Prospective Predictors of Novel Tobacco and Nicotine Product Use in Emerging Adulthood

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Abstract

Objective—To investigate whether risk factors for cigarette smoking assessed in adolescence predict the use of novel tobacco and nicotine products (hookah, little cigars, and e-cigarettes) in early emerging adulthood.

Methods—In a longitudinal study (N = 862), risk factors were measured in middle and high school and novel product use was measured in emerging adulthood (mean age 22.4 years). Structural equation modelling was used to test a model predicting lifetime use of any of hookah, little cigars, and e-cigarettes in early emerging adulthood from distal predictors (gender, maternal smoking through Grade 8, already tried alcohol, cigarettes, or marijuana by Grade 8, and sensation seeking at Grade 8), and potential mediators (intentions to smoke cigarettes, drink alcohol or smoke marijuana at Grade 9, and smoking trajectory across high school).

Results—The most prevalent novel tobacco product was hookah (21.7%), followed by little cigars (16.8%), and e-cigarettes (6.6%). Maternal smoking, having already tried substances, and sensation seeking each predicted the use of at least one of these products via an indirect path through intentions to use substances and membership in a high school smoking trajectory.

Conclusions—Risk factors for cigarette smoking were found to predict novel tobacco use, suggesting that interventions to prevent cigarette smoking could be extended to include common novel tobacco products.

Keywords

hookah; little cigars; e-cigarettes; emerging adults; predictors

The use of novel tobacco and nicotine products, particularly hookah, little cigars, and electronic cigarettes (e-cigarettes), is rapidly increasing among emerging adults (aged 18–29) compared to older or younger individuals [1,2]. Because each of these products may

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pose health risks, it would be valuable to identify adolescent predictors that could be targeted in prevention interventions.

Hookah (waterpipe) use has accelerated [3], with marked increases over recent years among high school [4] and college students [5,6]. It has been estimated that 10–20% of some young adult populations in the US are current waterpipe users [3], and 30.5% of college students reported ever trying a waterpipe [6]. The health risks of tobacco smoked through a hookah may include decreased pulmonary function, cancer, and heart disease [7,8]. The use of little flavored cigars has increased among emerging adults in recent years despite their link with head and neck cancers and possibly the development of chronic obstructive pulmonary disease [9]. The 2013 Youth Risk Behavior Surveillance indicated that 12.6% of high school students were current cigar smokers, with twice as many boys using cigars than girls [10]. The use of Electronic Nicotine Delivery Systems (ENDS; aka e-cigarettes) to inhale vapor containing nicotine is rapidly escalating: one study reported 41% of young adults using e-cigarettes in the past month in 2013 compared to 6.2% in 2009 [11]. E-cigarettes appear to be less of a health risk than conventional cigarettes [12], but the potential long-term health effects of of "vaping" are not known [13].

There has been little prospective research on predictors of novel tobacco products. However, novel tobacco use is more prevalent among smokers than non-smokers [14–18] and prior use of alcohol and marijuana predicted hookah use one year later among female college students [5]. These findings suggest that there may be overlap among predictors of conventional tobacco and other substances and predictors of novel tobacco, consistent with a Common Liability model [19]. The Common Liability model proposes that the same influences (liabilities) underlie the use of different substances, both licit and illicit. These influences include mother's smoking [20,21], early trying of cigarettes and other substances in childhood [22], and adolescent sensation seeking. The trait of sensation seeking refers to the tendency to seek out experiences that are novel, exciting, or rewarding, and has been identified as a risk factor for under-age tobacco use and other illicit drug use [23].These predictors may indirectly influence novel product use through more proximal precursors, including behavioral intentions and patterns of smoking across high school. Favorable intentions to use substances predict later use of cigarettes and alcohol [24,25], and marijuana [26,27].

In the present study, it was hypothesized that novel tobacco and nicotine product use in emerging adulthood would be influenced by variables assessed in adolescence that have been found to predict cigarette, alcohol, and marijuana use. Maternal tobacco use, early trying of substances, and higher levels of sensation seeking in the year prior to high school were expected to influence later novel product use through more proximal predictors of intentions to use substances (cigarettes, alcohol, or marijuana), and the level of smoking across high school. This conceptual model is shown in Figure 1. The same predictors were tested across different novel products with the aim of identifying common and unique predictors.

Methods

Participants

The sample comprised 862 youth in the Oregon Youth Substance Use Project (OYSUP). The original sample was recruited using epidemiological sampling techniques from elementary students in the first through fifth grade within one school district in a working class community in Western Oregon. Parents of 1,075 children gave consent for their child's participation. At the first assessment (T1, 1998–1999), an average of 215 students in each grade cohort participated, 50.3% were female and the mean age at T1 was 9.0 years ($SD = 1.45$). Participants were representative of students in the school district in terms of race/ethnicity (i.e., primarily White) and participation in the free or reduced school lunch program at the first assessment (40%), but the 3rd and 5th grade cohorts had slightly higher achievement test scores on reading and math (for more details, including assessment procedures, see Andrews, Tildesley, Hops, Duncan, & Severson) [25]. These youth were assessed annually until one-year post high school, and again at age 20 to 22. The original study and all of its extensions were approved by the Institutional Review Board at Oregon Research Institute.

All of those in the original OYSUP sample who had not actively withdrawn from the study and for whom we had current contact information (N = 906; 84% of the original 1075 participants), were asked to complete a questionnaire in 2013 regarding their novel tobacco/nicotine product use: smoking shisha in a hookah, little cigars, and e-cigarettes, and using snus and dissolvables. Among these, 862 (95%) completed the questionnaire. Of those who did not participate, 9 were out of the country on religious missions or in the military, 5 were in prison, 3 declined, and the remainder (27) failed to respond.

The average age of those who completed the questionnaire was 22.4 years (range 20.0 to 25.0), 52.0% were female, 86.0% were of European American descent, and 48.6% were raised in poverty (defined by eligibility for free/reduced lunch at least once in the elementary school). At the time of the assessment, 95.7% had graduated from high school or obtained their GED, 8.6% had an associate's degree, 11.9% had a bachelor's degree and 31.7% were currently in school. Among those who completed the questionnaire, 71.9% were working with 59.5% working 30 to 40 hours per week, and 33.8% were married or living with someone as if married. The sample for this study (N = 862) was similar to the original OYSUP sample in race/ethnicity, the presence of childhood poverty, and whether or not they had a parent who smoked sometime in childhood or adolescence. However, a significantly higher proportion of females (83% of the OYSUP sample) than males (77% of the OYSUP sample) participated in the present study.

Measures

Mother's report of maternal smoking of at least some cigarettes each month on any assessments at Grade 1 through Grade 8 was coded dichotomously (0 = no smoking versus 1 = some smoking during this period). Using the same item and scoring, child reports of maternal smoking were assessed at Grades 4 through 8. In 91.8% of cases, mother and child reports were consistent, and these reports were highly correlated (.80) so the mean of the

two dichotomous reports was used as a measure of mothers' smoking history through Grade 8. At Grade 8, participants were asked whether they had ever tried a cigarette or cigar, had an entire drink of alcohol, or tried marijuana (Yes/No to each). Responses across the three substances were summed (alpha = .69) to give a measure of early trying. Sensation seeking at Grade 8 was measured by the sum of three items from the Thrill and Adventure Seeking subscale of the Sensation Seeking Scale for elementary and middle school children [28]. They responded (Yes/No) to whether they would like to do dangerous things, parachute jumping, and skiing really fast. The mean inter-item correlation (r = .27) reflects the diversity of the items.

At Grade 9, participants were asked about their intentions to use cigarettes, alcohol, or marijuana after high school, and when they grow up (2 = "yes," 1 = "maybe," 0 = "no"). For each substance, responses were averaged across the two items, and these were averaged across the three substances (alpha = .66).

Smoking was assessed each year in high school. Participants were asked the frequency with which they had smoked cigarettes in the past 12 months (0 = "never," 1 = "once," 2 = "a couple of times," 3 = some each month," 4 = "some each week," and 5 = some each day. Growth mixture modeling is a person-centered approach that identifies distinct groups of individuals who share a similar trajectory of continuity or change on a variable over time [29]. Previously, we reported using this method to determine classes of OYSUP participants with similar smoking trajectories across high school [30]. We identified four trajectories : Stable High Smokers (who maintained their level of smoking some cigarettes most days throughout high school); Rapid Escalators (who began high school using cigarettes only once or twice a year but by 12th grade were smoking some cigarettes each week); Experimenters (who started high school having smoked on average less than one cigarette and increased modestly to smoking between twice a year and less than some each month); and Stable Non-smokers (who either did not smoke cigarettes at all across high school or only very rarely). Based on their membership in these classes from the previous analyses, participants for the present report were categorized as Stable High Smokers (6% of the sample), Rapid Escalators (8%), Experimenters (15%) and Stable Non-smokers (71%). These percentages were identical to those found for the full data set.

In early emerging adulthood, participants were asked the number of times they had used each of hookah, little cigars, and e-cigarettes "in your entire life" (pictures of the novel products were provided). Following the National Epidemiologic Survey on Alcohol and Related Conditions definition of a lifetime user of snuff or chewing tobacco, novel tobacco users [31], users were defined as those who reported using the product at least 20 times in their lifetime. Any novel product use was defined as use of at least one versus none of hookah, little cigars, and e-cigarettes.

Model testing was conducted using Mplus Version 7.0 [32], with maximum likelihood estimation for missing data. Model fit was evaluated by the chi-square statistic and, because it is sensitive to sample size, it was supplemented by the two-index approach recommended by Hu and Bentler [33]: the Root Mean Square Error of Approximation (RMSEA), and the Comparative Fit Index (CFI). They suggested cutoffs of .06 for RMSEA and .95 for CFI for

excellent fit, and statistics close to these cutoffs are considered acceptable. The initial model included all the directional paths shown in Figure 1, and the distal predictors were allowed to correlate. Non-significant paths were removed sequentially, starting with the least significant path first. Using this trimmed model, we tested the significance of all indirect paths use using a bootstrapping method within MPlus [34].

Results

Lifetime use of each novel product, and use of one, two, or all three products, is shown in Table 1. Hookah was the most prevalent novel product, followed by little cigars, and e-cigarettes. Use of each novel product, and use of multiple novel products was more likely for men than women.

The correlations among study variables are shown in Table 2. Use of hookah and little cigars was each more highly correlated with use of any novel product compared to the correlation between e-cigarette use and use of any novel product. The pattern of correlations among the predictors and lifetime novel product use was similar for each novel product with one exception: intentions to use substances were positively related to subsequent use of hookah and little cigars, but was unrelated to subsequent use of e-cigarettes.

Chi square analyses of membership in the three smoking trajectories (i.e., Stable High vs. Rapid Escalators vs. Experimenters) by use vs non-use of each novel product were non-significant for each product: hookah ($\chi^2 = .48$, $df = 2$, $p = .79$); little cigars ($\chi^2 = 1.29$ $df = 2$, $p = .52$); and e-cigarettes ($\chi^2 = .69$, $df = 2$, $p = .71$). Given that there was no difference in the likelihood of novel product use among the three smoking trajectory classes, it was more parsimonious to combine membership in the three smoking trajectories into one group for model-testing purposes.

The conceptual model (see Figure 1) was first tested separately for hookah, little cigars, and e-cigarettes. The significant direct and indirect paths for the final trimmed models were very similar for each of these products. The only differences were that the direct path from early trying of substances was significant for little cigars but not for hookah or e-cigarettes, and the direct path from intentions to use substances was positive for hookah and little cigars but negative for e-cigarettes.

Given the similarity among the models for the individual products, the model reported here predicted lifetime use of any of these three novel products by emerging adulthood (i.e., use of at least one versus none). The trimmed model with direct path coefficients is shown in Figure 2 ($\chi^2 = 4.66$, $df = 4$, $p = .32$, RMSEA = .01, 90% CI = .00, .05) and the indirect path coefficients are provided in Table 3. Men were more likely to use novel products than women, but gender did not influence the proximal predictors therefore these indirect paths were trimmed from the model. Maternal smoking was related directly to novel product use and indirectly through both intentions and high school smoking. Early trying of substances was not directly related to novel product use, but was indirectly related through both intentions and high school smoking. Sensation seeking was related directly to novel product use as well as indirectly through intentions. All three hypothesized distal predictors were

related to use of novel products via an indirect path through intentions and membership in a high school smoking trajectory. Intentions were related both directly to novel product use and indirectly through high school smoking.

The model was also tested with the number of novel products used as the outcome (none, one, or two or more). The trimmed model for number of products included the same significant paths as the trimmed model for any novel product, with one exception. The direct path from maternal smoking to number of products was not significant whereas this path was significant in the model for any novel product. The same indirect paths were significant in both models.

Discussion

Hookah and little cigars were the most prevalent novel products in the OYSUP sample in early emerging adulthood. This finding is a concern because of the known negative health consequences of these tobacco products. The health effects of inhaling e-cigarette vapor are not yet fully understood [35], but all three most prevalent products are similar in that they deliver nicotine, which is a highly addictive substance. The risk factors examined here, which are known to increase the likelihood of future conventional cigarette smoking, were found to influence the subsequent use of these novel products, supporting a Common Liability model [19]. All three distal predictors, mother's smoking, early trying of substances, and sensation seeking, indirectly influenced novel product use in emerging adulthood through a chain of influence involving intentions to use substances (cigarettes, alcohol, and marijuana) and high school smoking trajectory.

The models predicting each novel product were similar, so it was more parsimonious to combine them and present one model predicting use of any novel product. These findings indicate, with respect to the risk factors studied here, a shared etiology across the most prevalent types of novel tobacco and nicotine products in emerging adulthood. This finding also was confirmed when the model was tested on the number of novel products used. However, an examination of the correlations with individual product use suggested a path from prior intentions to use substances for little cigars and hookah, but not for e-cigarettes. The bivariate association between intentions and subsequent e-cigarette use was minimal, whereas the positive bivariate associations between intentions and the other two novel products were small to moderate. Intentions to use cigarettes, alcohol, and marijuana may predict subsequent use of hookah and little cigars but not e-cigarettes because the latter may be perceived differently, perhaps as less "drug-like." Supporting this account, emerging adults perceived e-cigarettes as less dangerous than conventional cigarettes [36] and less harmful than other novel products [37] and, in a prospective study, emerging adults' perception of less harm predicted initiation of e-cigarette use [38].

Novel product use appears to be changing rapidly, potentially limiting the generality of the present findings. The lifetime prevalence of e-cigarettes (defined here as having used 20 times or more, not as ever tried) was 6.6% in the OYSUP sample at the time of assessment (2013), and the current prevalence rates for all three novel products may be higher now for this age group [5,6,10]. Given that "vaping" appears to be on the increase among adults [10],

continued investigation of possible unique pathways to e-cigarette use is warranted. Recent studies indicate that there is an increase worldwide in adolescents' use of e-cigarettes among never smokers as well as in the dual use of conventional and e-cigarettes, which suggests that unique predictors of e-cigarette use are likely [39]. Surveillance studies are needed to determine whether the greater use of hookah and little cigars observed here is limited to early emerging adulthood or maintained over time. A waterpipe is often smoked in a group, and little cigars can be purchased singly, both of which may make these products attractive to high school students and young emerging adults in particular.

This study had a number of other limitations that suggest directions for future research. Only lifetime novel product use was measured here, whereas more detailed assessment of novel product use would be desirable. The measure of lifetime use did not specify when novel product use began, frequency of use, or whether use was ongoing. Given the trend for increasing use of novel products, it is important for future studies to assess extent and frequency of use, and change in use over time. More thorough assessment of novel product use would permit the prediction of different kinds of novel tobacco users (e.g., experimenters vs. established users).

This present investigation indicated that prior cigarette smoking was a risk factor for later novel product use, but did not study whether novel products serve as a pathway to subsequent conventional cigarette smoking. This critical question will be best addressed by a longitudinal follow-up of a well-characterized sample of emerging adults. This study investigated a limited set of predictors assessed in adolescence. More proximal predictors, such as perceptions of health risk or intentions to use novel products measured closer in time to the assessment of novel product use are likely to be stronger predictors than those examined here.

To date, there has been little prospective research on predictors of novel tobacco use. The unique contribution to understanding the etiology of novel product use made by this study was to demonstrate that early predictors of cigarette smoking are also predictors of novel product use, which is consistent with a Common Liability model. Demonstrating that known predictors of conventional tobacco use also predict use of the most widely used novel products presents an opportunity to intervene. These findings suggest that it may be appropriate to extend existing, tobacco prevention programs for adolescents to also include novel products. The framework for developing effective interventions to prevent both conventional and novel tobacco use by youth should be based on etiological studies such as this. We recommend that interventions should contain components shown to change modifiable risk factors such as intentions to use tobacco and other substances. In addition, these components should be equally effective for those with and without fixed risk factors that cannot be changed, such as gender, and risk factors that are less readily changed, such as sensation seeking. This approach has been applied successfully to a school-based tobacco prevention intervention [40], and should now be extended to include novel products.

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Figure 1.
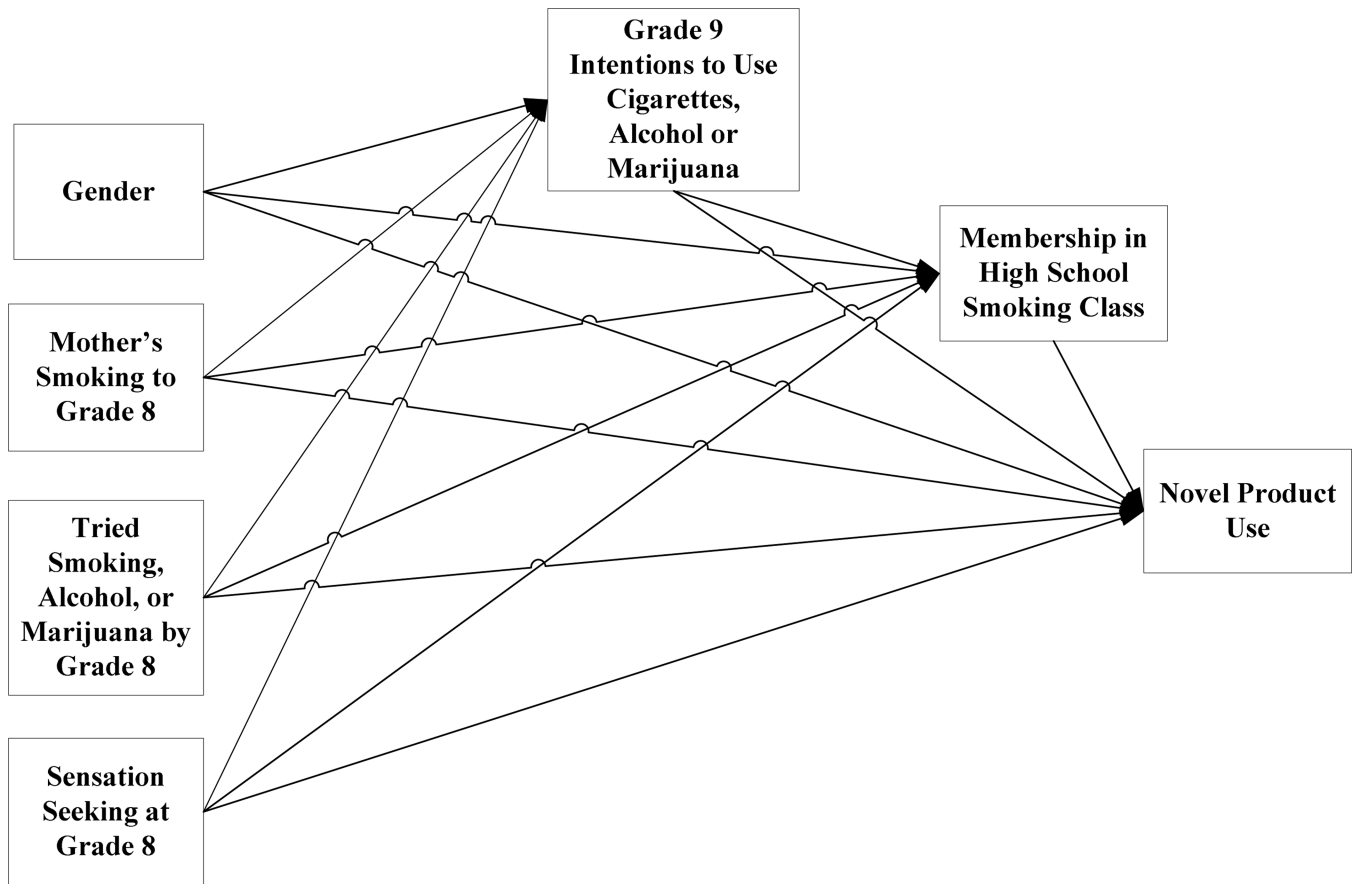Conceptual model showing hypothesized directional paths from gender, mother's smoking, already tried substances, and sensation seeking (all measured at Grade 8) through Grade 9 intentions to use substances and high school smoking trajectory.
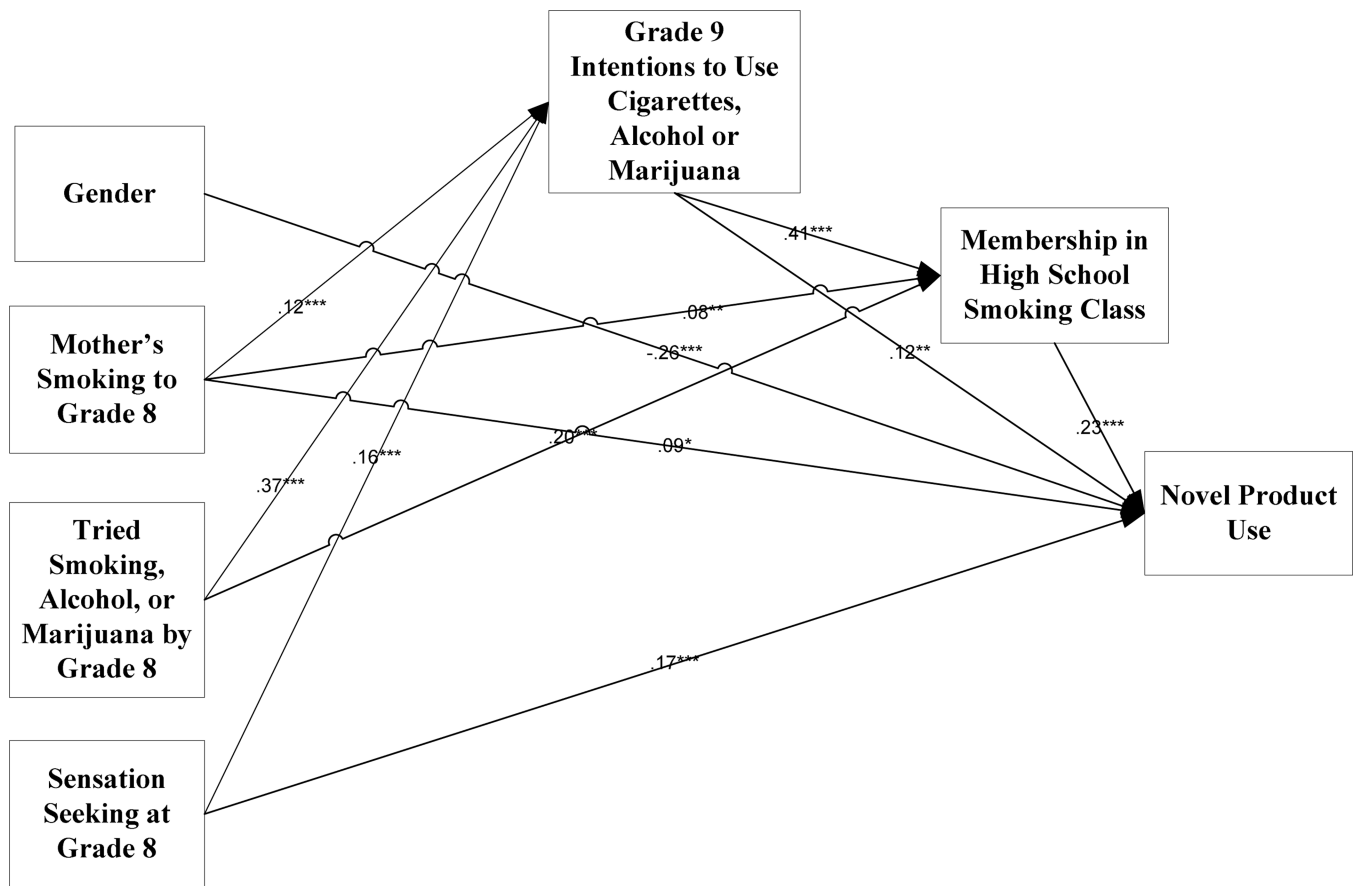
Figure 2.
Trimmed model retaining significant hypothesized paths predicting novel product use defined as use of any of hookah, little cigars, and e-cigarettes.

Table 1

Percent of lifetime users of novel tobacco products (defined as 20 or more times), for the entire sample, and men and women separately including the significance of the gender difference

Product	Prevalence		Gender		p
	N	%	% M	% F	
Hookah	187	21.7	29.0	15.0	<.001
Little Cigars	145	16.8	26.4	8.0	<.001
E-cigs	57	6.6	9.9	3.6	<.001
One product	175	20.3	23.4	17.4	<.001
Two products	83	9.6	15.5	4.2	<.001
Three products	16	1.9	3.6	0.2	<.001

Table 2

Correlations among all study variables

		2	3	4	5	6	7	8	9	10
1	Gender	.02	.07*	-.17**	.04	.00	-.17**	-.24**	-.13**	-.22**
2	Mother's smoking		.29**	.06	.24**	.24**	.10**	.06*	.07*	.14**
3	Tried substances			.19**	.43**	.40**	.10**	.18**	.10**	.18*
4	Sensation seeking				.18**	.13**	.19**	.17**	.12**	.21**
5	Intentions					.51**	.19**	.22**	.04	.24**
6	HS smoking						.18**	.24**	.21**	.28**
7	Hookah							.31**	.16**	.77**
8	Little cigars								.26**	.66**
9	E-cigarettes									.39**
10	Any novel product									

Note. Men coded 0, women coded 1; HS = high school; Novel product = hookah, little cigars, and e-cigarettes.

Table 3

Standardized effects for indirect paths in the final model shown in Figure 1

	Effect	*p*	95% CI
Total indirect effect: Momsmk→Use	.045	.001	.019, .071
Momsmk→Intent→HSsmk→Use	.012	.009	.003, .020
Momsmk→HSsmk→Use	.018	.033	.001, .034
Momsmk→Intent→Use	.015	.052	.000, .031
Total indirect effect: Trying→Use	.125	.000	.081, .169
Trying→Intent→HSsmk→Use	.034	.000	.018, .050
Trying→HSsmk→Use	.046	.001	.019, .074
Trying→Intent→Use	.045	.027	.005, .085
Total indirect effect: Senseek→Use	.036	.000	.017, .055
Senseek→Intent→HSsmk→Use	.015	.001	.006, .025
Senseek→Intent→Use	.020	.021	.003, .037

Note. The path from one variable to another is indicated by an arrow. For example, Momsmk→Intent→Use = the path from mother's smoking through intentions to any novel product use. The total indirect effect for a variable is the sum of the specific indirect effects for that variable.

CI = confidence interval; Momsmk = mother's smoking; Intent = intentions to use substances; HSsmk = high school smoking trajectory; Trying = tried substances by Grade 8; Senseek = sensation seeking.