



# Predictors of Vaping Behavior Change in Young Adults Using the Transtheoretical Model: A Multi-Country Study

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**ABSTRACT:** Electronic nicotine products remain popular among college students. These products contain heavy metals, carcinogens and the addictive substance nicotine. By understanding where students are in their behavior change can help to determine and focus messages and campaigns. The aim of this study was to assess predictors of the Transtheoretical model in college-aged vaping. This study consisted of an online/Ipad delivery of a voluntary survey to 1249 young adults/college students at 5 universities (International and within the U.S.). Data was analyzed using Stata. Regression analysis was performed to assess predictors of the stages in the Transtheoretical Model of behavior change. Our study found that women tended to be further along in the stages of change as compared to their male counterparts. Additionally, the older students were more likely to be in maintenance stage as compared to the younger students. The students who vaped longer tended to not have advance into any of the stages of change besides precontemplation. Understanding where students are in the stages of change can help to inform behavioral message campaigns enabling more focused targeting of messages and efforts to reduce consumption. Electronic nicotine products are highly prevalent on college campuses, both nationally and internationally. The nicotine is addictive and may result in less of a desire or ability to quit as young adults age.

**KEYWORDS:** Vaping, transtheoretical model, young adults, behavior change, electronic nicotine devices

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## Introduction

Electronic cigarettes, commonly referred to as vaping, are devices that deliver nicotine and other aerosolized chemicals when inhaled by users. In particular, users may inhale and exhale carcinogens such as formaldehyde, acetaldehyde and acrolein.<sup>1–3</sup> Additionally, vape devices contain heavy metals that are also found in traditional cigarettes.<sup>4</sup> These devices differ from traditional cigarettes in that they contain liquid nicotine that is heated by a coil system and aerosolized. Traditional cigarettes contain tobacco which is lit and inhaled. Both products produce inflammation and alter our innate immune system—the lung epithelium. However, due to the novelty of vape devices and introduction of these products only a decade ago, research is in its infancy; compared to cigarettes that have been researched for decades. The inhalation of nicotine, flavoring, and other chemicals by a user can be referred to as “vaping” and is 3 times more common among youth and young adults than older adults.<sup>5</sup> Vaping is a public health concern according to the Surgeon General.<sup>6</sup> In the U.S. 2011 to 2018 National Youth Tobacco Survey (NYTS), there were over 3 million high school students and 570 000 middle school students reporting current (past 30-day) e-cigarette use.<sup>7</sup> In the 2018 National Health Survey (NHIS), it was concluded that the prevalence of vaping in college-age adults (18–24 years of age) was greater than all

other age groups.<sup>8</sup> The U.S. is witnessing a setback in nicotine/tobacco reduction strategies as the popularity of vaping has increased among youth and young adults.

Prevalence begins with incidence and understanding why students vape is important. Adolescence is often associated with risky behaviors. One large-scale study provided evidence related to vaping in the formative years of youth and found multiple influencers to vaping. Such influencers included peers, environments, and consumption of alcohol.<sup>9</sup> While another study tested motives for use in college and established vaping to be a risk marker for the use of substances that are known to pose substantial health problem.<sup>10</sup>

Theoretical models help to understand behaviors. The transtheoretical model of behavior change (TTM) conceptualizes health behavior change as a process.<sup>11,12</sup> The model postulates that smoking cessation develops across 5 stages (which represent the temporal aspect of change), and suggests that people in different stages behave in qualitatively different ways and that the interventions needed for moving through these stages vary from stage to stage.<sup>13</sup> In the (1) *precontemplation stage* people are not thinking about change and do not intend to quit smoking within the next 6 months. In the (2) *contemplation stage* individuals are weighting the pros (benefits) and cons (costs) of changing and consider smoking cessation within the next



6 months. In the (3) *preparation stage* people are already making small changes and decided to quit smoking within the next 30 days. In the (4) *action stage* people changed their behavior and quit smoking, but for less than 6 months and in the (5) *maintenance stage* people maintained smoking cessation for more than 6 months. Our research assessed predictors of TTM. In particular, we were interested in knowing if demographic characteristics (age, gender, ethnicity) asthma status, health perception, factors influencing choice and time of use would predict an individual's level of behavior change in the TTM.

## Methods

This research study consisted of a cross-sectional survey design, whereby, an online survey or an iPad version (Germany) was disseminated to college-aged students from 3 U.S. universities and 2 International universities (South Africa and Germany). All university institutional review boards approved the study design. The survey consisted of 31 items including demographics and socio-behavioral characteristics, personal health variables, and the transtheoretical model as related to vaping.

Demographic data included university, age, gender, and race/ethnicity. Social behavioral characteristics consisted of asthma status, time of use, health status, influencers, and stage of change.

The TTM questions centered on vaping were addressed for respondents who noted that they had vaped in the past, even 1 or 2 puffs. Those individuals who never vaped were excluded from the analysis. Current vapers are defined as those individuals who have vaped in the past thirty days. TTM questions included: Precontemplation: *I currently vape an electronic device and I am not planning to give up vaping within the next 6 months.* Contemplation: *I currently vape an electronic device, but I am planning to give up vaping within the next 6 months.* Preparation: *I currently vape an electronic device, but I am planning to give up vaping within the next 3 months.* Action: *I have vaped in the past year and I quit within the last 6 months.* Maintenance: *I vaped in the past and quit more than 6 months ago.*

## Analysis

We analyzed data in this study using Stata IC Version 16. First, we calculated frequencies and percentages for all study variables, given that each variable was categorical in nature. Second, we estimated a multilevel multinomial logistic regression model,<sup>14</sup> in which the polytomous “five stages of change” variable was regressed on the following independent variables: age (18, 19, 20, 21, and  $\geq 22$ ), race (white and nonwhite), gender (male and female), asthma diagnosis (yes or no), general health status (poor/fair, average, and excellent), the factor most influencing the choice to use e-cigarettes (advertisement, nothing, or friend/family), and time of e-cigarette use (<6 months or  $\geq 6$  months). Our model included a random intercept for a student's residence (ie, in the USA or not in the USA). We present adjusted beta coefficients in a table to summarize the results of the model.

## Results

Our study consisted of a sample size of 1249 young adults. Each survey was sent by the institution. One U.S. institution emailed out a link to a random sample of undergraduate/graduate students. A Qualtrics survey form was randomly emailed to 5001 college-aged students (of the 30 400 total students). The office of institutional research created a randomized sample, using a list of computer-generated email addresses. Of the students who received the invitation to participate, 507 (10%) completed the survey. Another U.S. university emailed a survey link to all 11 695 students enrolled during the semester. The survey link was active for 2 weeks. Students were sent an email reminder after 1 week. Of the 11 659 students emailed, a total of 52 (0.44%) completed the survey. The third U.S. university sent the survey out to all undergraduate students during the semester using Google Survey. The survey was open for 1 week. The response rate was approximately 0.03%. One International University targeted young adults between the age of 18 to 25 years of age. Recruitment were done by setting up a lung function screening in an area frequented by persons of this age. Persons interested in having their lung function test performed were then approached to complete the online survey by making a tablet available for them to complete the survey. It was not possible to calculate the response rate for this university. At the final International University, Student assistants distributed the survey at our university and it was not possible to compute a response rate.

Demographic and socio-behavioral characteristics of the study sample are shown in Table 1. Results showed that approximately 26% of our sample were above the age of 22 years, leaving 74% of the sample between the 18 to 21-year-old group. The sample was predominantly white (88%) and female (55%). The prevalence of asthma in the sample was 18% and 51% of the sample indicated that their health was “average.” The e-cigarette users in our study were most influenced by friends or family, followed by “nothing” and advertisements. The sample was balanced in terms of self-reported length of e-cigarette use at a 6 months point of dichotomization. Furthermore, our results showed that 29% of the sample was in the “maintenance” stage of the Transtheoretical Model and 29% of the sample was in the “precontemplation” stage.

Results of the multilevel multinomial logistic regression model are presented in Table 2. Our model indicated that 6 relationships were statistically significant at  $P < .01$  after controlling for all other variables in the study. Specifically, individuals who were aged 22 years or more were more likely than individuals aged 18 years to be in the maintenance stage of the Transtheoretical Model compared to the precontemplation stage. Additionally, females were more likely than males to be in the action or maintenance stages of the model than in the precontemplation stage of the model. Lastly, individuals who reported using e-cigarettes for 6 months or more

**Table 1.** Demographic and socio-behavioral characteristics of the study sample.

VARIABLE	N	%
Age		
18	162	12.97
19	303	24.26
20	240	19.22
21	221	17.69
≥22	323	25.86
Race		
Non-white	149	11.93
White	1110	88.07
Gender		
Male	568	45.48
Female	681	54.52
Asthma Dx		
No	1029	82.39
Yes	220	17.61
Health status		
Poor/fair	118	9.45
Average	638	51.08
Excellent	493	38.47
Influenced most by		
Advertisement	105	8.41
Nothing	376	30.10
Friend/family	768	61.49
Time of use		
<6 mo	632	50.60
≥6 mo	617	49.40
Transtheoretical stages		
Precontemplation	362	28.98
Contemplation	133	10.65
Preparation	115	9.21
Action	275	22.02
Maintenance	364	29.14

(compared to individuals who reported less than 6 months of use) were less likely to be in the preparation, action, or maintenance stages of the model than in the pre-contemplation stage of the model.

## Discussion

The findings from this study aimed to determine the predictors of the stages of behavior change of vaping in the TTM. Our sample was primarily white and female. Approximately half of the participants reported their health status as average and one-fifth reported being diagnosed with asthma. Age, race, gender, family and friends as well as time of vaping, were all factors that contributed significantly to the stages of behavior change in the TTM. In order to address intervention strategies to reduce the continuous increase in vaping within the young adult population, it is essential to understand the factors that contribute to behavior change.

Our results suggest that young adults who vape for more than 6 months are significantly less likely to be in the preparation, action or maintenance stages of behavior change compared to the contemplation stage. It is reasonable to suggest that nicotine addiction of these products may have factored into these results and supported by studies that suggest addiction is most often noted in those who are precontemplation.<sup>15</sup> Influencers were consistent with other studies. These young adults indicated that vaping was mostly influenced by their family and friends. The social acceptability of vaping is supported by the findings from this study as well as other studies.<sup>16-18</sup> This social influence was statistically significant in individuals in the maintenance stage, suggesting that having that sphere of social influence can potentially propel quit attempts similarly to the literature on smoking traditional cigarettes.<sup>19,20</sup>

In terms of demographic differences, we found that age and the TTM, our study found that older students were more likely to be in the maintenance phase of change as compared to younger students. The possibly reason for this could be that with increase in age, individuals have had more attempts to quit and therefore more likely than younger individuals to have success and be in maintenance phase. Another possible factor could be with increase in age there is increase in awareness and knowledge of the harmful effects of nicotine addiction which serves as a motivation to maintain abstinence. Participants who identified as 22-years and older were significantly more likely to be in the maintenance phase of change, compared to the participants younger than 22-years. Previous research indicates that young adults are more likely to experiment with e-cigarettes compared to older adults.<sup>21</sup> More recent data from a three-country survey (USA, Canada & England) report an increase in vaping in young adults. Their results indicate that vaping is becoming less of an experimental behavior and more of a regular habit. The results also support our finding of persons in the upper age range being in the maintenance stage.<sup>22</sup>

Furthermore, we found that females were more likely than males to be in the action or maintenance stages of the model than in the pre-contemplation stage. This is counter to smoking literature that suggests that females have a more difficult

**Table 2.** Results of the multi-level multinomial logistic regression model for e-cigarette use behavior according to the transtheoretical model.

VARIABLE	CONTEMPLATION <sup>A</sup>	PREPARATION <sup>A</sup>	ACTION <sup>A</sup>	MAINTENANCE <sup>A</sup>
	b (SE)	b (SE)	b (SE)	b (SE)
<b>Age</b>				
18	Ref	Ref	Ref	Ref
19	-0.26 (0.32)	0.09 (0.36)	-0.15 (0.27)	-0.08 (0.27)
20	-0.23 (0.38)	0.38 (0.38)	0.25 (0.28)	0.05 (0.29)
21	-0.19 (0.35)	0.51 (0.38)	-0.02 (0.29)	0.38 (0.29)
≥22	-0.46 (0.34)	-0.58 (0.42)	-0.27 (0.28)	<b>0.72*</b> (0.26)
<b>Race</b>				
Non-white	Ref	Ref	Ref	Ref
White	0.04 (0.35)	-0.21 (0.35)	-0.17 (0.26)	-0.66* (0.23)
<b>Gender</b>				
Male	Ref	Ref	Ref	Ref
Female	0.21 (0.20)	0.35 (0.21)	0.72** (0.16)	0.71** (0.16)
<b>Asthma Dx</b>				
No asthma	Ref	Ref	Ref	Ref
Asthma	0.30 (0.25)	0.07 (0.27)	-0.33 (0.23)	0.27 (0.19)
<b>Health status</b>				
Poor/fair	Ref	Ref	Ref	Ref
Average	0.05 (0.38)	-0.12 (0.37)	0.09 (0.30)	-0.24 (0.27)
Excellent	0.11 (0.38)	-0.30 (0.38)	0.20 (0.31)	-0.09 (0.27)
<b>Influenced most by</b>				
Advertisement	Ref	Ref	Ref	Ref
Nothing	0.17 (0.37)	0.50 (0.49)	-0.13 (0.31)	0.23 (0.31)
Friend/family	0.13 (0.36)	0.82 (0.46)	0.51 (0.29)	0.79* (0.29)
<b>Time of use</b>				
<6mo	Ref	Ref	Ref	Ref
≥6mo	-0.39 (0.23)	-0.96** (0.23)	-2.11** (0.18)	-2.49** (0.18)

The random intercept in this model included 2 categories (ie, USA student and non-USA student).

<sup>A</sup>Reference category for the dependent variable is "pre-contemplation."

\* $P < .01$ .

\*\* $P < .001$ .

time in abstinence. Additionally, an explanation could be the reason for initiation differences between genders.<sup>23</sup> One online survey found that men are more likely to use ENDS as a tool to quit smoking cigarettes and because they enjoy the taste of ENDS as compared to women who report using due to more non-nicotine reasons such as social influences, appearance, dealing for stress and controlling mood, perceived weight loss benefits.<sup>24</sup>

The results of this study are consistent with previous studies that indicate that young persons are influenced by friend and family that vape and the longer they vape, the less the chances of cessation. To our knowledge this study is the first to identify the factors that are associated with the stages of change according to the TTM in particularly a young adult population. Our study exhibited both strengths and limitations. The limitations of the study are the use of a



cross-sectional design and lack of apriori sample size calculations. Furthermore, the nicotine dosage, frequency of use and device type were not recorded. Due to a non-random sampling and self-report of an online survey, the findings from the study lacks generalizability. Strengths include the large sample size and a balance of sexes. The use of the TTM for the stages of changes in particular young adults, is the novelty of this study.

## Conclusion

There are limited studies on perceptions related to vaping and perceived harm in college students. Vaping has enhanced approval in young adults and college age students. Tobacco cessation programs in colleges and universities should focus on vaping cessation given the high levels of nicotine in these products. Understanding where individuals are in the TTM can help cessation counselors with utilizing motivational interviewing and other techniques to understand and advance the cessation efforts of the clients. Public health statewide programs should offer FDA approved cessation products to assist in cessation and the World Health Organization should provide resources for all countries that align with the resources available. Additionally, age restrictions seem to curtail behavior to a degree and should be enforced. Policy aimed at increasing the age to which vaping manufacturers can target young adults could help to deter and decrease usage. Free and reduced priced products aim to encourage trialing and possible addiction.

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