

Multi-dimensional Categorization of ENDS Susceptibility and Use

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Background

The increasing use of Electronic Nicotine Delivery Systems (ENDS), also known as e-cigarettes or vapes, among youth has become an important, recent concern. There is increasing evidence that such use, typically referred to as vaping, produces substantial negative health and behavioral consequences, potentially long-term.¹ As a nicotine delivery device, ENDS are attractive to many youths because they tend to be easily obtained and are odorless to use and easy to conceal. ENDS may deliver nicotine and other harmful chemicals at levels that surpass conventional cigarettes.¹ Taken on the whole, ENDS and their use by youth constitute an important public health and public policy problem.

The questions are not only why youth vape, but also what factors make youth susceptible to experimenting with vapes in the first place. Both questions hold important implications for developing and targeting preventative approaches. And while there is substantial research on factors related to youth cigarette use initiation,^{2,3} there is a relatively small, though slowly growing, body of research on youth ENDS use and their susceptibility to it. Such studies have primarily examined the differences between youth who have vaped and those who have not,⁴ and between different frequencies of usage overall.^{5,6,7} To date, most efforts to assess youth susceptibility to vaping have directly asked youth about their curiosity and likeliness to use ENDS.⁸⁻¹¹

Such early studies take constructive steps to categorize youth by their vaping status but lack a comprehensive array of empirical and multivariate variables to help better predict which youth are most susceptible to vaping. Understanding the characteristics of youth most likely to vape may increase the ability of practitioners to target preventative interventions more efficiently at susceptible youth.

In this paper, we review existing research as a foundation for future testable, multivariate models on youth vaping susceptibility. To do so, we segment the paper in the following manner. First, we review existing definitions of cigarette and ENDS use susceptibility, particularly among youth. We explain how theoretical mechanisms of youth susceptibility have informed research on the contextual and social influences that are of most predictive interest. Finally, we suggest how demographic and psychographic questions, integrated with questions about use, openness, and frequency of tobacco product use may be the most fruitful approach to developing categorizations of youth vapers that are highly descriptive and actionable for prevention practitioners.

Cigarette and ENDS use categorization models

There is a rich literature on cigarette use and how to categorize and describe youth smokers. For example, Park, Seo, and Lin, (2016) defined three categories of smoking status: “never-smoking youths” who had never smoked before, “youth experimenters” who reported smoking at

least one puff, but less than 100 cigarettes in their lifetime and none in the last 30 days, and “current youth smokers” who smoked 100 or more cigarettes previously and smoked within the previous 30 days.¹² Other researchers have avoided the 30-day use requirement altogether to include more recent experimenters, defining “cigarette experimenters” as those who reported smoking more than one cigarette puff, but had yet to smoke 100 cigarettes total.^{13,14}

Research on ENDS use has often borrowed from the usage classifications of cigarettes before them. Gentzke (2020) defined “current e-cigarette users” as respondents who reported using an e-cigarette product one or more days in the past 30 days.¹⁵ Roditis et al. (2020) defined an “e-cigarette experimenter” as a person who took between 1-49 puffs of an e-cigarette ever but used fewer than 21 e-cigarettes in the past 30 days.¹⁶ Keller-Hamilton et al. (2020) defined “ever e-cigarette users” as respondents who reported trying a vape at least once.⁴ Other researchers have further segmented ENDS use. For example, Villanti, et al. (2017) defined ENDS use with seven categories of frequency: zero days a month; one to two days a month; three to five days a month, six to nine days a month, 10 to 19 days a month, 20 to 29 days a month, and everyday use.⁷ Similarly, Mantey et al. (2019) defined and compared four profiles of ENDS use among high school students, including infrequent (one to two days per month), light (three to nine days per month), moderate (10 to 29 days per month), and daily.⁶

Most previous definitional work on cigarette and ENDS use has used frequency of use, recency of use, or both to define the susceptibility to use spectrum. Another dimension to consider is types of tobacco products used, which Sung et al. (2018) categorized as “mono,” which is the use of only one nicotine product, “dual,” which is the use of two nicotine products, and “poly,” which is the use of two or more products.¹⁷ Baig and Giovenco (2020) followed this work by studying the differences between heavy and light dual usage (cigarettes and ENDS) while classifying respondents’ predominant use of cigarettes or ENDS: “heavy dual users”, “light dual users”, “predominant smokers”, and “predominant vapers” and found significant intergroup differences in education and income.⁵

Defining ENDS use susceptibility

While there is a small but growing and informative research body on the consequences of ENDS use by youth, there is less known about the factors that make youth susceptible to ENDS in the first place. Only a handful of studies have examined the differences among youth vapers and non-vapers to offer why some youths are inclined to start vaping.

For example, Bold et al. (2018) adapted questions from the Pierce measure to assess susceptibility among youth who had not vaped and used a longitudinal approach to assess whether those deemed susceptible at baseline were more likely to have initiated ENDS use after six months.⁸ They found that this measure of susceptibility was a significant predictor of ENDS initiation and use of ENDS in the previous month when assessed half a year later.

Some researchers have begun to explore ENDS susceptibility correlates. For example, Bold et al. (2018) noted that susceptible youth tended to be older males who had previously used alcohol, marijuana, or conventional tobacco products.⁸ Similarly, by using the 2013-2014 Population Assessment of Tobacco and Health (PATH) data, Kwon et al. (2018) found that youth susceptibility to ENDS relates to being older on average, Hispanic, having emotional struggles, such as anxiety and depression, having previous substance use/tobacco use, and were more likely to report experiences with bullying, restlessness, and struggles with attention.⁹ They also found that susceptible youth were less likely to view ENDS as harmful or addictive. Sawdey et al. (2019) also analyzed the PATH to find youth susceptibility statistically relates to substandard academic performance and coming from households where someone uses tobacco products.¹⁰

Moreover, Mantey et al. (2016) studied 2014 National Youth Tobacco Survey (NYTS) data and found that high school aged youth exposed to ENDS marketing had higher odds of being susceptible to initiating ENDS use.¹⁸ A more recent look at the 2018 NYTS data by Kalan et al. (2020) found some similar and conflicting correlates of susceptibility. While their findings supported previous notions that exposure to ENDS advertising and perceptions of ENDS as being less harmful and addictive were associated with susceptibility, they also found evidence that females had greater susceptibility odds, contradicting findings from earlier studies.¹⁹ Tacket et al. (2020) began stitching together these lists of susceptibility correlates in their review and analysis of the 2018 NYTS data.¹¹ They estimated that roughly 35 percent of youth aged 12-17 who had never used ENDS were nonetheless susceptible to future ENDS use. They assessed both the standard composite measure of susceptibility adapted from the Pierce measure and individual questions in the Pierce measure to produce nearly consistent results. Their list of significant susceptibility correlates included respondents who were female, Hispanic, viewed ENDS as less harmful, easy to purchase, and had parents who used tobacco products. More recently, Mantey et al. (2021) found that youth susceptibility to using ENDS positively correlates with seeing other students use ENDS at school.²⁰

Taken together, there are common correlates from these susceptibility studies, including age, previous substance and/or tobacco use, emotional struggles, household proximity of use, and views of ENDS as less dangerous or addictive. The question that we address in the remainder of this paper is how can we effectively build upon this research to create an ENDS use categorization model that is most useful for prevention programming and intervention?

Theoretical predictors of nicotine use

Researchers exploring youth initiation of nicotine use have noted that youth experience a multitude of social contexts across home, school, family, and friends; and that each of these contexts may be influenced by other contextual differences such as community, state, and country. Furthermore, there may be interaction effects between these social contexts that affect perceptions of nicotine use and resulting choice to initiate use.²¹ Because assessing every possible context simultaneously is overwhelming, Ennett et al. suggest Bronfenbrenner's ecology of human development to guide which social contexts may be most significant.²¹ In this regard, microsystems such as friends, family, and school contexts are most influential to youth development and behavior.

Bronfenbrenner's ecology of human development suggests that development occurs in static and changing social environments and behavior results as an accumulating output of social environmental experiences. Ennett et al., (2010) also list social learning theory and social control theory as the two most prominent theories relevant to youth nicotine initiation.²¹ While both theories focus on potential peer influences, social learning theory addresses how exposure to nicotine use is a mechanism that increases the likeliness to initiate use through modelling.

Meanwhile, social control theory focuses on the strength of conventional controls like parental support, supervision, and healthy family relationships, and posits that the stronger these conventional controls are the less likely a youth will be influenced to initiate use.²¹ Under these notions of environmental and social influence, it is of special interest how the presence of certain environments, peer influences, and healthy social moderators differ between youth who are susceptible to initiating ENDS use and those who are not.

Risk factors for cigarette use

As an older tobacco product, cigarette use has been more widely studied over time. And as a result, much is known about risk factors for cigarette susceptibility and initiation. Studies have looked at demographic characteristics of adolescents susceptible to cigarette smoking using NYTS data. Compared with Whites, Latino/a adolescents were consistently more susceptible from 1999 to 2018, while Black and Asian adolescents fluctuated between being less or equally susceptible over time. American Indian, Alaska Native, Native Hawaiian, and Pacific Islander adolescents were more susceptible from 2014 to 2017, compared to Whites. Additionally, adolescents' cigarette smoking susceptibility peaked at age 14 years.²² Further study has examined perceptions and behaviors associated with cigarette smoking susceptibility among 8th and 10th grade never-smokers of cigarettes from the 2014-2016 Monitoring the Future survey.²³ This study found that alternative tobacco product use, ownership of tobacco promotional items (TPIs), and easy access to cigarettes were associated with increased likelihood of cigarette smoking susceptibility, while perceived great influence by antismoking advertisements and higher perceived addictiveness of cigarette smoking were associated with lower odds of cigarette susceptibility.²³

Comparisons of predictors for cigarettes and ENDS

Case et al. (2020) assessed predictors of both ENDS and combustible tobacco and found several overlaps.²⁴ For instance, previous marijuana use and having friends who smoke cigarettes were found to be significant predictors for all tobacco products. ENDS marketing was significantly associated with ENDS initiation (particularly the Juul brand) but not conventional cigarettes. Case and colleagues pointed out that roughly 40% of youth do not believe there is nicotine in their Juul, a misunderstanding that likely contributes to perceptions of reduced risk. Similarly, a study performed in Spain by Patino-Maso et al. (2019) found that having previously tried tobacco was a strong predictor of initiating use for both ENDS and traditional cigarettes.²⁵ However, there appeared to be slight variations in how peer influence predicted initiation of use. While in home proximity to smoking and perceptions of smoking as being low risk were found to be

The best predictors of cigarette initiation, having friends who smoke or vape was a better predictor of ENDS initiation.

Next directions for more robust categorization of ENDS use as a springboard for prevention

As illustrated in the review above, current attempts to categorize the ENDS use spectrum have borrowed heavily from the cigarette literature and relied mostly on self-reports of frequency of vaping, openness to or curiosity about vaping, and recency of vaping. At the same time, new research is emerging on correlates of ENDS susceptibility and experimentation. In the paragraphs below, we propose an agenda for future research that brings together the field's understanding of who is at risk for vaping and how to describe and classify levels of use, susceptibility, and experimentation. We believe that merging these currently disparate streams of research is necessary to create robust and targeted prevention efforts.

Agenda item 1: *Explore a multidimensional way of assessing ENDS use in the past and future.*

Questions about frequency and recency of ENDS use captures a static moment in time when the respondent made the decision to use ENDS. Future surveys seeking to explore ENDS use should add questions that probe curiosity and openness to vaping in the future for all respondents. Just because someone tried vaping once does not necessarily mean that they will continue vaping, and survey questions should not assume that use in the past will predict future or ongoing use.

Agenda item 2: *Overlay questions about ENDS behavior with questions about respondent characteristics.*

Categorization of ENDS use status will be more helpful if merged with an understanding of the whole person – what other demographic, psychographic and socioemotional characteristics of the respondent would help identify them for prevention messaging or design messaging tailored to their characteristics? Future surveys of ENDS usage should explore a larger variety of questions related to such things as hygiene, physical exercise, social interactions, perceptions of self, parental and school characteristics, and self-care, so that the field may explore more subtle characteristics that are associated with susceptibility and experimentation.

Agenda item 3: *Remember that vapes are not cigarettes.*

As ENDS were emerging as a new tobacco product with public health impact on teens, the research and prevention community, lacking research specifically about ENDS, often defaulted to using models developed for cigarettes and retrofitting them to ENDS. As time goes on, we are learning that the motivations for using ENDS may differ substantially from cigarettes, just as the barriers to using cigarettes are very different for those of ENDS.¹⁰ As mentioned earlier, ENDS are odorless and thus easier to conceal and use in more environments than traditional cigarettes. As ENDS are a newer product and often perceived to be less harmful, or even wrongly assumed not to contain any nicotine, it is likely to attract less stigma than cigarette smoking. Furthermore, ENDS marketing has been criticized for specifically targeting adolescents.^{1,24} New research striving to understand ENDS users should consider vaping as a distinct product and shake free from preconceived similarities to cigarettes.

A deeper understanding of the unique characteristics of ENDS use, characteristics of ENDS users, and how those two sets of traits interact will help the field develop more nuanced approaches to ENDS messaging and prevention, ultimately resulting in a healthier population of teens in the United States.

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