ABSTRACT

Dental Practitioner Knowledge, Perception and Understanding of E-Cigarettes in Waco, TX

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Increased usage of e-cigarettes by youth and adults constitutes an immediate cause for concern among dental practitioners who have the ability to impact clinical care and affect patient's decision making. While research is currently shifting focus to quantify the long term effects of e-cigarettes, the present knowledge and perceptions of e-cigarettes among dental practitioners is vastly under-researched. The goal of this study was to obtain a better understanding of dentist's perception and knowledge of e-cigarettes and assess whether those factors influenced patient care. Dental practitioners (n=30) in Waco, Texas completed a 15-item Qualtrics survey to convey their knowledge, perception and subsequent clinical behavior among patients who use and those who do not use e-cigarettes. A Fishers test and factor analysis were performed. Additionally, this study compared data to that of a similar study performed in Baltimore, Maryland. There is a significant relationship between one's dental specialty and whether the dentist includes questions about patients' e-cigarette usage on medical history forms. Factor analysis indicated that dentists who feel ill-informed about the risks of e-cigarettes do not discuss the risks of adverse effects on oral health caused by e-cigarettes with patients actively using e-cigarettes, and also tended to believe that e-cigarettes were safer than conventional cigarettes. Additionally, the percentage of dentists in Waco, TX who explicitly ask patients about the use of e-cigarettes or conventional cigarettes is comparable to that found in the Baltimore, MD study. According to this study of Waco, TX dentists, definitive knowledge of e-cigarette risks on oral health is lacking and this influences patient interaction. This research identifies the importance of educating dental practitioners on the evidence of e-cigarette's effect on oral health, so that they can inform patients of potential health risks and positively impact clinical care.

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DENTAL PRACTITIONER KNOWLEDGE, PERCEPTION AND UNDERSTANDING OF E-CIGARETTES IN WACO, TX

A Thesis Submitted to the Faculty of

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By

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INTRODUCTION

Electronic cigarettes (e-cigarettes) are battery-powered devices that heat up liquid solutions to vaporize an aerosol which often contains comparable amounts of nicotine to that of conventional cigarettes[1]. The creation of the first e-cigarette has been credited to a Chinese pharmacist in 2003[2]. E-cigarettes have quickly circulated the globe since their creation and entered the United States in 2006, where they have peaked in popularity in the last five years. The sleek, high-tech cartridge designs, thousands of flavoring options, and advertising touting the safety of e-cigarettes have made them popular globally.

The World Health Organization claimed the number of global "vapers", a term used commonly to refer to e-cigarette users, reached 41 million in 2018[3]. Today, about 13 million people in the United States use them, along with the millions of others worldwide. A study from November of 2019 estimated 4.1 million high school students and 1.2 million middle school students currently use e-cigarettes[4]. In January of 2018, a congressionally mandated report from the National Academies of Sciences, Engineering, and Medicine conducted a study of youths, whose usage of e-cigarettes currently exceeds that of adults, concluding that youth e-cigarette usage "increases the risk of transitioning

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1 "Study: Some e-Cigarette Liquids May Increase Caries Risk."

2 Jones, "How Many People Vape?"

3 "The History of E-Cigarettes | Electronic Cigarettes the Past, Present and Future | CE Course | Dentalcare.Com."

4 Cullen et al., "E-Cigarette Use Among Youth in the United States, 2019."

to conventional cigarettes"[5]. The study also concluded, based on analysis of research available, that the long-term health effects of e-cigarette usage are unclear. The combination of these findings are a cause for immediate concern among health professionals and suggest the need for expedited research.

E-cigarettes use a battery powered device to heat a liquid to high enough temperatures to aerosolize the liquid for inhalation. The liquid is contained in widely sold cartridges which are commonly referred to as "e-juice" or "vape juice". The contents of the aerosol, supplied by cartridges, commonly contain nicotine, propylene glycol, glycerin, a wide range of flavorings and other chemical ingredients[6]. The devices often resemble pens or USB flash drives.

Unfortunately, there is a significant amount of variance in the content of cartridges and e-cigarette refill solutions. The Center for Disease Control (CDC) claims that e-cigarette aerosols can contain the following: nicotine, ultrafine particles, flavorings such as diacetyl, volatile organic compounds, carcinogens and heavy metals[7]. Prior to January of 2020, the U.S. Food and Drug Administration (FDA) did not regulate e-cigarettes nor the composition of their cartridges.[8] Some e-cigarettes, which have been marketed as containing no nicotine, have been found to

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[5] "New Report One of Most Comprehensive Studies on Health Effects of E-Cigarettes; Finds That Using E-Cigarettes May Lead Youth to Start Smoking, Adults to Stop Smoking."

[6] Products, "Vaporizers, E-Cigarettes, and Other Electronic Nicotine Delivery Systems (ENDS)."

[7] Health, "Smoking and Tobacco Use; Electronic Cigarettes."

[8] Commissioner, "FDA Finalizes Enforcement Policy on Unauthorized Flavored Cartridge-Based e-Cigarettes That Appeal to Children, Including Fruit and Mint."

contain nicotine[9]. Diacetyl is a flavoring agent in e-cigarettes. In butter-flavored microwaved popcorn and other foods, diacetyl is considered safe for consumption. However, evidence suggests that its effects are different when inhaled and it can cause serious lung damage[10] Lungs that are scarred and constricted are referred to as "popcorn lung". Strangely enough, popcorn lung is a potential side effect of inhaling diacetyl. Additional studies have detected heavy metals, such as chromium, nickel, lead, manganese, aluminum, tin and iron in e-liquid and aerosols generated by e-cigarettes. These are likely byproducts of metal components located within the e-cigarette device[11].

The diversity of e-cigarettes and the compounds in their aerosol make it difficult for consumers to be knowledgeable about the safety of these products. The United States health system learned this the hard way, starting in 2019, when there was an outbreak of lung injury associated with the use of e-cigarette or vaping products. In October of 2019, the FDA released their first statement warning consumers to stop using tetrahydrocannabinol (THC) vaping products[12]. At this time, the FDA only speculated that THC containing cartridges were the cause of the lung damage because THC was present in most samples associated with the lung damage cases.

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[9] "Nicotine Levels in Electronic Cigarette Refill Solutions: A Comparative Analysis of Products from the US, Korea, and Poland - ScienceDirect."

[10] Boston and Ma 02115 +1495-1000, "Common E-Cigarette Chemical Flavorings May Impair Lung Function."

[11] National Academies of Sciences et al., *Toxicology of E-Cigarette Constituents*.

[12] Sharpless, "Statement on Consumer Warning to Stop Using THC Vaping Products amid Ongoing Investigation into Lung Illnesses."

The U.S. Centers for Disease Control and Prevention (CDC) began reporting the data of sudden clusters of serious and sometimes fatal respiratory injuries in December of 2019. The first report released by the CDC on December 4th 2019, reported 2,291 cases of hospitalized e-cigarette or vaping use-associated lung injury (EVALI) and 48 deaths related to EVALI[13]. On January 2nd, 2020, due to Trump Administration pressure, the FDA released an enforcement policy ceasing the manufacture, distribution and sale of certain flavored cartridge-based e-cigarettes[14]. This enforcement was targeted to "combat the epidemic of youth e-cigarette use" by banning certain flavors that have been enticing youth to the market.[15] The latest update to case numbers released by the CDC was in February 18th, 2020 and the report claimed a total of 2,807 hospitalizations or deaths due to lung pathology related to e-cigarette or vaping product use. There have been 68 deaths confirmed in the United States.[16] Along with the latest February 18th report, the CDC confirmed laboratory data showing that vitamin E acetate, an additive in some THC-containing e-cigarettes is "strongly linked to the EVALI outbreak"[17]. In this study, vitamin E acetate was found in fluid samples collected from the lungs of EVALI patients.

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[13] "CDC, States Update Number of Cases of Hospitalized E-Cigarette, or Vaping, Product Use Associated Lung Injury (EVALI) | CDC Online Newsroom | CDC."

[14] Commissioner, "FDA Finalizes Enforcement Policy on Unauthorized Flavored Cartridge-Based e-Cigarettes That Appeal to Children, Including Fruit and Mint."

[15] Commissioner.

[16] Health, "Smoking and Tobacco Use; Electronic Cigarettes."

[17] Health.

The CDC and the U.S. Food and Drug Administration (FDA) recommended that consumers not vape tetrahydrocannabinol (THC) or any liquids obtained off the streets or from unknown sources through friends or family[18].

On a more positive note, the emergency department visits related to EVALI cases are continuing to decline in the United States after increasing in August of 2019 and peaking in September 2019, the month prior to the FDA releasing their recommendation to stop usage of cartridges containing THC. The CDC credits this to increased public awareness of the risk of using THC containing e-cigarettes, "removal of vitamin E acetate from some products and law enforcement actions related to illicit products".[19]

Closer to home, in May of 2019 the Texas House voted to raise the legal smoking age to twenty-one in Texas. This law, nicknamed "Tobacco 21", prohibits the sale of cigarettes and other tobacco products, including e-cigarettes, to anyone under the age of twenty-one, excluding military personnel.[20]

The misleading advertisement of e-cigarette companies about e-cigarettes to consumers is rampant. They are often advertised as being "healthier" than conventional cigarettes despite overwhelming amounts of contrary data. E-cigarettes that contain no tobacco are able to "circumvent many of the marketing and usage bans imposed on conventional cigarettes"[21]. However, due to the presence of nicotine, a derivation of tobacco, "therapeutic claims are not openly advertised" and therefore "they are regulated

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[18] Commissioner, "Vaping Illness Update."

[19] Health, "Smoking and Tobacco Use; Electronic Cigarettes."

[20] Byrne, "Texas House Votes to Raise Legal Smoking Age to 21."

[21] Kolandaivelu, "Vaping—Vaccine or Virus?"

as tobacco products rather than medical devices" which shield them "from demanding scientific and regulatory standards"[22].

Manufacturers of e-cigarettes often advertise e-cigarettes as a mode for smoking cessation. Juul, an e-cigarette and cartridge manufacturer, has advertised its nicotine pods as being safer than traditional cigarettes and suggested its use as a method to quit smoking. Lawmakers have been urging the FDA to investigate their misleading marketing and to take "appropriate enforcement action to protect the American public from the fraudulent and unapproved medical claims made by Juul".[23]

In theory, e-cigarettes may reduce the usage of conventional cigarettes and the consumer's consumption of tobacco. However, in application, e-cigarettes may perpetuate nicotine addiction in some users while encouraging the new addiction of others. What is concerning for health professionals, specifically dental practitioners, are youths, who were not engaged in smoking prior to their introduction to e-cigarettes but become enticed by the marketing campaigns and are later seized by their addiction. Not to mention the "passive bystanders now being exposed to aerosolized particulates of unknown consequences" [24].

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[22] Kolandaivelu.

[23] LaVito, "Lawmaker Accuses Juul of Illegally Advertising Vaping as a Way to Quit Smoking."

[24] Kolandaivelu, "Vaping—Vaccine or Virus?"

MATERIALS AND METHODS

Dental practitioners (n=30) in Waco completed a 15-item survey to convey their e-cigarette knowledge, perception and current clinical practices with patients who use e-cigarettes. The survey was prepared in English and made available to dental practitioners who were members of the Central Texas Dental Society (CTDS) through an online survey system, Qualtrics. The questions that were included on the survey are listed in Figure 1. The survey can also be viewed and completed on Qualtrics via the following link: https://baylor.qualtrics.com/jfe/form/SV_26pTj7R3a1KVD93 .

Information Questions	
Q1	What is your dental specialty?
Q2	What year did you complete your dental training?
Qualitative Questions	
Q3	What do you recommend, if anything, for smoking cessation?
Q4	Have you seen information about e-cigarettes in continuing education courses?
	If so, to what extent
Knowledge Based Questions	
Q6-1	I am well informed about the risks of e-cigarettes
Q6-2	In my opinion, e-cigarettes are overall safer than conventional cigarettes
Q6-3	E-cigarette use increases the risks for oral cancer
Q6-4	E-cigarette use can cause dry mouth and/or increase the risk of caries
Q6-5	E-cigarette use increases risk of susceptibility to periodontal disease
Q6-6	E-cigarettes are helpful to patients who want to quit smoking cigarettes
Behavior Based Questions	
Q7-1	Information about the risks from e-cigarette use is included in my patient consent forms
Q7-2	My medical history forms ask my patients about the use of e-cigarettes
Q7-3	My medical history forms ask my patients about the use of conventional cigarettes
Q7-4	I (would) modify my treatment recommendations if a patient reports smoking e-cigarettes
Q7-5	If my patients use e-cigarettes, I discuss the risks of adverse effects on oral health

Figure 1 - 15 item Qualtrics Survey

Institutional Review Board (IRB) approval for this survey was obtained in April of 2019. The survey collected background data for each practitioner first asking their dental specialty with the following options given: General Dentistry, Periodontics, Endodontics, Pediatric Dentistry, Orthodontics, Oral/Maxillofacial Surgery, Prosthodontics, or other. Next, the subject was given the option to select the year in which the highest level of dental training was completed (ten year increments starting at 1955). The dentist's knowledge and behavior in regard to e-cigarettes and dentistry was assessed on the basis of their following responses. A total of 15 questions (2 informational, 6 knowledge based, 5 behavior based, 2 qualitative) were evaluated. The first Likert scale (Q6) used included the six knowledge based questions and the options that the participants were given to choose from were strongly agree, agree, somewhat agree, unsure, somewhat disagree, disagree, and strongly disagree. The second Likert scale (Q7) analyzed the dental practitioner's behavior and the participants were given the option to choose from always, sometimes, rarely, never, and doesn't apply. These two different Likert scales were used; one for knowledge based questions and one for perception based questions. Two qualitative questions regarding smoking cessation and inclusion of e-cigarette information in continuing education were asked. The participant had the ability to write anything in the text box for those two questions.

The subject population that was targeted were members of the Central Texas Dental Society (CTDS). The Central Texas Dental Society is the 11th District of the Texas Dental Societies and is located within Waco, Texas. I was given the opportunity to introduce my thesis on September of 2019 to the members at the beginning of their meeting. Subjects were sent the Qualtrics survey link, through the CTDS President, Dr.

Jason Jolivet, to all members of the Central Texas Dental Society of Waco, TX after the meeting. Subjects were selected through their membership as a dentist in CTDS and through their willingness to complete the survey. There was a disclaimer at the beginning of the Qualtrics survey, conveying anonymity and usage of no personal identifiers. The follow up question asked for consent to participate in the study. Answering "yes" brought the subject to the full survey. Answering "no" brought subjects to end of survey and no data was collected.

Currently, there is one piece of literature regarding dentists' perceptions and subsequent clinical practice related to electronic cigarettes. I credit the paper "Knowledge, Perceptions and Behavior regarding E-cigarettes among Dental Practitioners" by Dr. Shashank Joshi for the inspiration and as a resource for the questionnaire used for the participants of the Qualtrics survey[25]. Based upon the review of Dr. Joshi's thesis along with review of literature, research and news, a survey was designed to assesses the knowledge, perceptions and understanding of dental practitioners in relation to e-cigarettes and oral health in Waco, TX. Additionally, similar questions from Dr. Joshi's survey were used to compare the results of this research in Waco, TX to the results of the study concluded in Baltimore, MD. In addition, please note that Dr. Joshi's survey was sourced directly from the University of Maryland's School of Dentistry faculty, whereas my research is sourced from Waco area dentists who are members of the CTDS. The difference in subject pool may skew the data comparison.

[25] Joshi, "Knowledge, Perceptions and Behavior Regarding E-Cigarettes among Dental Practitioners."

DATA INFORMATION

Dental practitioners (n=30) completed the 15-item survey. The majority of practitioners surveyed were general dentists (80%). The distribution of practitioners according to specialty is shown in Figure 2.

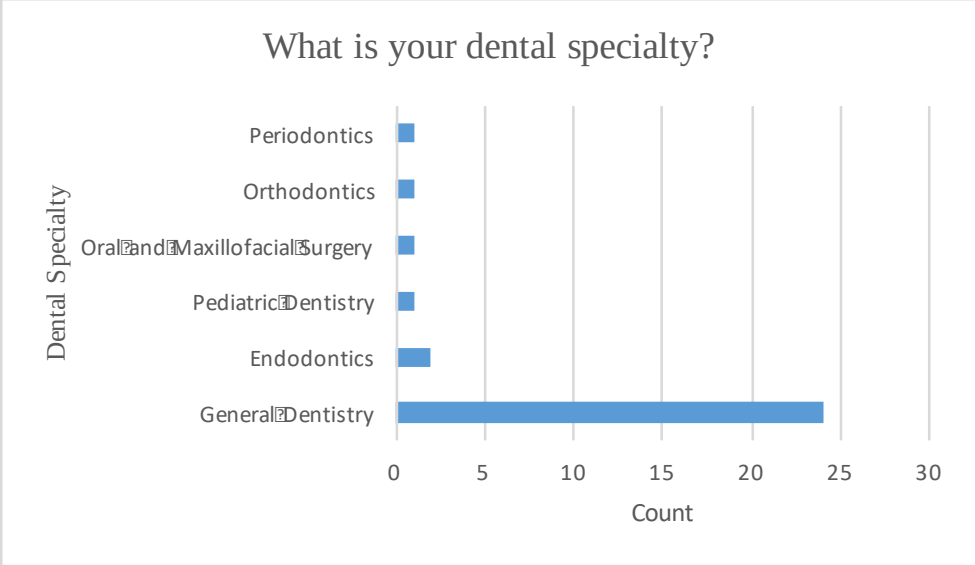

Figure 2 - Dental specialties

Of the 30 dentists who completed the survey, forty-seven percent completed their training in the interval of 2010 to the current year of 2020 (figure 3). Twenty percent completed their training in the interval of 1988-1998 and twenty percent in 1977-1987 (figure 3). Ten percent of the participants completed their training in the interval of 1999-2009 and about three percent completed their training in the time interval of 1966-1976 (figure 3).

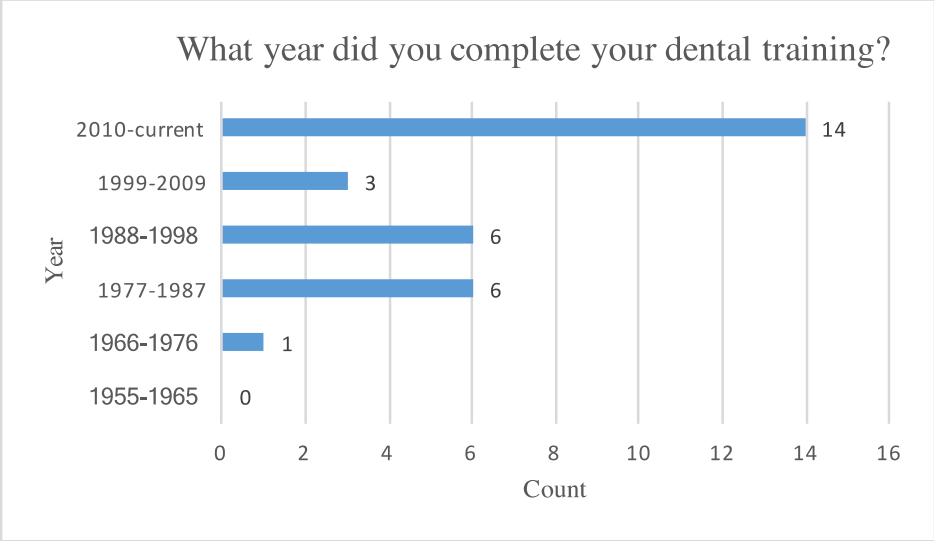

Figure 3 - Year completed dental training

When these participants were asked whether their medical history forms ask patients about the usage of conventional cigarettes, 80% of respondents indicated a positive answer (sometimes and always). See figure 4. However, when these same participants were asked whether their medical history forms ask their patients about the use of e-cigarettes, 70% indicated a negative answer (never and rarely). See figure 5.

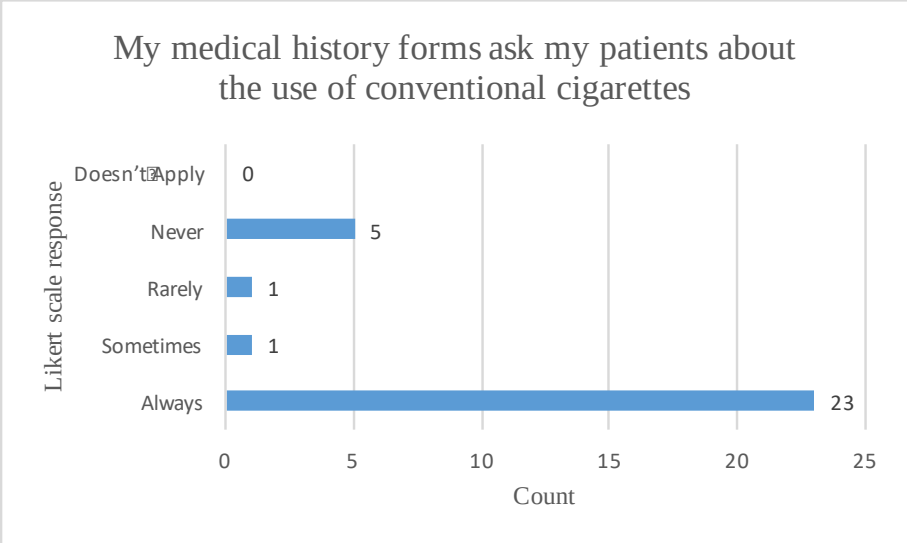

Figure 4 - Medical history form asks patients about use of conventional cigarette

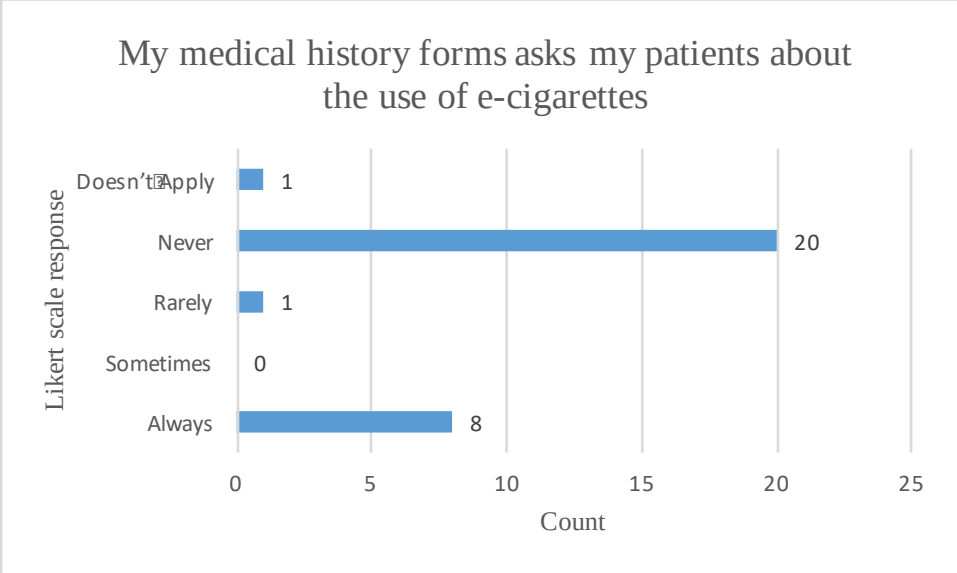

Figure 5 - Medical history form asks patients about the use of e-cigarettes

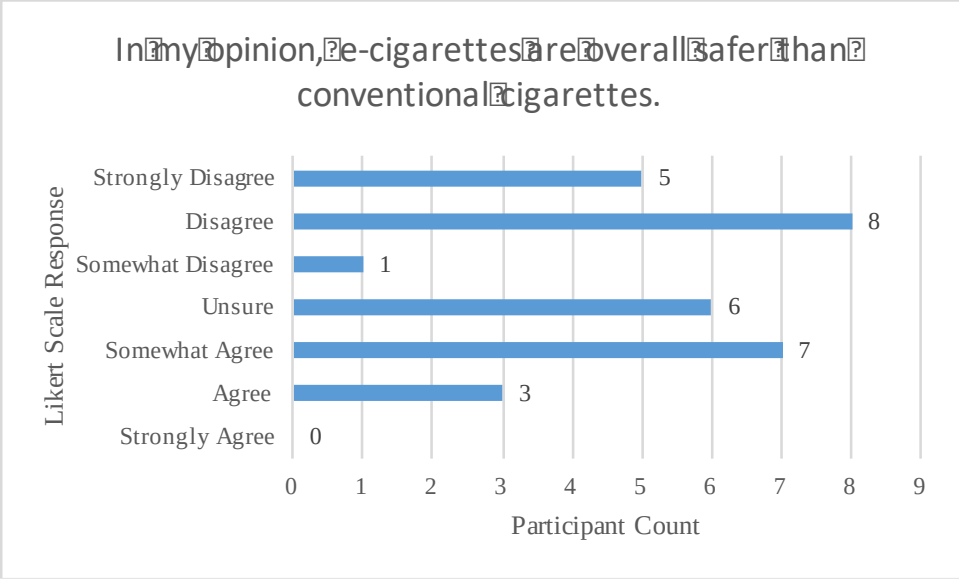

Figure 6 - E-cigarettes are safer than conventional cigarettes

In figure 6, regarding question 6-2, roughly 47% indicated they disagreed (strongly disagree, disagree, somewhat disagree) that e-cigarettes are overall safer than conventional cigarettes whereas 33% indicated they agreed that e-cigarettes are overall safer than conventional cigarettes.

The qualitative responses to question 3 (what do you recommend, if anything, for smoking cessation?) garnered a significant variety of answers. Figure 7 categorizes the answers. Note that some respondents put multiple methods for smoking cessation and thus the numbers for this figure only correspond to the number of recommendations for each method – not the number of participants.

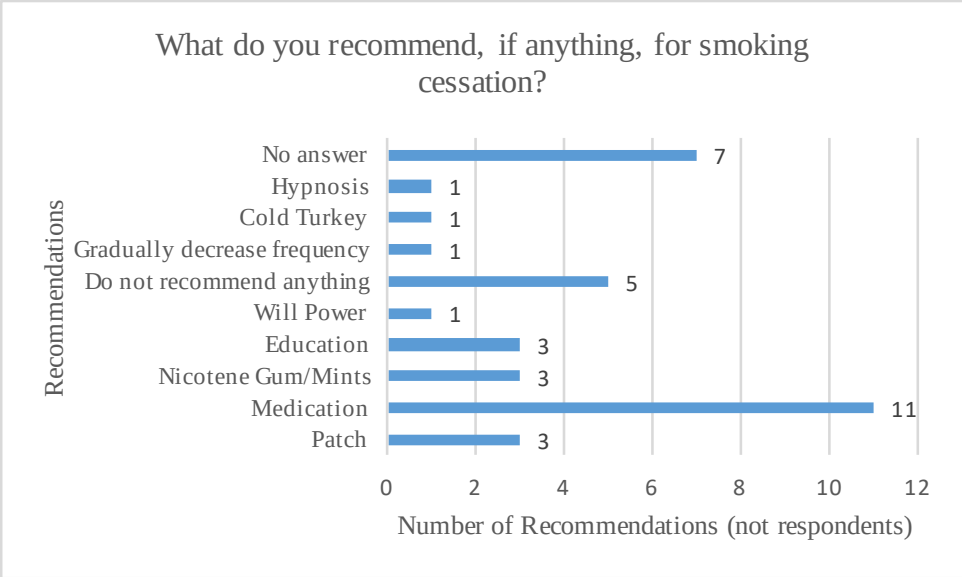

Figure 7 - Recommendation for smoking cessation

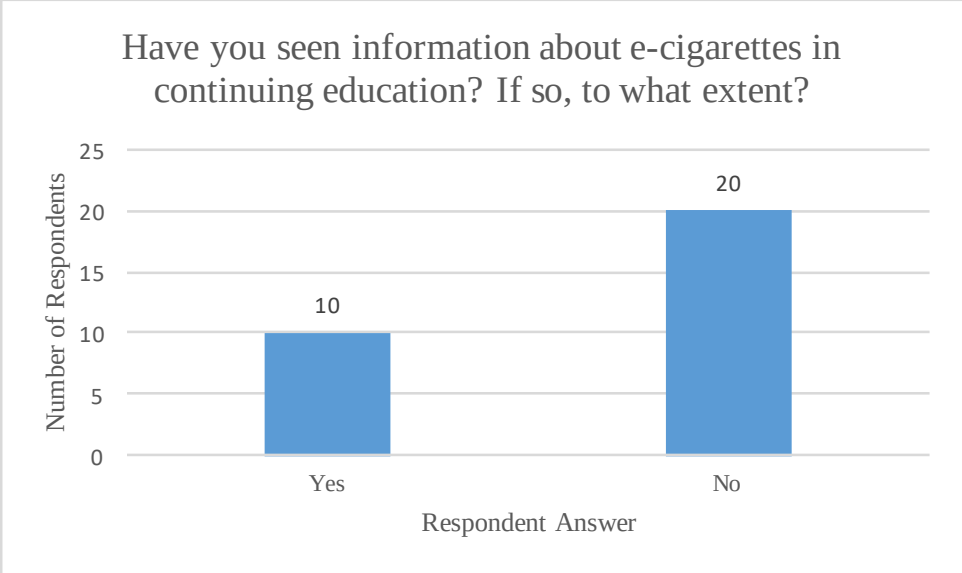

Figure 8 - Information about e-cigarettes in continuing education courses

Figure 8 analyzes the second qualitative question, question 4 (have you seen information about e-cigarettes in continuing education? If so, to what extent?). Sixty-seven percent of respondents wrote no and thirty-three percent of respondents wrote yes.

Out of the ten yes answers, six responded with the extent to which e-cigarettes were prevalent in continuing education. Fifty percent or 3 respondents, indicated they received very little information.

Due to the small sample size, a Fishers exact test was used (figure 9). This test is typically used when sample sizes are small, but it is applicable for all sample sizes. This test is used to establish nonrandom associations between qualitative variables. The Fishers exact test obtains the probability of the combination of frequencies that are obtained.

Fishers Exact Test	
Dental Specialty vs Q7-2	
p-value	0.0313

Figure 9 - Fishers exact test

A Fishers exact test was performed to establish statistical significance between dental specialties and answers to the Likert scale questions (Questions 6.1-6.6 and 7.1-7.5). The Fishers exact test indicates how significant the differences between two compared groups are and indicates whether those differences could have happened by chance through the p-value. We established the statistical significance at a p-value of less than .05. One Fishers test established statistical significance (Figure 9). The Fishers exact test compared dentist's dental specialty and the answers to Question 7-2 (My medical history forms ask my patients about the use of E-cigarettes) establishing a significant result. This means that there is a significant relationship between one's dental specialty

and whether or not their medical history form asks their patients about the usage of e-cigarettes.

Fishers tests were computed to compare statistical significance between year of training completed and the answers to Question 6.1-6.6 and 7.1-7.5. No statistical significance in these Fisher tests were found.

The following test is called factor analysis (figure 10). Factor analysis' main objective is to condense a large number of variables into a few variables or factors. This test took eleven questions from the Likert scales and condensed them down to four factors. The higher the number is, or the closer it is to one, in figure 10, is associated with the more positive side of the Likert scale (strongly agree, agree, somewhat agree and always, sometimes). The more negative the number is on figure 9 indicates the respondent indicated the negative side of the Likert scale (somewhat disagree, disagree, strongly disagree and rarely, never).

	Factor 1	Factor 2	Factor 3	Factor 4
Q6_4	**0.967338**	-0.125734	-0.041701	0.038061
Q6_5	**0.903207**	-0.071037	-0.048831	0.095232
Q7_5	**0.470485**	**-0.633654**	0.072647	0.176297
Q6_1	**0.436419**	**-0.321231**	0.140590	0.297580
Q7_4	**0.305079**	-0.168086	-0.042347	0.234892
Q6_3	0.186232	-0.094637	**-0.469693**	-0.027611
Q6_2	-0.030568	**0.741723**	0.151123	-0.017381
Q6_6	**-0.485547**	**0.525082**	-0.143430	-0.045817
Q7_1	**0.336882**	0.069965	**0.934682**	-0.023881
Q7_2	-0.024277	-0.248994	**0.363436**	0.161339
Q7_3	0.072668	-0.026906	0.066452	**0.543623**

Figure 10 - Factor analysis

Factor 2 is of the most interest in the factor analysis (figure 10). Dentists who indicated that they do not discuss the risks of adverse effects on oral health if patients use e-cigarettes (Q7-5) and that they are not well informed about the risks of e-cigarettes (Q6-1) also indicated that they believed e-cigarettes are overall safer than conventional cigarettes (Q6-2) and that e-cigarettes are helpful to patients who want to quit smoking cigarettes (Q6-6). While there is conflicting research on whether e-cigarettes are safer than conventional cigarettes and whether e-cigarettes are helpful to patients that want to quit smoking conventional cigarettes, this finding suggests that a better understanding of the risks of e-cigarettes may make dentists more comfortable talking with their patients about this topic and it may also change their overall opinion of the general safety of e-cigarettes.

As seen from the Figure 9, factor 3 involved Question 6-3 (E-cigarette use increases the risks for oral cancer), Question 7-1 (Information about the risks from e-cigarette use is included in my patient consent forms) and Question 7-2 (My medical history forms ask my patients about the use of e-cigarettes). The factor analysis concluded that, of all the Likert scales, there was an established association in which participants answered the three following questions similarly. Factor 3 is interesting because -0.469693, by Question 6-3, indicates that the same participants who did not believe e-cigarette usage increases the risks of oral cancer, included information about the risks from e-cigarette usage in patient consent forms and had medical history forms that asked patients about usage of e-cigarettes. This suggests that dentists who believed that e-cigarettes did not increase the risk of oral cancer tended to ask their patients about e-cigarette usage and included information about the risks of e-cigarettes in their patient

consent forms. While there is conflicting data on this matter, this clearly indicated the need for greater dissemination of existing research on the risks of oral cancer and e-cigarette usage and further research into what dentists are conveying as possible risks of e-cigarette usage to their patients.

While factor 2 and factor 3 seem to be a slight cause for concern for dental professionals, factor 1 shows promise. Dentists who believe e-cigarette usage could cause dry mouth and/or cavities, believe e-cigarettes to increase risk of susceptibility to periodontal disease, discuss the risk of e-cigarettes on oral health, feel well informed about the risks of e-cigarettes, would modify their treatment recommendations of a patient who reported using e-cigarettes, do not believe e-cigarettes are helpful to patients who want to quit smoking, and include information about the risks of e-cigarette usage in their patient consent forms. These variables suggest a positive outcome.

Factor 4 is of no interest because it was condensed to only one variable.

DISCUSSION

The results from this study suggest that majority of practitioners in Waco, TX ask patients about the usage of conventional cigarettes, but do not ask patients about e-cigarette usage in medical history forms. This is a cause for concern as many patients associate conventional cigarettes as being different than using e-cigarettes, likely due to the fact advertisers tout e-cigarettes as the "healthy alternative" to conventional cigarettes. Dentists could play a role in educating patients about the hazards of both smoking and vaping.

A study produced in 2015 found that over 60% of middle school and high school students believed that e-cigarettes caused 'little or some harm'.[26] Additionally, youths who exclusively use e-cigarettes also reported significantly greater intention to use cigarettes and do eventually initiate cigarette use. [27] This "renormalization" of smoking via e-cigarettes has caused youth to believe e-cigarettes much healthier and therefore different than conventional cigarettes. A false disconnect has been constructed between the consequences from using e-cigarettes and conventional cigarettes. Dispelling the notion of a disconnect can assist dentists in diagnosing, treating and informing patients. Asking patients about both conventional and e-cigarette usage would provide a better picture of the patient's overall health as well as an opportunity to educate patients about the dangers of e-cigarettes.

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[26] Health, *Patterns of E-Cigarette Use Among U.S. Youth and Young Adults*.

[27] Wills et al., "Longitudinal Study of E-Cigarette Use and Onset of Cigarette Smoking among High School Students in Hawaii."

Questions 7-2 and 7-3 (figure 4 and figure 5) ask dental practitioners if their medical history form asks patients about conventional cigarette usage and subsequently e-cigarette usage. The comparison between the Baltimore and Waco study produce surprisingly similar results. In Baltimore, 86% of dental practitioners ask patients about conventional cigarettes in their medical history form, while in Waco, 77% of dental practitioners ask their patients about conventional cigarette usage in their medical history forms. In Baltimore, 21% of dental practitioners ask their patients about e-cigarette usage while in Waco, 27% of dental practitioners ask their patients about e-cigarette usage in their medical history forms. Despite the substantial differences in location, culture, source of dental education, number of participants in each study and other variables, the percentage of dental practitioners who asked their patients about e-cigarette usage and conventional cigarette usage varied by only a few percentage points between the studies. Dental school graduates may receive inadequate education nationwide about e-cigarettes and their effects on patient oral and general health. As a result, they omit questions concerning e-cigarette usage on medical history forms. Further studies could be done to determine if a better understanding of e-cigarette usage and its health effects would cause these percentages to improve.

Fishers exact test (figure 9) suggests a significant relationship between one's dental specialty and whether the dentist asks patients about the usage of e-cigarettes in medical history forms. This suggests that certain dental specialties may be more knowledgeable about the importance of asking patients about e-cigarettes. If dentists are educated about the health effects of e-cigarettes, they may be more likely to add questions to their medical history questionnaire concerning e-cigarette usage. This would

give the practitioners a better understanding of their patient's overall health and oral health.

The factor analysis produced many revelatory results (figure 10). Factor 2 suggested that dentists who indicated they do not discuss the risks of adverse effects of e-cigarettes with patients who use the device, feel ill-informed about the risks of e-cigarettes, believe e-cigarettes to be overall safer than conventional cigarettes and believe e-cigarettes are a useful method for patients who want to quit smoking conventional cigarettes. This finding suggests that practitioners may avoid discussion of a topic due to inadequate knowledge.

It is important that dentists and patients understand e-cigarette usage is not innocuous. There is a clear indication that this topic should be discussed in professional dental meetings and continuing education opportunities. While there is conflicting research on the severity of health consequences due to e-cigarettes or conventional cigarettes, it has been definitively proven that each method has its own drawbacks. This factor analysis finding suggests that additional education for dentists, may allow a better understanding of the health impacts of e-cigarettes, and encourage dentists to have open and knowledgeable conversations with their patients about the harmful effects of e-cigarette usage. Additionally, with more education on the topic, dentists may perceive e-cigarettes to be implicated in significant harm to one's health and thus not a useful method for patients who want to quit smoking conventional cigarettes. While 37% of the dentists suggested e-cigarettes to be a helpful method for patients who want to quit smoking conventional cigarettes, none listed e-cigarettes as a method for smoking cessation in question four (what do you recommend, if anything, for smoking cessation?).

It is reassuring to know that dentists have not been advocating e-cigarette use for smoking cessation.

Factor 3 suggest there is availability for more educational resources to dental practitioners on e-cigarettes. This factor suggested that dentists who believe e-cigarette usage does not increase the risk for oral cancer, do include information about the risks from e-cigarette use in patient consent forms and ask their patients about the usage of e-cigarette in medical history forms. While it is a positive finding that these dentists are asking their patients about e-cigarette usage, and are attempting to educate them about the risks, it calls into questions the education their patients are receiving. Perhaps, these dentists educate their patients on other risk factors and do not discuss the possible risk of oral cancer. There are currently no documented cancer diagnoses directly linked to vaping or e-cigarettes[28]. This could be due to the fact that vaping is a recent phenomenon. However, e-cigarette usage has been linked to cancer in mice, suggesting that further research needs to be done to understand the effects on humans[29].

A more pressing consequence of vaping is lung damage. This does not require long term use of e-cigarettes and can be deadly. In October of 2019, a 17-year-old boy, believed to be the first person in the United States with EVALI, underwent a double lung transplant after experiencing detrimental lung damage[30]. His family described him as an athletic teenager who enjoyed participating in sailing, swimming, running and playing video games with friends prior to his emergency room visit. Alarmingly enough, he has

[28] "Does Vaping Actually Cause Cancer?"
[29] "E-Cigarette Vapor Linked to Cancer in Mice."
[30] Shamus, "17-Year-Old Is First Vape-Injured Patient in U.S. to Undergo Double Lung Transplant."

stated that he never bought an e-cigarette and his usage was strictly limited to that of friend's e-cigarettes. His parents were not aware of his e-cigarette usage prior to his respiratory emergency.[31] Cases such as this one, show the importance of widespread education and early intervention.

According to the American Dental Association, in 2018 more Americans wanted to visit the dentist than their primary care physician[32]. Dentists have the responsibility to discuss oral hygiene and other risk factors that may impact oral health. A knowledgeable dentist may have averted this young boy's respiratory emergency and consequential double lung transplant through open discussion about the health effects of vaping. Dentist's knowledge and understanding of the hazards of vaping may reverse current e-cigarette trends and misinformation.

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[31] America, "17-Year-Old Warns Others about the Dangers of Vaping after Double Lung Transplant."

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APPENDIX