e-cigarette rule (W4):								
Partial or no rule	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Strict rule	-0.040	0.093	0.22**	0.079	0.28**	0.10	0.15	0.092
2. Parent factor (W4):								
Age	0.0041	0.0038	-0.0021	0.0031	-0.0035	0.0038	0.00087	0.0039
Gender: Female	-0.070	0.078	-0.088	0.079	0.10	0.077	-0.016	0.079
Race/ethnicity:								
Non-Hispanic White	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Non-Hispanic Black	-	0.096	0.18	0.097	0.14	0.080	-0.033	0.099
Hispanic	0.54*** -0.28*	0.11	0.11	0.093	-0.052	0.11	-0.057	0.077
Other	-0.077	0.13	0.032	0.13	0.034	0.14	0.039	0.11
Education								
Less than high school	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
High school graduate/GED	0.0076	0.12	0.11	0.11	-0.084	0.12	0.024	0.11
College no degree/Associate degree	0.077	0.12	0.029	0.11	-0.050	0.13	0.059	0.10
Bachelor's/Advanced	0.030	0.12	0.29*	0.12	-0.018	0.12	0.055	0.13
Employment								
Not currently working	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Part-time	0.14	0.11	-0.22**	0.079	-0.18	0.093	0.044	0.10
Full-time	0.14	0.077	-0.19*	0.079	-0.14	0.077	-0.031	0.096
Own or rental home								
Own	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Rent	-0.076	0.074	-0.11	0.072	0.011	0.072	0.022	0.076
Other	-0.051	0.13	-0.22	0.14	-0.027	0.14	-0.20	0.16
Use e-cigarettes: yes	0.28	0.17	-0.27	0.15	0.13	0.14	0.22*	0.11
Use other tobacco products: yes	0.12	0.072	-0.34***	0.074	-0.054	0.089	-0.0033	0.082
Perceived e-cig harmfulness								
Not at all harmful	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Slightly harmful	-0.037	0.34	-0.13	0.29	-0.25	0.28	0.43	0.26
Somewhat harmful	-0.14	0.29	-0.16	0.26	-0.014	0.24	0.31	0.23
Very harmful	-0.069	0.30	-0.071	0.27	0.022	0.25	0.40	0.23
Extremely harmful	-0.074	0.31	0.00026	0.28	0.16	0.27	0.44	0.25
3. Youth factor (W4):								

	Perceived social norm: Descriptive		Perceived social norm: Injunctive		E-cigarette use expectancy: Harmfulness		E-cigarette use expectancy: Addiction	
	β	(SE)	β	(SE)	β	(SE)	β	(SE)
Age	0.12***	0.031	-0.022	0.029	-0.079**	0.026	-0.040	0.029
Gender: Female	0.16**	0.059	-0.17**	0.065	0.14*	0.064	0.077	0.063
GPA								
D and below	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
C	-0.18	0.25	0.19	0.21	0.19	0.22	-0.16	0.23
B	-0.25	0.22	0.040	0.19	0.22	0.23	-0.016	0.23
A	-0.31	0.22	0.15	0.18	0.33	0.22	0.14	0.21
Unweighted N	1,171		1,161		1,168		1,167	

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

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Table 3:

Associations of having a strict home rule for e-cigarette use with youth's later e-cigarette use susceptibility, initiation, and regularity from weighted logistic regressions

	E-cigarette use susceptibility ^a		E-cigarette use initiation ^a		Regular e-cigarette use ^b	
	OR	95% CI	OR	95% CI	OR	95% CI
1. Home e-cigarette rule (W4):						
Partial or no rule	Ref	Ref	Ref	Ref	Ref	Ref
Strict rule	0.80	(0.51, 1.26)	1.14	(0.69, 1.90)	0.36*	(0.16, 0.85)
2. Parent factor (W4):						
Age	1.02	(0.99, 1.04)	1.00	(0.98, 1.02)	1.00	(0.95, 1.05)
Gender: Female	0.97	(0.66, 1.44)	1.08	(0.74, 1.56)	0.46*	(0.21, 0.99)
Race/ethnicity:						
Non-Hispanic White	Ref	Ref	Ref	Ref	Ref	Ref
Non-Hispanic Black	0.58*	(0.35, 0.95)	0.28***	(0.14, 0.56)	0.34	(0.093, 1.26)
Hispanic	1.03	(0.65, 1.65)	0.59	(0.34, 1.03)	0.89	(0.29, 2.74)
Other	1.08	(0.53, 2.20)	0.28*	(0.090, 0.85)	0.60	(0.056, 6.51)
Parent education						
Less than high school	Ref	Ref	Ref	Ref	Ref	Ref
High school graduate/GED	0.93	(0.53, 1.63)	1.34	(0.64, 2.80)	1.60	(0.35, 7.29)
College no degree/Associate degree	0.98	(0.56, 1.71)	1.49	(0.73, 3.04)	3.37	(0.72, 15.9)
Bachelor's/Advanced	1.31	(0.72, 2.36)	1.09	(0.53, 2.23)	3.01	(0.47, 19.1)
Parent employment						
Not currently working	Ref	Ref	Ref	Ref	Ref	Ref
Part-time	1.62	(0.90, 2.95)	1.11	(0.64, 1.95)	2.31	(0.72, 7.36)
Full-time	1.70*	(1.05, 2.77)	1.04	(0.69, 1.58)	1.63	(0.70, 3.81)
Own or rental home						
Own	Ref	Ref	Ref	Ref	Ref	Ref
Rent	1.03	(0.66, 1.61)	0.76	(0.48, 1.19)	0.99	(0.51, 1.95)
Other	1.50	(0.71, 3.18)	0.83	(0.34, 2.04)	0.20	(0.020, 2.01)
Use e-cigarettes: yes	1.37	(0.56, 3.39)	1.50	(0.77, 2.91)	1.08	(0.38, 3.12)
Use other tobacco products: yes	1.05	(0.68, 1.61)	1.43	(0.91, 2.24)	0.58	(0.25, 1.33)
Perceived e-cig harmfulness						
Not at all harmful	Ref	Ref	Ref	Ref	Ref	Ref
Slightly harmful	1.63	(0.26, 10.4)	2.17	(0.42, 11.1)	1.34	(0.029, 61.9)
Somewhat harmful	1.10	(0.17, 7.17)	1.66	(0.35, 7.89)	1.38	(0.040, 48.2)
Very harmful	1.35	(0.20, 8.94)	1.42	(0.31, 6.41)	1.67	(0.039, 72.3)
Extremely harmful	1.10	(0.16, 7.73)	1.33	(0.29, 6.18)	1.41	(0.032, 61.8)
3. Youth factor (W4):						
Age	1.03	(0.87, 1.22)	1.12	(0.95, 1.31)	1.34	(0.97, 1.85)
Gender: Female	1.83***	(1.31, 2.56)	1.15	(0.84, 1.59)	1.94	(0.90, 4.22)

	E-cigarette use susceptibility ^a		E-cigarette use initiation ^a		Regular e-cigarette use ^b	
	OR	95% CI	OR	95% CI	OR	95% CI
GPA						
D and below	Ref	Ref	Ref	Ref	Ref	Ref
C	0.93	(0.14, 6.34)	0.22*	(0.069, 0.72)	1.50	(0.41, 5.57)
B	0.69	(0.11, 4.49)	0.35	(0.11, 1.18)	0.47	(0.12, 1.75)
A	0.83	(0.12, 5.57)	0.27*	(0.087, 0.86)	0.29	(0.079, 1.07)
Unweighted N	807		1,027		293	

*
 $p < 0.05$

 $p < 0.001$

^a Among participants who were never e-cigarette users at Wave 4 and provided susceptibility and initiation information at Wave 5 (i.e., those who were at risk for Wave 5 susceptibility)

^b Among participants who were ever e-cigarette users at Wave 5