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E-cigarettes and conventional cigarettes: perceived risks and benefits among college students

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E-CIGARETTES AND CONVENTIONAL CIGARETTES:

PERCEIVED RISKS AND BENEFITS AMONG COLLEGE STUDENTS

A Thesis

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ABSTRACT

Background: Accompanying the decline in cigarette smoking rates has been a rise in prevalence of electronic cigarette (e-cigarette) use. The ongoing investigations on the health impact of e-cigarettes have been accompanied by mixed messages and a lack of consensus, which may lead college students to rely on their own perceptions of risk and benefits in deciding whether to use e-cigarettes.

Purpose: The purpose of this study was to evaluate the association between perceived risks/ benefits and e-cigarette use/cigarette smoking among college age students. Knowledge on the relationship between risk and benefit perceptions and e-cigarette use/cigarette smoking will provide a foundation for health-related professionals and programs to understand how the current literature on e-cigarettes is interpreted among college students and inform intervention strategies.

Methods: Using a cross-sectional study design, the association between the independent variables (perceived risks and benefits) and the dependent variables (e-cigarette use and cigarette smoking status) were assessed using logistic regression models. Perceptions of overall harm of e-cigarettes were grouped into quartiles (Q 1-4) ranging from lowest to highest and the perception of overall harm of cigarettes were classified into two groups (Group 1- perception scores <100 and Group 2- perception scores= 100). Statistical significance was set at α=0.05.

Results: Among 1011 participants in this study, 63.9% had used an e-cigarette at least once and 34.8% were current users of e-cigarettes. About half (50.6%) of the participants in this study had

used a cigarette at least once while 16.1% of the participants were current cigarette smokers. Compared to Q4, participants in Q1 had 8.29 times the odds (OR 8.29, 95% CI 4.69-14.64, p<.001) and Q2 had 2.18 times the odds (OR 2.18, 95% CI 1.38-3.43, p<.01) of e-cigarette ever-use. Compared to participants who rated their perceived overall harm of cigarettes as 100, those who had ratings of less than 100 had almost a 2-fold increase in odds for ever-use of cigarettes (OR 1.97, 95% CI 1.43-2.70, p< .001).

Conclusion: Considering the significant association of perceived risks and benefits with e-cigarette and cigarette use, this study yields some findings that show the importance of appropriately addressing perceptions. It is paramount to keep the public updated on pertinent research findings on e-cigarettes as this could influence the development of well-guided perceptions. Approximately half of the participants gave the maximum rating for the perceived overall harm of cigarettes highlighting that the adverse effects of cigarettes have been well disseminated. On the other hand, the more widespread distribution for perceptions on e-cigarettes mirrors the mixed messages regarding e-cigarettes. It is imperative for health professionals to have a clear message regarding the absolute safety of e-cigarettes. In addition, we recommend the introduction of lessons on e-cigarettes into health-related curricula in schools.

DEDICATION

I dedicate this work to Faith Chukwu whose brilliance, diligence and selflessness continuously motivates me.

LIST OF ABBREVIATIONS AND SYMBOLS

FDA	Food and Drug Administration
HBM	Health Belief Model

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CHAPTER I

BACKGROUND

Cigarette smoking has declined among U.S. adults, with 14% (34.3 million) representing the lowest levels of cigarette smoking rates ever recorded among U.S adults (Wang et al., 2018). Cigarette smoking has been causally linked to diseases of nearly all organs of the body, including cancer, cardiovascular, respiratory and oral diseases (U.S. Department of Health and Human Services, 2014). Accompanying the decline in cigarette smoking rates has been a rise in prevalence of electronic cigarette (e-cigarette) use (Agaku et al., 2014; Coleman et al., 2017). Twenty-five percent increase in e-cigarette use among current smokers and three percent increase among non-smokers were observed over 14 months among college students (Loukas, Batanova, Fernandez, & Agarwal, 2015). In 2015, e-cigarettes were the most commonly used tobacco product among middle and high school students with prevalence rates of 5.3% and 16% respectively (Singh et al., 2016). Currently, 2.8% (6.9 million) U.S. adults use e-cigarettes (Wang et al., 2018).

E-cigarettes were introduced in 2003 and have been available in the United States since 2007 (Roger, Abayon, Elad, & Kolokythas, 2016). In 2016, the Food and Drug Administration (FDA) issued a final deeming rule to include e-cigarettes under the regulative authority of the FDA and made provisions to protect public health through regulating e-cigarette manufacturing, advertisement and sale (Food & Drug Administration, 2016). E-cigarettes are electronic nicotine

delivery devices that simulate the same sensory experience of smoking conventional cigarettes. They are designed as cigarette-like tubes comprising a battery, an airflow sensor, a vaporizer, and a nicotine cartridge (Sutfin, McCoy, Morrell, Hoeppner, & Wolfson, 2013). The chamber of liquid nicotine is warmed by a heating element and produces a white vapor of smoke when exhaled (Kempton, 2014). Some e-cigarettes are disposable and discarded after consumption of the e-liquid while others can be reused by refilling the reservoir with e-liquid or replacing the prefilled cartridge (Kaisar, Prasad, Liles, & Cucullo, 2016). E-cigarette use is also called vaping.

E-cigarettes exist as different brands and the composition of the fluid in the cartridge may differ based on nicotine content, flavors and other components (Goniewicz & Zielinska-Danch, 2012). Most e-liquids contain nicotine, propylene glycol and/or glycerin, water or ethanol, flavors and other additives (Jankowski, Brozek, Lawson, Skoczynski, & Zejda, 2017). Based on nicotine concentration, manufacturers usually categorize e-liquid strength as zero (0 mg/ml), low (6, 12 mg/ml), medium (18 mg/ml) and high (24 mg/ml) (Kaisar et al., 2016). However, some "nicotine-free products" have been found to contain nicotine (Cheah, Chong, Tan, Morsed, & Yee, 2014; Hutzler et al., 2014; Trehy et al., 2011). There are about 466 brands and 7,764 unique flavors of e-cigarettes that have been identified (Zhu et al., 2014).

The comparisons of the risks versus benefits of e-cigarettes have been controversial. Because of the lower levels of toxicants in e-cigarettes compared to cigarette smoke and the absence of tobacco and combustion in e-cigarettes, e-cigarettes may be a safer alternative to conventional cigarettes, and could also be useful adjunctively for smoking cessation (Bullen et al., 2013; Caponnetto, Auditore, Russo, Cappello, & Polosa, 2013; Goniewicz et al., 2014). On

the other hand, there is some concern regarding the potential role of e-cigarettes as an avenue for subsequent cigarette smoking initiation (Leventhal et al., 2015; Primack et al., 2018; S. Soneji et al., 2017) and the possible adverse health consequences of some constituents of the e-liquid including nicotine (England, Bunnell, Pechacek, Tong, & McAfee, 2015) and flavors (Allen et al., 2015; Bahl et al., 2012). Bunnell et al, reported higher odds (OR= 1.70) for having smoking intentions among e-cigarette ever-users compared to never-users (Bunnell et al., 2015). A flavoring chemical, diacetyl, which is associated with bronchiolitis obliterans (also known as "popcorn lung") has also been detected in e-cigarettes (Allen et al., 2015). Furthermore, e-cigarette aerosol extracts suppress cellular antioxidant defenses and result in significant DNA damage independent of nicotine concentration (Ganapathy et al., 2017). Also, the vapor from e-cigarettes with or without nicotine induces DNA strand breaks and cell death (Yu et al., 2016). These results demonstrate the need for further investigation of the potential carcinogenic effects of e-cigarette vapor (Ganapathy et al., 2017; Yu et al., 2016). Case reports of spontaneous failure and explosion of e-cigarettes have pointed out a potential risk of accidental injuries to the teeth and oral soft tissues including intraoral burns, luxation injuries and alveolar fractures (Harrison & Hicklin Jr, 2016; Roger et al., 2016). It has been suggested that consumer adherence to manufacturer's instructions for charging the lithium-ion battery of e-cigarettes can reduce the chance of explosion or fire (Harrison & Hicklin Jr, 2016). Soneji et al. (2018), quantified the population-level benefits and harms of e-cigarette use in the United States and reported that e-cigarette use currently represents more population-level harm than benefit (S. S. Soneji, Sung, Primack, Pierce, & Sargent, 2018). However, there is paucity of longitudinal evidence characterizing the long-term health consequences of e-cigarettes, in part because they are new on the market.

Due to the deleterious effects of tobacco on health, health professionals often counsel on the benefits of avoiding tobacco use. With the increasing popularity of e-cigarettes, health professionals are more likely to encounter patients that may have questions regarding e-cigarette's health effects, safety of use, efficacy as an aid for tobacco cessation, and possible adverse events associated with use. Considering the limited scientific evidence to conclusively ascertain the long-term impact of e-cigarette use, it will be beneficial for health-related professionals to continuously review research on e-cigarettes and be aware of evidence-based findings that will influence client education. Tomar et al. (2015) recommend that all forms of tobacco and nicotine use including e-cigarettes should be documented when taking health histories and that all patients should be advised about the unknown dangers of e-cigarette use (Tomar, Fox, & Connolly, 2015).

Perceptions of risk and benefit

The ongoing investigations on the health impact of e-cigarettes have been accompanied by mixed messages and a lack of consensus, which may lead college students to rely on their own perceptions of risk and benefits in deciding whether to use e-cigarettes (Abadi, Couch, Chaffee, & Walsh, 2017). Value-expectancy based concepts such as the Health Belief Model suggests that perceived risk and benefit can influence health behavior (Stretcher & Rosenstock, 1997). An increase in perceived risk and benefits increases the adoption of preventive actions of smoking (Sharifirad, Hazavehei, Hasanzadeh, & Danesh, 2007).

Chaffee et al. (2015) examined relationships between adolescents' risk and benefit perceptions with e-cigarette use. Ever-users of e-cigarettes had a statistically significant lower

perceived risk probability in most of the outcomes assessed (Chaffee et al., 2015). Similarly, never-users of e-cigarettes perceived a higher likelihood of experiencing physical and social risks from e-cigarette use than ever-users (Abadi et al., 2017). Dobbs et al. (2017) examined the influence of perceived harm of e-cigarettes on e-cigarette use among adolescents. The odds of lifetime use (OR= 2.40, 95% CI: 1.98-2.90) and past 30-day use (OR= 2.18, 95% CI: 1.63-2.92) were higher for students who perceived e-cigarettes as less harmful than conventional cigarettes (Dobbs, Hammig, & Henry, 2017).

Although the level of toxicants found in e-cigarette vapor may be lower than toxicants in cigarette smoke (Goniewicz et al., 2014), some individuals may misinterpret this comparison as an affirmation of the safety of e-cigarettes. This could potentially result in initiation of e-cigarette use among several populations, such as college students, who may be predisposed since they attain a new level of autonomy and are at an age for exploration (Rozmus, Evans, Wysochansky, & Mixon, 2005).

Purpose

The purpose of this study is to:

1.) Evaluate the association between perceived risks and benefits and the use of e-cigarettes among college age students.

2.) Evaluate the association between perceived risks and benefits and the use of cigarettes among college age students.

Hypothesis

It is hypothesized that:

1.) There will be a statistically significant association between perceived risks and benefits of e-cigarettes and the use of e-cigarettes (categorized as ever-users and never-users).

2.) There will be a statistically significant association between perceived risks and benefits of cigarettes and the use of cigarettes (categorized as ever-users and never-users).

Ever-user: Participants that have used cigarettes/e-cigarettes, even once or twice.

Never-user: Participants that have never used cigarettes/e-cigarettes, even once or twice.

Significance of the study

Per the Health Belief Model, the likelihood of exploration with e-cigarette use may be associated with perceptions of risk and benefits. Also, with the rising popularity of e-cigs marketed as safer alternatives to conventional cigarettes, it is important for healthcare professionals to provide a clearer message regarding e-cigarette use. Knowledge on the perceived risks and benefits associated with e-cigarette use and cigarette smoking will provide a foundation for health-related professionals and programs to understand how the current literature on e-cigarette use is interpreted among college students.

CHAPTER II

METHODOLOGY

Study Design & Participants

Using a cross-sectional study design, in the first phase of this study, participants were recruited from classes and sent a link to complete a survey using Qualtrics. The participants were given the same survey three days later. This phase of the study was done to assess the test-retest reliability of the instrument.

In the second (main) phase of the study, random sample of college students were invited by email to complete an online Qualtrics survey. The sample included undergraduate and graduate college students in any of the five campuses. The Office of Institutional Research, Effectiveness and Planning generated this random sample from a pool of all eligible students. Consenting participants completed the online survey (anonymously) assessing demographic characteristics, e-cigarette use, conventional smoking pattern, and perceived risks and benefits associated with e-cigarette use and conventional smoking. The utilized surveys are included in appendix A. Approval was obtained by the university's institutional review board. The students who completed the survey were eligible to receive one of five $20 Wal-Mart gift cards.

Demographic Variables

Participants were asked questions about the following demographic variables: age, gender, race/ethnicity, year in school, location of residence (on-campus or off-campus), and involvement with Greek organizations (fraternities or sororities).

Cigarette Smoking and E-cigarette Use

To assess cigarette smoking and e-cigarette use, participants were asked about tobacco-related behaviors separately for conventional cigarettes and electronic cigarettes (Chaffee et al., 2015). Participants provided a yes or no response to the question, "Have you ever smoked a cigarette in your life, even once or twice?" The response yes was categorized as 'ever-user' and no was categorized as 'never-user.' A brief description of electronic cigarettes (including alternative names such as e-cigarettes, vapor pens and hookah pens) was provided and participants were asked whether they had ever heard of the product. Participants who had heard of e-cigarettes were asked: "Have you ever used an as e-cigarette in your life, even once or twice?" The response no was categorized as 'never-user.' Participants who respond with the option 'yes' for use of electronic cigarettes were classified as 'ever-users'. In addition, ever-users of either product were asked, "During the past 30 days, on how many days did you use (cigarettes/electronic cigarettes)?" Responses included: '0 days', '1 or 2 days', '3-5 days', '6-9 days', '10-19 days', '20-20 days' and 'all 30 days'. The participants who responded ≥1 day were categorized as 'current-users.' Never-users were asked, "Do you think you will be using (cigarettes/electronic cigarettes) a year from now?" Participants who responded "definitely not" were categorized as no intention to use, while those who responded "probably not", "probably yes," or "definitely yes" were grouped as having a possible intention to use.

Perceived Risks and Benefits

Perceived risks and benefits was assessed by utilizing an approach (conditional risk assessment) employed in previous studies (Abadi et al., 2017; Boo et al., 2018; Chaffee et al., 2015). The conditional risk assessment tool was adapted for use with e-cigarettes (Chaffee et al., 2015) from items used to assess perceptions associated with cigarette use (Halpern-Felsher, Biehl, Kropp, & Rubinstein, 2004). Compared to unconditional risk estimates, conditional risk assessment provides a situation or outcome for participants to consider with respect to an often hypothetical behavior in which they may engage, and has been shown to be a superior indicator of behavior (Chaffee et al., 2015; van der Velde, Hooykaas, & van der Pligt, 1996). Also, this measure has been shown to predict cigarette smoking initiation (Song et al., 2009). As utilized in a similar study to evaluate perceived risks and benefits of smokeless tobacco use, the items to measure perceptions were categorized into three composite scales for 'oral and rule breaking risks', 'systemic health risks', and 'benefits'; each component had demonstrated strong internal consistency with Cronbach's alpha of 0.882, 0.905 and 0.769 respectively (Chaffee & Cheng, 2018).

Participants were asked separately for cigarettes and e-cigarettes to estimate the probability (0-100%) that 19-20 health-related or social outcomes would happen to them based on a hypothetical scenario: "Imagine that you just began using (cigarettes / electronic cigarettes). You use them 2 to 3 times per day. Sometimes you use alone, and sometimes you use with friends. Please touch and move the bar to show what you think is the chance (from 0 to 100%) that each of the following will happen to you." Responses were measured on a frequency sliding scale. Fourteen possible risks assessed were: bad cough, decreased athletic performance, heart

attack, lung cancer, mouth cancer, mouth sores, trouble catching your breath, bad breath, become addicted, brown teeth, get into trouble, harm someone nearby, upset family, and upset friends. Also, the item (start smoking cigarettes) was included in the measures for perception of risk for e-cigarettes. Five possible benefits assessed were: feel more alert, feel more relaxed, fit in more, increased athletic performance, and look cool.

In addition, a global measure of overall harm was assessed and participants were asked: "In your opinion, how harmful is using (cigarettes/e-cigarettes) to general health?" Responses were measured from 0-not at all harmful to 100-extremely harmful. The scores for perceptions of overall harm of e-cigarettes were grouped into quartiles (Q 1-4) for clearer comparison of groups of participants with different levels of perceived overall harm: Q1 (0-41.99), Q2 (42-66.99), Q3 (67-88.24), and Q4 (88.25-100). For perceptions of overall harm of cigarettes, quartile grouping yielded two groups (Q3 and Q4) with the same cut-off point (100). Considering approximately half of the participants responded with cigarette perceived overall harm score of 100, two groups were created. Group 1 represented scores less than 100 while Group 2 represented perceived overall harm score of 100.

Two supplemental questions were included in the survey to assess the knowledge of the students on the institution's policies on e-cigarette use as well as their knowledge on resources available to aid smoking-cessation. Participants were asked: Does the university allow e-cigarette use on campus? Does the university offer free smoking cessation programs for all students who desire to quit smoking? Response options were 'yes', 'no' and 'do not know'.

Statistical Analyses

All statistical analyses were computed using IBM SPSS Statistics for Windows Version 24.0. Armonk, NY: IBM Corp. The demographic characteristics and use of e-cigarettes and cigarettes were described as frequency and percent. Pearson's chi-square test was done to evaluate the relationship between the demographic variables and e-cigarette/cigarette use. The reliability of the composite scales for perceived risks and benefits was assessed using two approaches. Test-retest reliability in the first phase of the study was examined by calculating the intra-class correlation coefficients (ICC). In the main study, internal consistency was assessed by calculating the Cronbach's alpha coefficients.

Perceived risks and benefits were classified into: 1.) composite scales "oral and rule breaking risks," "systemic health risks" and "benefits" and, 2.) an overall score for perceived harm categorized into groups from low to high. The association between the independent variables (perceived risks and benefits composite scores and perceived overall harm) and the dependent variables (e-cigarette use and cigarette smoking status) were assessed using logistic regression models. Unadjusted models and adjusted models controlling for demographic covariates were analyzed. Statistical significance was set at $\alpha=0.05$.

CHAPTER III

RESULTS

Research Participant Characteristics

During the first phase of this study, a test-retest analysis was conducted to assess the reliability of the instrument utilized in the subsequent study. Of the 30 participants who completed the test survey, 25 participants completed the retest survey three days later. The second phase of this study (main study) had a response rate of 22.2% with 1110 students accepting the email invitation to participate in the study. However, 129 students provided little to no data and withdrew from the study. Hence, these students were excluded from the study. In addition, the 30 participants who completed the first phase of the study were included in the main study. In total, 1011 students were eligible for inclusion in analytic procedures.

The demographic characteristics of the study sample are displayed in Table 1. Of the 1011 study participants, 37% (374) were male and 63% (637) were female. Among the participants, 65% (657) were 18-21years, 21.1% (213) were 22-24 years and 13.9% (141) were 25 years or more. As depicted in Table 1, 82.2% (831) of the participants identified as Non-Hispanic White, 3.1% (31) Hispanic/Latino, 8% (81) African-American, 4.5% (45) Asian and 2.3% (23) were from other race/ethnicity. The racial/ethnic profile of the study sample was similar to the demographic characteristics of the institution suggesting that the sample is representative of the institution's student population. Additionally, 19.5% (197) of the

participants were first year undergraduates, 18.2% (184) second year undergraduates, 21.1% (213) third year undergraduates, 17.7% (179) fourth year undergraduates, 5.1% (52) fifth year undergraduates, and 18.4% (186) were graduate students.

Table 1 Descriptive Statistics (N=1011)

Measure	**Item**	**Frequency (n)**	**Percentage (%)**
Age			
	18-21 years	657	65.0
	22-24 years	213	21.1
	≥ 25 years	141	13.9
Gender			
	Male	374	37.0
	Female	637	63.0
Race/ethnicity			
	Non-Hispanic White	831	82.2
	Hispanic/Latino	31	3.1
	Black or African American	81	8.0
	Asian	45	4.5
	Other	23	2.3
Year in School			
	First year undergraduate	197	19.5
	Second year undergraduate	184	18.2
	Third year undergraduate	213	21.1
	Fourth year undergraduate	179	17.7
	Fifth year undergraduate	52	5.1
	Graduate	186	18.4
Greek Affiliation			
	Member	362	35.8
	Non-Greek	649	64.2
Location of Residence			
	On-Campus Housing	298	29.5
	Off-Campus Housing	713	70.5

The majority of the sample (63%) did not belong to any Greek organization (fraternity or sorority), 1.2% pledges and 35.8% were members of Greek organizations. Due to the low proportion of pledges among this sample, participants who identified as pledges were included in

the non-Greek category for analysis. There were 70.5% of the students who resided in off-campus housing with 29.5% residing on campus.

E-cigarette Use

Majority (98.7%) of participants in this study had heard of e-cigarettes. Compared to other studies (Abadi 2017, Hefner 2019, Trumbo 2018) reporting ever-use of e-cigarette ranging from 21.7% to 49%, e-cigarette ever-use among the participants in this study was higher; a larger percentage of participants (63.1%) had used an e-cigarette at least once. Similarly, with over half (55.2%) of ever-users of e-cigarettes being current users in this study, the current users of e-cigarettes (34.8%) were more in comparison with other studies that typically produce rates of current e-cigarette use around 10% (Abadi 2017, Hefner 2019, Trumbo 2018).

Following Pearson's chi-square tests, e-cigarette use had a statistically significant association ($p < 0.05$) with age, gender, year in school, race/ethnicity, location of residence and involvement with Greek organizations. As shown in Table 2, among the participants, those aged 18-21 years had higher rates of e-cigarette ever-use (70.4%). More males reported ever-use of e-cigarettes than females at a rate of 73.1% for males and 58.6% of females. Higher levels of e-cigarette ever-use were seen among first year and second year undergraduates: 71.8% and 72.1% respectively. The proportion of Non-Hispanic Whites that had ever-used e-cigarettes was higher (67.6%) than other race/ethnicity groups. However, the number of participants across the race/ethnicity categories was substantially different and direct comparison should be made cautiously. Although the regulations of the university prohibit e-cigarette use on campus, interestingly more students who reside on campus reported higher levels of ever-use of e-

cigarettes (67.3%) than those who reside off campus (62.5%). This could be because students who reside on campus may use e-cigarettes whenever they are away from the university or that they do not entirely adhere to the university's tobacco policies. Moreover, the first time participants used e-cigarettes was not assessed in this study and many participants may have used e-cigarettes prior to enrollment. Based on involvement with Greek organizations, participants who were members of sororities or fraternities reported higher rates of ever using e-cigarettes (77.8%) compared to non-Greek members (56%).

Cigarette Use

In contrast with other studies that reported rates of ever-use of cigarettes as 11% (Trumbo, 2017) and 14.1% (Hefner, 2019), about half (50.5%) of the participants in this study had used a cigarette at least once. Also, 16.1% of the participants were current cigarette smokers. This finding was more than 7.1% of current smokers reported in another study (Hefner, 2019). The Pearson's chi-square tests showed ever-use of cigarettes had a statistically significant association ($p < 0.05$) with age, gender, year in school, race/ethnicity, location of residence and involvement with Greek organizations. Compared to their counterparts, higher levels of cigarette ever-use was reported among participants who were 25 years or more (66.7%), males (66%), fourth year undergraduate (56.4%), Non-Hispanic White (53.6%), residing off-campus (55.1%) and members of Greek organizations (59.7%).

Table 2 Frequency of Ever-use of E-cigarettes and Cigarettes (N=1011)

Measure	Item	E-cigarettes[a] n (%)	Cigarettes[a] n (%)
Total (N=1011)		638 (63.1)	511 (50.5)
Current Use		352 (34.8)	163 (16.1)
Age			
	18-21 years	459 (70.4)	306 (46.6)
	22-24 years	118 (56.5)	111 (52.1)
	≥ 25 years	61 (44.5)	94 (66.7)
Gender			
	Male	269 (73.1)	247 (66.0)
	Female	369 (58.6)	264 (41.5)
Race/ethnicity			
	Non-Hispanic White	558 (67.6)	445 (53.6)
	Hispanic/Latino	18 (60.0)	16 (51.6)
	Black or African American	29 (36.7)	21 (25.9)
	Asian	21 (50.0)	17 (37.8)
	Other	12 (54.5)	12 (52.2)
Year in School			
	First year undergraduate	140 (71.8)	80 (40.6)
	Second year undergraduate	132 (72.1)	87 (47.5)
	Third year undergraduate	145 (68.7)	112 (52.6)
	Fourth year undergraduate	112 (62.6)	101 (56.4)
	Fifth year undergraduate	26 (51.0)	29 (55.8)
	Graduate	83 (46.4)	102 (54.8)
Greek Affiliation			
	Member	281 (77.8)	216 (59.7)
	Non-Greek	357 (56.0)	295 (45.5)
Location of Residence	On-Campus Housing	198 (67.3)	119 (39.9)
	Off-Campus Housing	440 (62.5)	392 (55.1)

[a]E-cigarette/Cigarette ever-use represents a yes response to the having used e-cigarettes/cigarettes at least once in their lifetime.

Relationship between E-cigarette Use and Cigarette Use

Pearson's chi-squared test demonstrated statistically significant association between e-cigarette use and cigarette use (χ^2 (1) = 228.6, $p < 0.01$). Among the participants who had never used e-cigarettes, 81.1% had never used cigarettes while among e-cigarette ever-users, 68.8% had used cigarettes at least once. Similarly, in comparison with never-users of cigarettes, higher levels of e-cigarette ever-use (86.6%) were reported by participants who were ever-users of cigarettes.

Perceptions of Risks and Benefits – Descriptive and Reliability Data

Test-retest reliability was adequate for most of the perceived risk and benefit measures. The intra-class correlation (ICC) for e-cigarette perceived oral and rule breaking risks was 0.88, perceived systemic health risks (ICC = 0.88) and perceived benefits (ICC = 0.76). For perceptions regarding the use of cigarettes, ICC for perceived oral and rule breaking risks was 0.57, perceived systemic health risks (ICC = 0.80) and perceived benefits (ICC = 0.78). From the main study comprising 1011 participants, the mean, standard deviation and internal consistency measures of participant's perceptions rated on a scale of 1-100 are displayed in Table 3. The mean perceived oral/rule breaking risks and systemic health risks for cigarettes was higher when compared to e-cigarettes while the mean perceived benefits for cigarettes was lower than e-cigarettes. On the average, participants perceived the overall harm of e-cigarettes as 63.5 (± 27.8) and the overall harm of cigarettes as 91.2 (± 15). The perceived risk and benefit scales demonstrated acceptable to good internal consistency. For e-cigarettes: perceived oral and rule breaking risks ($\alpha = 0.84$), perceived systemic health risks ($\alpha = 0.88$) and perceived benefits ($\alpha = 0.71$). For cigarettes: perceived oral and rule breaking risks ($\alpha = 0.83$), perceived systemic health

risks (α = 0.85) and perceived benefits (α = 0.74).

Table 3 Reliability and Descriptive Statistics- Perceived Risks and Benefits

	E-Cigarettes			***Cigarettes***		
Variable	*M*	*SD*	*(α)*	*M*	*SD*	*(α)*
Perceived Oral and Rule Breaking Risks	47.09	23.48	0.84	72.76	20.10	0.83
You'll have bad breath	44.13	35.23		85.46	21.95	
You will get mouth cancer	45.39	32.42		70.64	27.64	
You will have brown teeth	38.67	33.35		79.06	24.62	
You will get mouth sores	41.04	32.17		67.91	31.08	
You will get into trouble	25.25	30.56		41.14	38.86	
You will become addicted	72.04	30.29		84.45	23.95	
You will upset your family	63.13	36.19		80.67	29.15	
Perceived Systemic Health Risks	39.05	24.05	0.88	68.31	22.07	0.85
Your performance in sports will get worse	47.10	35.36		76.20	29.17	
You'll get a bad cough	51.77	33.35		76.88	26.36	
Your friends will be upset with you	26.32	32.51		53.66	37.87	
You'll have trouble catching your breath	51.52	32.96		78.02	25.43	
You'll have a heart attack	29.97	28.92		59.32	30.85	
You will get lung cancer	46.51	32.56		76.81	24.64	
You will harm someone nearby	27.35	32.54		57.29	37.35	
You will start smoking cigarettes	31.86	34.71				
Perceived Benefits	20.64	17.96	0.71	17.54	17.08	0.74
You will look cool	18.68	28.21		12.81	22.14	
You'll feel more alert	19.27	26.13		18.25	25.58	
You'll feel more relaxed	38.44	33.18		36.69	33.09	
You will fit in more	20.53	27.25		13.26	22.16	
You will have better athletic performance	6.29	12.90		6.68	14.96	

Relationship between Perceptions of Risks and Benefits and E-cigarette Use

Table 4 displays the logistic regression models examining the association between perceived risks and benefits of e-cigarettes (Independent Variable) and e-cigarette use (Dependent Variable). Model 1 represents composite scores for perceptions (oral/rule breaking risks, systemic health risks and benefits) and e-cigarette use. Model 2 represents perception of overall harm of e-cigarettes and e-cigarette use. In both models, cigarette use and all demographic variables were included as covariates.

On average, for every 1-unit increase in perceived oral and rule breaking risk, there was a 2% decreased odds of e-cigarette ever-use (OR 0.98, 95% CI 0.96-0.99). Similarly, for every 1-unit increase in perceived systemic health risk, there was a 2% decreased odds of e-cigarette ever-use (OR 0.98, 95% CI 0.96-0.99). Regarding perceived benefits, every 1-unit increase was accompanied by a 4% increased odds of e-cigarette ever-use (OR 1.04, 95% CI 1.02-1.05). Participants who had never used cigarettes had a 91% reduced odds of e-cigarette ever-use (OR 0.09, 95% CI 0.06-0.15). Among the analyzed demographic covariates, age and involvement with Greek organizations were statistically significantly associated with ever-use of e-cigarettes. Participants aged 18-21 years had 5.5 times the odds of e-cigarette ever-use (OR 5.50, 95% CI 2.46-12.32) compared to those 25 years or older. Members of Greek organizations had slightly over two-fold increase in odds of e-cigarette ever-use than those who were not members of Greek organizations (OR 2.24, 95% CI 1.51-3.31).

Compared to Q4, participants in Q1 had 8.29 times the odds (OR 8.29, 95% CI 4.69-14.64), Q2 had 2.18 times the odds (OR 2.18, 95% CI 1.38-3.43), and Q3 had 1.11 times the

odds (OR 1.11, 95% CI 0.72-1.70) of e-cigarette ever-use. There was a statistically significant difference between Q1 and Q4 ($p < 0.01$), Q2 and Q4 ($p < 0.01$), but no statistically significant difference between Q3 and Q4 ($p > 0.05$).

Relationship between Perceptions of Risks and Benefits and Cigarette Use

The logistic regression models examining the relationship between perceived risks and benefits of cigarettes (Independent Variable) and cigarette use (Dependent Variable) are shown in Table 5. Model 3 represents composite scores for perceptions (oral and rule breaking risks, systemic health risks and benefits) and cigarette use. Model 4 represents perception of overall harm of cigarettes and cigarette use. E-cigarette use and all demographic variables were included as covariates in both models.

With respect to the composite scores, only perceived systemic health risks were not statistically significantly associated with ever-use of cigarettes. There was an associated 3% (OR 0.97, 95% CI 0.95-0.98) decrease in odds of ever-use of cigarettes with every 1-unit increase in perceived oral and rule breaking risk scores. For every 1-unit increase in the perceived benefits, there was a 2% increase in the odds of cigarette ever-use (OR 1.02, 95% CI 1.01-1.03). Participants who had never used e-cigarettes had a 93% decrease in odds of cigarette ever-use (OR 0.07, 95% CI 0.05-0.11). Age, gender, and involvement with Greek organizations were statistically significantly associated with cigarette ever-use. For participants aged 18-21 years, there was a 92% decreased odds (OR 0.08, 95% CI 0.03-0.18) of cigarette ever-use compared to those 25 years or more. Males had a 2.2 fold increase in odds (OR 2.22, 95% CI 1.58-3.12) of cigarette ever-use than females and participants who were members of Greek organizations had

1.8 times the odds (OR 1.83, 95% CI 1.28-2.61) of cigarette ever-use compared to non-Greek members. Compared to participants who rated their perceived overall harm of cigarettes as 100, those who had ratings of less than 100 had almost a 2-fold increase in odds for ever-use of cigarettes (OR 1.97, 95% CI 1.43-2.70).

Table 4 Logistic Regression Models Examining the Association between Perceived Risks and Benefits of E-cigarette Use (Independent Variable) and E-cigarette Use [a] (Dependent Variable)

Model	Independent Variable	Odds Ratio	95% C.I.	*p* value
1.	Perceived oral/rule-breaking risks, 1 unit increase	0.98	0.96-0.99	0.002
	Perceived systemic health risks, 1 unit increase	0.98	0.97-0.99	0.017
	Perceived benefits, 1 unit increase	1.04	1.02-1.05	< 0.001
2.	Overall perceived harm, quartile 1 vs 4	8.29	4.69-14.64	< 0.001
	Overall perceived harm, quartile 2 vs 4	2.18	1.38-3.43	0.001
	Overall perceived harm, quartile 3 vs 4	1.11	0.72-1.69	0.64

Footnotes: a. E-Cigarette use dichotomized into ever-use and never-use.
2 separate models (Models 1 and 2) were computed to examine the association between perceived risks and benefits and e-cigarette use. The predictor variables for Model 1 were perceived oral and rule breaking risks, perceived systemic health risks and perceived benefits of e-cigarettes. For Model 2, the predictor variable was overall perceived harm of e-cigarettes stratified into quartiles (quartile 1-quartile 4).
Covariates in each of the regression models were age (categorical)*, gender (categorical), race-ethnicity (categorical), year in school (categorical), location of residence (categorical), involvement with Greek organizations (categorical)*.
* ($p < 0.01$)

Table 5 Logistic Regression Models Examining the Association between Perceived Risks and Benefits of Cigarette Use (Independent Variable) and Cigarette Use[a] (Dependent Variable)

Model	Independent Variable	Odds Ratio	95% C.I.	*p* value
3.	Perception of oral/rule-breaking risks, 1 unit increase	0.97	0.95-0.98	< 0.001
	Perception of systemic health risks, 1 unit increase	1.01	0.99-1.02	0.17
	Perception of benefits, 1 unit increase	1.02	1.01-1.03	0.003
4.	Overall perception of harm, group 1 vs 2	1.97	1.43-2.70	< 0.001

Footnotes: a. Cigarette use dichotomized into ever-use and never-use.
2 separate models (Models 3 and 4) were computed to examine the association between perceived risks and benefits and cigarette use. The predictor variables for Model 3 were perceived oral and rule breaking risks, perceived systemic health risks and perceived benefits of cigarettes. For Model 2, the predictor variable was overall perceived harm of cigarettes stratified into groups (group 1 and group 2); (Group 1 <100; n=464) and (Group 2 =100; n=547).
Covariates in each of the regression models were age (categorical)*, gender (categorical)*, race-ethnicity (categorical), year in school (categorical), location of residence (categorical), involvement with Greek organizations (categorical)*.
* ($p < 0.01$)

Knowledge on campus policies and resources

Supplemental questions were included in this study to examine the knowledge of the students on the institution's policies on e-cigarette use as well as their knowledge of resources available to aid smoking-cessation. Among the participants, 4.8% responded that e-cigarette use was permitted on campus, 64.9% responded correctly that e-cigarette use was not permitted on campus, and 30.2% did not know the campus policy regarding e-cigarette use. Concerning the availability of free smoking-cessation programs for students who desire to quit smoking, 33.3% of participants were aware of the smoking-cessation programs, 3.5% responded that there were no smoking cessation programs and 63.1% of students did not know whether free smoking-cessation programs were available to students.

CHAPTER IV

DISCUSSION

The purpose of this study was to examine the association between perceptions of risk and benefit and the use of e-cigarettes/cigarettes. According to the Health Belief Model (HBM), perceived benefits and perceived risks of harm also referred to as perceived susceptibility influence the adoption of recommended preventive health actions (Stretcher & Rosenstock, 1997). Studies have identified perceptions as predictors of several health behaviors (Carpenter, 2010; Jones et al., 2015; Orji, Vassileva, & Mandryk, 2012). As a result, health interventions have utilized strategies targeted at changing perceptions to drive behavior change (Abood, Black, & Feral, 2003; Sharifirad et al., 2007).

By separately measuring the perceived risks and benefits of e-cigarettes and cigarettes, this study evaluates the absolute perceptions associated with e-cigarette and cigarette use. From the results, perceived risks and benefits were associated with e-cigarette use. Participants with higher perceived oral and rule-breaking risks and higher perceived systemic health risks had decreased odds of e-cigarette ever-use while participants with higher perceived benefits had increased odds of e-cigarette ever-use. Following division of the participants into 4 groups based on their level of perceived overall harm of e-cigarettes, those in the group with the lowest scores had 8.29 times the odds of e-cigarette ever-use compared to participants with the highest scores

for perceived overall harm of e-cigarettes. As the perceived overall harm of e-cigarettes increased, the odds of e-cigarette ever-use decreased among the participants.

Similarly, perceived oral and rule breaking risks and perceived benefits were statistically significantly associated with cigarette use. Higher perceived oral and rule breaking risks was associated with decreased odds of cigarette use while higher perceived benefit was associated with increased odds of cigarette ever-use. With approximately half of the participants rating the maximum (100 on a scale of 1-100) overall harm of cigarettes, comparison was made between two groups of participants. Participants with less than the maximum score for perceived overall harm of cigarettes had almost a two-fold increased odds of cigarette ever-use compared to those who rated the maximum score for perceived overall harm of cigarettes. The scores for perceptions of overall harm of e-cigarettes were more widespread when compared to scores of perceived overall harm of cigarettes. The widespread distribution for perceptions on e-cigarettes mirrors the mixed messages of safety of e-cigarettes. Considering the significant association of perceived risks and benefits with e-cigarette and cigarette use, this study yields some findings that show the importance of appropriately addressing perceptions.

Results from this study were similar to other reports that have shown that lower risk perceptions are associated with increased likelihood of ever using e-cigarettes (Abadi et al., 2017; Cooper, Loukas, Harrell, & Perry, 2017; Dobbs et al., 2017). This study contributes to the body of literature that aims to understand the absolute perceptions regarding e-cigarette use. While it is important to understand how e-cigarettes are viewed in comparison to cigarettes, it is also beneficial to evaluate the absolute risk and benefit perceptions regarding e-cigarettes. As

reports that suggest the role of e-cigarettes as a smoking cessation aid (McNeill et al., 2015) are being publicized, reports that have demonstrated the potential harm of e-cigarettes (Allen et al., 2015; S. S. Soneji et al., 2018; Yu et al., 2016) should be adequately communicated to ensure that the messages regarding the relative and absolute harm of e-cigarettes are appropriately distinguished. Non-smokers may be more likely to initiate e-cigarette use if they misunderstand the messages passed across by proponents of e-cigarettes as smoking cessation aid as an absolute affirmation of the safety of e-cigarettes. The rapid rise in prevalence of e-cigarette use has been a cause for concern to health professionals. Unlike cigarettes, the long-term health effects of e-cigarettes are not well understood. It is therefore important to improve research in this area until a clear consensus regarding e-cigarettes is obtained. Since perceptions play a role in the ever-use of e-cigarettes, it is paramount to keep the public updated on pertinent research findings on e-cigarettes as this could influence the development of well-guided perceptions.

The policy in the institution where this study was done prohibits the use of e-cigarettes on campus. From this study, it was observed that approximately 35% of students did not know the correct campus policy on e-cigarette use. Also, a majority of the students were unaware of the free smoking-cessation programs available to students on campus. We recommend the introduction of lessons on e-cigarettes into health-related curricula in schools to provide up-to-date information to students regarding e-cigarettes. In addition, institutions with smoking-cessation programs should improve the spread of information about the availability of such beneficial resources for students who desire to quit smoking or obtain more information on cigarettes, e-cigarettes and other tobacco products.

This study is not without limitations. The cross-sectional methodology of this study limits the interpretation of the temporality of the observed associations. There is however plausibility for the observed association between perceptions and use of e-cigarettes and cigarettes. Since the study was done among a college population, there is limited generalizability of the findings among other populations. Future studies can replicate this study among non-college populations to determine whether similar associations exist between perceived risks and benefits and the use of e-cigarettes and cigarettes.

In conclusion, this study examines the association between perceived risks and benefits and the use of e-cigarettes and cigarettes. We found support for the potential application of the perceived risks and benefits of e-cigarettes and cigarettes as strategies for health education programs. This study provides useful information for health professionals and college institutions that aim to curb the rising rates of e-cigarette use by implementing health education programs or enacting tobacco-free policies. The adverse effects of cigarettes have been well documented and disseminated, however clearer messages regarding the safety of e-cigarettes are needed. It is imperative for health professionals to have a clear message regarding the absolute safety of e-cigarettes.

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Curriculum Vitae

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EDUCATION

The University of Mississippi, Master of Science (Health Promotion), 2017-present (GPA 4.0)
The University of Port Harcourt, Nigeria, Bachelor of Dental Surgery (BDS), 2007-2014

WORK EXPERIENCE- TEACHING

2017-present Graduate Instructor – Department of Health, Exercise Science, and Recreation Management, School of Applied Sciences, The University of Mississippi

Courses Instructed

ES 396 (Medical Terminology): Undergraduate 3-hour credit course
HP 203 (First Aid & Cardiopulmonary Resuscitation): Undergraduate 3-hour credit course
EL 124 (Racquetball): Undergraduate 1-hour credit course
EL 156 (Jogging): Undergraduate 1-hour credit course

WORK EXPERIENCE- CLINICAL

2018-present Dental Extern – Collier Dental, Oxford, MS
2017-present Dental Extern – Oxford Dental Clinic, Oxford, MS
2017 Dentist – Beaconhill Smile Clinic, Lagos, Nigeria
2016-2017 Dental Officer – National Youth Service Corps (N.Y.S.C), Lagos, Nigeria
2015-2016 Dental Intern – University of Port Harcourt Teaching Hospital, PH, Nigeria

WORK EXPERIENCE- LEADERSHIP

2016 – 2017 Director – Project ADDOH, Awareness on Dental Diseases and Oral Health, Nigeria (I initiated a program to improve oral health at underserved regions in Nigeria).

2013 – 2014 Chairperson – Faculty of Dentistry Annual Health Event Planning Committee, The University of Port Harcourt, Nigeria (I coordinated planning and implementation of events comprising oral health education programs, health outreaches, sports and social activities).

2013-2014 Coordinator – Community Oral Health Education, Nigerian Conference of Christian Medical and Dental Students (I coordinated oral health promotion programs and activities in several communities in Rivers State).

2012 – 2013 Vice President – Port Harcourt University Dental Students Association (I was tasked with organizing oral health education programs for the benefit of the university and its environs).

PUBLICATIONS

Addoh E. Oral Hygiene Status and Practices among Dental Students. *NADS Journal*. 2015; 23.

PRESENTATIONS

Addoh, E. (May, 2014). Oral Hygiene Status and Practices among Dental Students at University of Port Harcourt. Nigeria Association of Dental Students Annual Scientific Conference and Leadership Summit, Nigeria.

WORK EXPERIENCE- VOLUNTEER

2019 Research Fellow – Project SCORE: Student Centered Outcomes Research Experience

2019 Volunteer – University of Mississippi M-Partner

2018 Volunteer – James C. Kennedy Wellness Center, Charleston, MS

2018 Volunteer – Mississippi State Department of Health, Mississippi Partnership for Comprehensive Cancer Control, Tupelo, MS

2018 Volunteer – McLean Institute for Public Service and Community Engagement, Entrepreneurial Learning Center, Charleston, MS

2018 Volunteer – The Partnership for a Healthy Mississippi, Generation Free from Tobacco, Oxford, MS

2018 Wellness Wednesdays Volunteer – Department of Health Promotion, The University of Mississippi, Oxford, MS

2018 Science Fair Judge – Oxford Intermediate School, Oxford, MS

2017 Students Health Fair Volunteer – The University of Mississippi, Oxford, MS

2017 Volunteer – Special Olympics, Area 4, Mississippi, Oxford, MS

HONORS/AWARDS

2019 H. Leon Garrett Achievement Award for Health Promotion

2019 Phi Kappa Phi Honor Society

2019 HESRM American Kinesiology Association Master's Scholar Award

2018 21st Century Student Scholarship
Society for Public Health Education (SOPHE)

2018 Gamma Beta Phi Honor Society

2018 Graduate Student of the Month (October)
The University of Mississippi, School of Applied Sciences

2018 Collegiate Champion –Society for Public Health Education, SOPHE

2014 Best Graduating Student, Course Awards – Anatomy, Physiology, Biochemistry, Pharmacology, Pathology, Surgery, Oral biology, Science of dental materials, Oral pathology, Child dental health, Restorative dentistry, Oral and maxillofacial surgery and Preventive dentistry

2014 Best Graduating Student Overall
The University of Port Harcourt, Faculty of Dentistry, Nigeria

2014 First Prize, Nigeria Association of Dental Students Annual Scientific Conference and Leadership Summit Presentation

PROFESSIONAL MEMBERSHIPS

Global Brigades Dental Chapter, The University of Mississippi
Ole Miss Smile Makers
Society for Public Health Education (SOPHE)
Nigerian Medical Association (NMA)
Nigerian Dental Association (NDA)

TRAININGS/ CERTIFICATIONS

2019 The Problem Solving for Better Health Model (PSBH)
2018 The National Institutes of Health (NIH) Clinical Center
Introduction to Principles and Practice of Clinical Research (IPPCR)
2018 First Aid, CPR & AED Instructor
2018 Online Instructor – eLearning Training Course (eTC)
2017 CITI (Collaborative Institutional Training Initiative)
2017 Diabetes Education Empowerment Program (DEEP)