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Detecting Electronic Cigarette User Disparity Behaviors: An Infovelliance Study on Twitter

A thesis submitted in partial satisfaction of the requirements for the degree Master of Arts

in

Global Health

by

Cortni Bardier

Committee in charge:

      Professor Raphael Cuomo, Co-Chair
      Professor Timothy Mackey, Co-Chair
      Professor Bonnie Kaiser

2020

The thesis of Cortni Bardier is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

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University of California San Diego

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ABSTRACT OF THE THESIS

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by

Cortni Bardier

Master of Arts in Global Health

University of California San Diego, 2020

Professor Raphael Cuomo, Co-Chair

Professor Tim Mackey, Co-Chair

The aims of the study were to characterize racial and ethnic disparities amongst electronic cigarette users through detecting and classifying user generated conversations associated with electronic cigarettes use on social media platforms. The investigative approach

was through a literature review, analyses of NHANES data, and data collection of geocoded tweets from Twitter. A total of 5,718 tweets were collected. Using a topic modeling approach called BTM, the study identified relevant clusters of Twitter conversation related to electronic cigarettes, 348 tweets were identified that included conversations about user behavior. These tweets were grouped into three categories and visualized on a map to see where conversations were located for racial ethnic associations. The results of the study provide insights into organic conversations regarding user behavior associated with electronic cigarettes. Future studies should focus on other themes and topics associated with electronic cigarettes on social platforms to inform health communication and global public health efforts towards addressing tobacco and nicotine addiction and prevention.

INTRODUCTION

Electronic cigarettes were first introduced in the market in 2006, since then they have become increasingly popular, especially amongst youth. They are also known as vapor pens, e-hookah, and electronic nicotine delivery systems. Electronic cigarettes have been advertised as a safer or healthier alternative to traditional combustible cigarettes. They are battery powered devices that heat a liquid mixture, which contains glycerin, propylene glycol, nicotine, flavors and other additives; when this liquid is heated it creates an inhalable aerosol known as vapor (Walley et al. 2019, 1). While these have been marketed as safer, there is not conclusive evidence as to how safe they are for users (Ghosh et al. 2017, 6). Although electronic cigarettes have been around for more than a decade, the surge in use has only happened in the past couple of years.

Increase in usage has been attributed to a rise in advertising and promotion (Huang et al. 2018, 1). Electronic cigarette advertisement spending increased in 2011 from $6.4 million to $115 million in 2014 (Simon et al 2018, 3). Marketing can be seen in retail stores, television, movies, magazines, newspapers, the internet, print media, and are also circulated on social media platforms (Collins et al. 2018, 1). While there has been some positive support for electronic cigarettes, they remain controversial, considering their marketing tactics, accessibility, and differing claims of harm reduction as previously mentioned. In late fall of 2019, Electronic Cigarette or Vaping Associated Lung Injury also known as EVALI, was introduced as an epidemic due to the increasing deaths and injuries associated with vaping (Deliwala et al. 2020, 1). There were two thousand and fifty-one cases of EVALI, and thirty-nine deaths over a fourth month period in the United States (Salzman et al. 2019, 4). The symptoms of EVALI are

shortness of breath, anxiousness, scarred lungs and loss of lung capacity. These injuries are new and pose new health threats due to vaping and electronic cigarettes.

More broadly, the health effects of tobacco and nicotine include increased heart rate, addiction, lung restriction and often results in lung cancer (Chaturvedi et al. 2015, 5-8). Lung cancer is the leading cause of death among all cancers (Nasim et al. 2019, 1). African Americans in comparison to other racial and ethnic groups are disproportionately affected by lung cancer in both incidence and survival (Sin 2017, 1-2). Although African Americans are more likely to start smoking later in life and more likely to be intermittent and light smokers, disparities and adverse health effects persist, and remain unequal when compared to other racial groups. (Ryan 2018, 1). While this can be attributed to other social determinants of health, menthol has been a driving force to the disparities of cigarette smoking. The percentage of African Americans who smoke menthol cigarettes is 70% compared to Whites at 30% (Besaratinia and Tommasi 2014, 166). Furthermore, African American people are more likely to live in neighborhoods where tobacco companies target their marketing and availability of products (Moran et al. 2019, 3; Ribisl 2017, 387). (This is consistent with higher mortality and incidence rates for lung cancer (Lathan et al. 2015, 1-2). Importantly, there is a thirty to forty-year lag between exposure to smoking and onset of cancer (Hara et al. 2010, 6). Hence, many decades had passed before the association was established between smoking and lung cancer, which was achieved through a series of retrospective and prospective cohort studies that contributed to the 1964 landmark Surgeon General's Report on Smoking and Health (Alberg et al. 2014, 3-5).

The goal of this paper is to characterize and better understand health disparity issues related to emerging and alternative tobacco products amongst African American people in the United States as this is a novel and understudied topic. Many people utilize the Internet to

engage in conversation regarding various topics. Social media has become a hub for members of society to build community and engage with one another. Vaping conversations have also become prominent on social media, with many users posting information about their products, purchases, and vaping tricks on social media, often garnering high levels of user engagement (Kong et al. 2019, 2-5). Tracking user behavior on social media can be a great tool to observe health topics, this is known as infodemiology and infoveillance. The purpose of this study is to observe user behavior in regard to electronic cigarettes to see if there is a racial disparity and association between users of electronic cigarettes, specifically smoking patterns and nicotine dependence. This will provide the health field with characterization of potential health threats that can be directly impact health behavior, tobacco uptake, and elucidate existing tobacco-related health disparities. Increasing our knowledge and understanding of electronic cigarettes use is important for the future of global and public health.

METHODS

The methods, procedures and investigative approach utilized in order to obtain information pertaining to the thesis' aims was conducted in three phases. First, a literature review on existing data in the field specific to tobacco and electronic cigarette related health disparities was reviewed. Second, a secondary data analysis of the National Health and Nutrition Examination Surveys (NHANES) pertaining to racial and ethnic differences concerning electronic cigarettes, was conducted. Finally, surveillance of the social media platform Twitter using geocoded tweets was conducted.

Literature Review

The aim of the non-systematic literature review was to identify alternative and emerging tobacco products and their relation to health disparities, with specific emphasis on the African American and Black community. This was conducted to better understand and characterize health issues and disparities related to tobacco and smoking use in this marginalized population and to identify key findings and potential gaps in the literature. A secondary aim of this review was to also examine the role of technology and social media within the health disparities literature and its association with alternative and emerging tobacco products. The literature review was conducted for journal articles that were indexed in two scholarly databases. This included conducting search term queries on the databases PubMed (Medline) and JSTOR. The rationale for choosing these databases was the multidisciplinary nature of the paper's aims which required a review of science and health literature which was obtained from PubMed, (which indexes journals that cover life sciences and biomedical topics) and JSTOR which was also chosen because it indexes social science journals and peer reviewed articles.

The searches were limited to English-Language articles and studies conducted on populations in the United States, published between 2010-2020. The search queries included Electronic Nicotine Delivery Systems, Electronic Cigarettes, Vaping, Electronic cigarette or Vaping Product Use Associated Lung Injury (EVALI), Black, African-American, Disparity, Health Communication, and Awareness. These terms were utilized in order to gain background information surrounding the use patterns of electronic cigarettes. They were also utilized in order to gain information on what electronic cigarettes are, how the device functions, and the current health implications surrounding electronic cigarettes and vaping. Overall, the literature review was completed to create a coherent literature review on the topic and identify associations between electronic cigarettes and African American/Black people.

After the search there was an inclusion and exclusion criteria based upon review of abstracts. Literature was excluded if it were published before 2010, as electronic cigarette use became more mainstream after this time period. Literature was also excluded if it did not focus on the United States or if there was not a health disparity component assessed.

Secondary Data Analysis of NHANES

The study conducted secondary data analysis on the National Health and Nutrition Examination Survey, also known as NHANES by the National Center for Health Statistics. The survey was conducted in 2015-2016 to explore cigarette use, electronic nicotine delivery systems, and tobacco use. The survey was distributed to participants over the age of twelve years old, through an interview style at home using the Computer Assisted Personal Interview (CAPI) system for participants 18 and over, with participants aged twelve to seventeen were asked questions at using the Mobile Examination Center utilizing an Audio Computer-Assisted Self-Interview (ACASI) system in the languages of English and Spanish only. These two systems were used in order to ensure quality assurance and quality control to reduce data entry errors. The study included all races and ethnicities totaling to ten thousand participants. Two variables were extracted for the purpose of this paper, SMQ900 which asked participants if they ever used an e-cigarette, and RIDRETH 3 which is the race-ethnicity variable. Statistical Analyses was then performed. The data provided information on whether differences existed across racial and ethnic groups amongst electronic cigarette use during the data time period examined.

Social Media Data Collection and Analysis

In order to more directly examine user knowledge, attitudes and behavior as self-reported in a publicly available social media dataset, the study used a filtered data set that contained geolocated posts from the popular microblogging platform Twitter as provided by study Thesis advisors. Twitter is a microblogging platform that permits users to post 280 characters with or without images gifs, video, and other multimedia uses. These characteristics allow users to post or tweet to address multiple topics. The original dataset included tweets from the year 2018-2019. The data collected included textual content of the tweet and post, user and account information, and date and time of post. In order to analyze large volumes of data (in the hundreds of millions), twitter data was filtered for tobacco-related behavioral keywords and then an unsupervised topic model was used to further filter data for conversation groupings of interest

The topic model, known as the biterm topic model (BTM) is a machine learning and natural language processing approach to discover highly correlated word groupings for specific topics, which are then selected for topics of interest and are then extracted for content analysis. The filters and related keywords used included: vape, vaping, and hookah. Using BTM to analyze topic clusters associated with these keywords, groups of messages and text containing the same word-related themes were then categorized into clusters. From the clusters the main themes of these clusters are considered as the topic of the aggregation of the text. Biterm topic model was used to extract social media conversations believed to have contained signal posts. Each thematic group was examined for relevance by assessing whether the frequency, distribution and combination of word groupings in output topics encompassed key topics pertaining to vaping, these topics included "ecig, electronic, nicotine, flavors, e-juice, vape community". After the signal groups were obtained, the posts were retrieved and manually annotated by this author in order to confirm if posts were related to electronic cigarette or

tobacco user behavior. Posts were excluded as signals if they were news related and not organically user-generated related content.

In order to fully capture and accurately classify topics expressed on Twitter related to vaping and electronic cigarettes, this author manually annotated all posts collected by conducting content analysis of text of the posts. The focus of the content analysis used an open inductive coding scheme which was used to detect themes associated with user behavior, characteristics, and sentiments surrounding vaping. Specific themes of interest were social media conversations pertaining to initiation of use, transition of use, and cessation of use of alternative and emerging tobacco use. As these tweets also contained geocoded information, tweets manually labelled as relevant to the study aims were plotted on a U.S map to visualize possible associations with communities and areas of the country associated with a high percentage of minorities or African American populations.

RESULTS

The literature review conducted in this study found that African Americans are substantially underrepresented in the context of scholarly research of alternative and emerging tobacco products. The overall results of the literature review identified two specific categories of related research including: (1) racial health disparity behaviors: (2) health communication and promotion messages and awareness.

In regard to race the literature review found that in general, awareness of electronic cigarettes was higher amongst white people than any other racial group. For other socioeconomic characteristics and demographics such as education, income, and marital status there was variance, however there was little to no significant difference in systematic reviews that covered

this subject (Hartwell et al. 2016, 4). Specific to racial and ethnic disparities examined in this paper, those from African American and Black backgrounds had a greater desire to quit smoking in comparison to those from a white background. Consistently white smokers smoked for a longer time period than Black smokers and also smoked more cigarettes per day than Black smokers. The results demonstrated that flavorings played a key role in user behavior, with African American and Black people more likely to smoke menthol flavored cigarettes than their white counterparts (Smiley et al. 2017, 5).

Behavior associated with use of electronic cigarettes amongst racial groups was also linked to sensory issues (Smiley et al. 2017 4-5). Largely the experience of menthol flavorings in electronic cigarettes was attributed to race as well (Smiley et al. 2017, 5). Reduced sensory and poor experiences with electronic cigarettes in comparison to traditional cigarettes by black users was reported (Smiley et al. 2017, 3-5). Black users of electronic cigarettes often cited that the products were not strong enough and that it did not satisfy their craving and that they did not find the electronic cigarettes helpful in cessation (Smiley et al. 2017, 5). However, Black people are more likely to use electronic cigarettes as cessation devices compared to white people, whereas white people were more likely to use them out of convenience, such as using them in non-smoking areas, due to their easy concealment (Baumann et al. 2019, 3).

Although African American/Black people are more likely to initiate use of electronic cigarettes as cessation devices, the rates of electronic cigarette use are still higher amongst white people who use electronic cigarettes. In terms of behavior and continued use of electronic cigarettes, they mirror trends similarly to those of traditional cigarettes. For example, African American/Black users of electronic cigarettes reported a greater intention to continue use of electronic cigarettes when compared to White and Hispanic users. In summary, while some

initiation and behavior characteristics amongst racial and ethnic groups may differ, higher rates of electronic cigarette use were observed amongst white people in comparison to other racial and ethnic identifying groups.

The literature review also revealed that tobacco-related marketing, specifically online marketing and advertisements, are the most successful and prominent ways to target and engage users to buy alternative and emerging tobacco products. Most of this is done through comparison to other brands, sales, or evoking emotions of a certain lifestyle of being cool, hip and trendy (Timberlake et al. 2017, 2). Smoking cessation is also considered as a tactic to entice users to purchase or in order to adapt new tobacco use habits, often resulting in dual use (i.e. when two types of tobacco products are used simultaneously) (Timberlake et al. 2017, 6). When users were presented with health promotion messages aimed at warning consumers about the risks of electronic cigarette, such as device explosion, negative respiratory health risk, cardiovascular health risks, and addiction, the awareness surrounding users' perceptions were generally moderate (Rohde et al. 2019, 4). Of the health-related harm messages, respiratory harm was seen as the most significant reason why a user might discontinue use or not initiate use, while addiction was the least discouraging reason users would not discontinue use (Rohde et al. 2019, 5). Association with electronic cigarette use was linked to advertisement exposure for Black people, however there was not much significance for white users. Health communication and social network analysis are related. The results of the literature review revealed that on social media sites such as twitter, groups with a high clustering coefficient were more linked, therefore health communication planners are integral in this area of study and could benefit from this collaboration.

In the next section, this study describes the specific studies reviewed and summarizes major findings.

Electronic Cigarette Tobacco Disparities Specific Studies

In the systematic review "E-cigarettes and equity: a systematic review of differences in awareness and use between sociodemographic groups" by Greg Hartwell and colleagues reports on the inequalities and behaviors in sociodemographic areas (Hartwell et al. 2016, 1). The goal of the review was to select cross-sectional or longitudinal studies that described e-cigarette awareness, current use, and ever use of electronic cigarettes. Little is known as to whether e-cigarette awareness and use across socio demographics exist. While electronic cigarettes are meant to be a tobacco control intervention, most interventions have historically widened the health inequality gap between users (Hartwell et al. 2016, 1). The results of the study showed that in the race and ethnicity demographic, higher awareness of electronic cigarettes was found among white respondents. Ever use and current use of electronic cigarettes also stayed consistent with white respondents reporting more use, when compared to other ethnic groups (Hartwell et al. 2016, 3).

The review also revealed disparities within education levels as well. Awareness of electronic cigarettes was higher within subgroups who possessed a higher level of education. However, there are mixed results within the ever use and current use data. Some studies showed that ever use was lowest in low educational attainment or no statistical significance was observed. Current use of electronic cigarettes varied as well. Some studies showed that higher levels of educational attainment were more likely to currently use electronic cigarettes, some studies reported higher current use in low educational attainment or found no significant results

(Hartwell et al. 2016, 4). Socioeconomic status was also reviewed, and the results varied as well, no pattern of association between socioeconomic status and use of electronic cigarettes emerged from the data, with the exception of one study where those with a higher income were more likely to ever use electronic cigarettes. (Hartwell 2016, 4). Other studies found no significant results. As for age, the findings revealed that young adults and older adolescents were more likely to be aware of electronic cigarettes. (Hartwell 2016, 4). In general, young adults and white people were found to be more likely to be aware of electronic cigarettes, or current use, in regard to ever use, and those with higher educational levels tended to report higher instances of ever use.

In the article "Will Electronic Nicotine Delivery System (ENDS) use reduce smoking disparities? Prevalence of daily ENDS use among cigarette smokers" by Kelvin Choi and Julia Chen-Sankey, the study explores the possibility of smokers utilizing ENDS to potentially reduce smoking disparities (Choi and Chen Sankey 2020, 1). A cross-sectional analysis was performed utilizing data from the 2014-2015 Tobacco Use Supplement to the Current Population Survey, where only self-respondents were included. The responses were focused on whether participants used electronic cigarettes every day, some days or not at all, it also accounted for whether they utilized electronic cigarettes every day, some days or not at all, and the number of days they used electronic cigarettes in the past 30 days (Choi and Chen-Sankey 2020, 2). The results of the study showed that the sample consisted of 44.8% of respondents being fifty years or older, 51.9% were female, 64.9% were non-Hispanic white, and 31.9% had a bachelor's degree, and 32.1% reported having an annual household income of more than $75,000. This compares to the overall sample of current smokers who were 50 years or older at 40.4%, 46.2% were female, 71.1% were non-Hispanic white, 17.6% had an income of $75,000 or more, and 12.2% received

a bachelor's degree (Choi and Chen Sankey 2020, 3). This means that users were more likely to be at least 50 years old, female, non-Hispanic white, but have lower educational attainment and a lower house hold income.

Additionally, as reported in this same study, 2.8% of US adult smokers reported using electronic cigarettes daily, while 4.7% of those who made a past-year quit attempt used electronic cigarettes daily. Daily electronic cigarette use was low amongst current cigarette smokers in general ranging from 1-6%, and of those who attempted to quit smoking within the past year ranged from 2-9%. Furthermore, non-Hispanic black people and Hispanics were less likely than non-Hispanic whites to use electronic cigarettes daily amongst current cigarette smokers and those who had attempted to quit within the past year (Choi and Chen Sankey 2020, 3). This is important given that there has been varying evidence on the efficacy of electronic cigarettes as cessation devices (Choi and Chen Sankey 2020, 3). There is a comparable amount of non-Hispanic black and non-Hispanic white traditional cigarette smokers, however non-Hispanic black people have lower rates of successful cessation, therefore if electronic cigarettes can be used as cessation devices and are not being utilized at rates as high than white people, then disparities amongst black and white smokers may continue to increase.

Furthermore, in the study "E-cigarette use and disparities by race, citizenship status and language among adolescents" by Alcala, Albert and Ortega, the study demonstrate that socio demographics that play into the use of electronic cigarettes. The primary study aim they were testing was to assess whether or not adolescent respondents used electronic cigarettes in a binary yes or no model. The design of the study was a cross-sectional phone survey of California adolescents, with one thousand and fifty-two respondents (Alcala et al. 2016, 2). The measurements of the study were conducted through variables relating to race, citizenship and

language; including variables for race classification as non-Latino white, non-Latino Asian, non-Latino other race, and Latino; citizenship classification of US citizen, naturalized citizen, non-citizen English only; and language classification of any other language with or without English (Alcala et al. 2016, 2). Chi-square tests were used to address association of electronic cigarettes with the measured variables. Logistic regression was utilized to anticipate odds of electronic cigarettes based on race, citizenship status and language; these models were duplicated for traditional cigarette smoking as the outcome and electronic cigarettes as the control for the model (Alcala 2016, 2).

The results of the study showed that 6.99% of the respondents used traditional cigarettes while 10.31% of respondents utilized electronic cigarettes. Electronic cigarette use was more common amongst traditional cigarette smokers when compared to those who have never used electronic cigarettes. The study also found that there was no association between race, schooling and electronic cigarette use. However, citizenship status was associated with use of electronic cigarettes, where United States citizens had higher rates of electronic cigarette usage and non-citizens had the lowest rates of electronic cigarette usage (Alcala et al. 2016, 2). Language also had significant associations, where English was the primary language spoken in the home and had higher usage rates of electronic cigarettes. When the controls were set, the results demonstrated that traditional smoking and poverty levels accounted for the differences in race and ethnicity differences of usage (Alcala et al. 2016, 3). Although some variance, was detected this overall finding has mirrored other studies and other patterns seen in traditional cigarette smoking (Alcala et al. 2016, 3-4).

In the study "Racial/Ethnic Differences in Electronic Cigarette Use and Reasons for Use among Current and Former Smokers: Findings from a Community-Based Sample" by Hooper

and Kolar, the study describes the differences of electronic cigarette use, using a community based cross-sectional exploratory study. Participants were recruited from Florida from June to September 2014. Eligibility requirements were 18 years of age, able to speak English or Spanish, and being a current smoker, or former smoker, which resulted in 286 respondents. Participants were given a survey which recorded their demographics, smoking status, electronic cigarettes use, and reasons for electronic cigarette use. (Hooper and Kolar 2016, 3). Electronic cigarette use was measured through a series of yes or no questions, "Have you ever used an e-cigarette", "Have you used an e-cigarette at least once in the past 30 days", "Do you now smoke e-cigarettes every day, some days, or not at all?", and "Do you plan to continue e-cigarette use".? (Hooper and Kolar 2016, 3). The study also measured 13 items on a Likert scale ranging from strongly disagree to strongly agree. Examples of the measurements are, "I use or used an e-cigarette to quit smoking", and "I use or used an e-cigarette to deal with feeling bad after quitting (headaches, nausea, dizziness)". Statistical analyses included descriptive statistics; racial and ethnic differences in demographics such as age and education, and smoking status were calculated by chi-squared tests for the categorical variables and analyses of variance for continuous variables (Hooper and Kolar 2016, 4). Logistic regression was also used to adjust for the independent associations of smoking in regard to ever use, use within the past 30 days, and plans to continue electronic cigarette use.

The study found that about two-thirds of participants reported ever use of electronic cigarettes. In comparison to White and Hispanic participants, African American/Black participants were the least likely to have ever used an electronic cigarette. (Hooper and Kolar 2016, 5). There were no differences amongst racial and ethnic groups for users who reported electronic cigarette use within the past thirty days or as a current smoker. However, behavioral

characteristics differed amongst racial and ethnic groups; more African American/Black ever users of electronic cigarettes reported higher intentions of continuing to use when compared to whites and Hispanics, with an adjusted odds ratio of 2.56 with a confidence interval of 95%. In contrast, there were no significant differences between Hispanic and White ever users. However overall current smokers were three or more times likely to report continued use of e-cigarettes in comparison to relative former smokers. In regard to smoking cessation, African American/Black participants were more likely to utilize electronic cigarettes as a cessation device when compared to White participants with a p value of 0.03 and Hispanic participants with a p value of 0.48 (Hooper and Kolar 2016, 5-6). In regard to costs, White participants were more likely to use electronic cigarettes in comparison to Hispanic participants, but no differed was observed with African American/Black participants. In summary, the current use of electronic cigarette use was high in the sample and some racial and ethnic differences were observed for cessation, continued use, use of electronic cigarettes, and cost of smoking.

In the study "Early Subjective Sensory Experiences with "Cigalike' E-cigarettes Among African American Menthol Smokers: A Qualitative Study" by Smiley et al. the study describes the importance of sensory response to the use of electronic cigarettes in regard to menthol taste. The study aims to understand how sensory perception may influence continued use of traditional cigarettes in comparison to electronic cigarettes. The sensory encounter of smoking can be defined by three categories which are taste sensation, throat sensation, and physiological satisfaction. Taste refers to a sweet or bitter aftertaste, whole throat sensation refers to the "throat hit" of inhaling a cigarette, and physiological satisfaction refers to the whole-body experience of alleviation through nicotine (Smiley et al. 2017, 2). The design of the study included fifteen adult daily menthol smokers who self-identified as African American to participate in semi structured

interviews. The focus was on African American users due to their underrepresentation in electronic cigarette research, and the fact that African Americans are more likely to use menthol flavored cigarettes, with menthol smokers having a more difficult time to quit smoking (Smiley et al. 2017, 2).

Participants were eligible if they smoked at least eight cigarettes daily for the past five years, have not used electronic cigarettes in the past thirty days, are interested in trying electronic cigarettes, and are significantly considering quitting traditional cigarette smoking in the next thirty days (Smiley et al. 2017, 2). Participants were given two disposable NJOY King menthol electronic cigarettes five packs containing three percent nicotine. These were received after the second and third visit. Participants were instructed to try a minimum of three puffs per day over the course of a week after their second visit; after their third visit participants received ten additional five packs and were instructed to use them as they would like which also included not at all (Smiley et al. 2017, 3). The visits consisted of semi structured interviews which outline topics concerning the meaning and utilization of cigarette smokers and their perceptions of electronic cigarettes. They also included users' experiences with electronic cigarettes, the sensory experience involved with use, comparison of traditional cigarettes with electronic cigarettes, and whether or not they would continue use.

The results of the study were divided into three categories associated with sensory experiences which were: evaluating menthol electronic cigarettes taste in comparison to traditional cigarettes, association between throat sensations of menthol electronic cigarette acceptance, and assessing satisfaction of menthol delivery to participants during weeks two and three of the study. Examples of participants' responses to taste were "The taste… you taste that menthol taste in there, but you know, I'm not going to sit there and say it tastes like a regular

cigarette. No, you know, it doesn't because I think that would be defeating the purpose if it tasted like a regular cigarette" and "The taste is just enough to resemble a cigarette." (Smiley et al. 2017, 3). On the contrary, some participants did not like the taste for example "So, like I said, the taste is really bad, it's nasty… The taste is like a menthol mixed with Comet or Ajax… I'm telling you, oh God, that's what it tastes like… I'm serious. I don't know what they put in them things, but those is not the ones. It is not.". In regard to throat sensation participants often emphasized that electronic cigarettes made them cough and greater exertion to inhale. One participant expressed that traditional cigarettes enter and exit smoothly, whereas in his experience electronic cigarettes enter strongly and exit raspy. There were not many positive reviews amongst participants for throat sensory, often characterizing this sensation as unpleasant and unpredictable when compared to a traditional cigarette that was smooth or predictable.

Lastly, for physiological satisfaction most participants did not feel satisfied by the electronic cigarette experience. Participants cited that the electronic cigarettes did not fulfill their cravings, and one respondent specifically stated that it is probably because he smokes menthol, where the taste lasts for a second and then fades away (Smiley et al. 2017, 4). The sensory experience affected users' choice to continue use of electronic cigarettes. Of the fifteen participants, eleven of them expressed that they used electronic cigarettes less in the second week of the study when compared to the first week, where they were instructed to take at least three puffs a day. The reason ascribed to this behavior was their experiences with electronic cigarettes not being physiologically strong enough, dissatisfied, and while they wanted to quit, they did not find that electronic cigarettes were helpful. However, four participants had positive experiences with the electronic cigarettes and perceived them as potential cessation aids. They attributed their positive experience to it not being too hard on the throat and no smoky aftertaste,

however one participant was concerned about the price (Smiley et al. 2017. 5). In summary, this study showed that use of electronic cigarette use can be associated with sensory experience.

In the study "Linking the content to demographic reach of online advertising of electronic nicotine delivery systems" by Timberlake et al. the study describes tobacco health communication advertising in regard to race and ethnicity. Online advertisements for electronic nicotine delivery systems is an imperative part of the success in evoking purchase behaviors associated with what potential consumers see. Marketers often use strategies such as comparing brands, types, or devices in advertising because they render greater recognition and clicks onto their website (Timberlake et al. 2017, 1). The study performed a meta-analysis between a recent randomized control trial of combustible cigarette users. The results were that advertisements which compared electronic nicotine delivery systems and combustible cigarettes generated greater interest (Timberlake et al. 2017, 1). It also found that advertisements related to electronic nicotine delivery systems need to be examined in order to minimize the existing disparities amongst racial and ethnic people in relation to tobacco-related diseases and illnesses. The methods of the study included a search of websites, for key words such as electronic cigarettes, e-cig, and electronic nicotine delivery system, with one thousand and ninety-four brands discovered through this search. Product included electronic cigarettes, vapourisers, starter kits, accessories and other vaping-related products which attributed to the wide search results. (Timberlake et al. 2017, 2). Race and ethnicity were defined as groups of non-Hispanic white, non-Hispanic black, Hispanic, and non-Hispanic. The racial and ethnic demographics of website visitors was assessed through the Health Information National Trends Survey (HINTS) and the comScore. The statistical analysis that was utilized was through generalized hierarchical linear models (Timberlake et al. 2017, 3).

The results of the study found that amongst the two-thousand and ninety-eight electronic nicotine delivery systems advertisements, 73.5% were for e-cigarettes or e-cigarette accessories, 10.3% were images of vapes, electronic hookahs, or electronic cigars, 2.7% were both types, and 13.4% had no images (Timberlake et al. 3). The advertisements consisted of 28% of comparative messages, 12.5% for smoking cessation, 5.4% for social and lifestyle benefits, 5% for convenience, 2% for less environmental impact, 1.6% of harm reduction, 0.6% for greater savings, and 0.9% for other benefits. An interesting result from the study showed that websites that had the greatest appeal for non-Hispanic whites were those that showed a lower odds of displaying a comparative message, which is comparing traditional cigarettes to electronic nicotine delivery systems. Advertisements that appealed greater to Hispanics had greater odds of referencing a traditional cigarette. In summary, the year of 2015 had significantly lower odds of traditional cigarettes being referred to online websites and advertising from the year 2010 to 2014 (Timberlake et al. 2017, 3-5). In all, the study's results demonstrated that non-Hispanic whites in comparison to other racial and ethnic groups composed a higher percentages of websites visitors to electronic nicotine delivery systems advertisements than the general composition of the United States internet users.

In the article "E-Cigarette Health Harm Awareness and Discouragement: Implications for Health and Communication" by Rohde et al. the study explores the role of health communication and electronic cigarettes. The methods of the study were a convenience sample of United States adults over the age of 18 who smoked, vaped or were dual users, with a total of 1,872 participants (Rohde et al 2019, 2). Tobacco product use was assessed by measuring vaping within the last thirty days, or if they smoked at least 100 cigarettes in their lifetime and whether or not they currently smoked. The demographics assessed were age, sex, education, race,

ethnicity, sexual orientation and annual household income. Participants took a survey online about e-cigarette health warnings, the warnings included awareness and discouragement about the use of electronic cigarettes. The survey included forty warnings which were classified into seven groups, device explosions, addiction, cardiovascular harm, respiratory harm, e-liquid toxicity, chemical exposures and other harms. The measures included awareness of e-cigarette harms by asking "if before today, had you ever heard that using e-cigarettes causes these risks", followed by a list of harms. Participants were then asked to check all that apply or none of the above (Rohde et al. 2019, 2). Discouragement measurements were assessed using the single item for each harm presented, the question asked was "E-cigarettes may expose users to the risks we just asked you about. How much does knowing that using e-cigarettes causes these risks discourage you from wanting to vape?" The participants responded on a five-point scale of not at all to very much. (Rohde et al. 2019, 2).

The respondents to the study were 54% of participants were female, while 46% were male, 80% of participants were white, while 20% were categorized as other, 24% of participants had a bachelor's degree or higher, while 59% made less than $50,000 per year, and 10% of participants identified as being gay, lesbian, or bisexual. Nineteen percent of participants used electronic cigarettes only, while 40% smoked only cigarettes, and 41% of participants were dual users. Other tobacco product use were cigars (17%), hookah (9%), and little cigars and cigarillos (20%). (Rohde et al. 2019, 3-4). Moderate awareness of electronic cigarette harms was observed, most people were aware of device explosion at 44%, respiratory harm at 34%, addiction at 29%, one set of chemical sets 28%, and cardiovascular harm at 26%. The other remaining health harm awareness was low, health effects 22%, second set of chemicals 21%, and e-liquid skin contact harm at 16%.

Discouragement measurement results were reported as respiratory issues being the most discouraging as to why they would not vape, followed by the two sets of chemical exposures. Cardiovascular harm, E-liquid toxicity harms, device explosion harms, other health harms, and addiction was the least discouraging category for health harm (Rohde et al. 2019, 3-5). In relation to demographics amongst these perceptions of health harms were participants who were white, gay, lesbian, or bisexual participants were less discouraged to vape after exposure to the harms of electronic cigarettes in comparison to those who were not. Additionally, electronic cigarettes were less popular and more discouraging amongst participants who were older, female, or current other tobacco product users. As for those who only smoked traditional cigarettes, the harm of electronic cigarettes was less discouraging than electronic cigarette users only and of those classified as dual users of electronic cigarettes and cigarettes (Rohde et al. 2019, 5). Therefore, the findings demonstrated that awareness of electronic cigarette health harms was moderately associated with vaping use, and addiction related health harms were the lowest motivators in people not pursuing vaping.

In the article "Differences in Electronic Cigarette Awareness, Use History, and Advertisement Exposure between Black and White Hospitalized Cigarette Smokers" by Baumann et al. the study discusses the differences between the race and awareness pertaining to electronic cigarettes. The methods of the study were a cross sectional study which examined data from cigarette smokers who were hospitalized over the course of nine months in monthly cohorts. Participants were those who spoke English, between the ages of nineteen to eighty, and admitted to the University of Alabama at Birmingham Hospital. Demographics assessed were age, marital status, and educational attainment. The measurements of the study were to assess electronic cigarettes awareness through a series of questions with yes or no answers, examples of

questions were "Have you ever heard of an electronic cigarette?". Self-reported exposure to electronic cigarettes and advertisements were assessed by asking questions such as "Where did you encounter these ads and how many ads have you seen, read or heard about within the past six months"; participants answered these questions in a numeric count. (Baumann et al. 2019, 3). Participants were also asked their desire to quit cigarette smoking on a ten-point scale where one represented no desire to quit and ten being a full desire to quit. Participants of the study who reported using electronic cigarettes were asked their primary reason for use, answers ranged from cessation, able to use in non-smoking areas, flavoring of electronic cigarettes such as wine, regular, menthol, or more than one kind (Baumann et al. 2019, 3). Logistic regression analysis was performed in order to determine if there was a difference between electronic cigarettes used by the black and white participants of the study. Poisson regression was also utilized to determine if observation of exposure to electronic cigarette advertisements varied between black and white participants. Furthermore, chi square tests were also used to examine the racial differences in the demographic variables for electronic cigarette use, cessation, amount of cigarettes smoked, and electronic cigarette flavors utilized. (Baumann et al. 2019, 3-4).

The results of the found that black participants had a greater desire to cease tobacco cigarette smoking, and that white participants smoked cigarettes more often within the past thirty days and smoked more tobacco cigarettes per day compared to Black participants. For participants that reported electronic cigarette use, Black people were more likely to use electronic cigarettes as a smoking cessation approach, whereas white people were more likely to utilize electronic cigarettes for use in non-smoking areas. Black participants were more likely to use menthol flavoring in electronic cigarettes when compared to white participants, when asked about their preferred flavor for electronic cigarettes. White participants were also 5.5 times more

likely to use electronic cigarettes when compared to Black participants, after controlling for desire to quit, number of cigarettes smoked daily, marital status, age, gender, and education.

White participants' exposure to electronic cigarette advertisements ranged from 25-79 exposures and Black participants ranged from 8-45, accounting for a 33% higher average rate among whites (Baumann et al. 2019, 4-5). Association with electronic cigarette use was significantly linked to advertisements exposure for Black people but not for white people. For every increase in ten advertisements there was a 6% increase in the probability of using an electronic cigarette for Black people. Radio and television were the greatest source of advertisements for both black and white people respectively at 67% and 73%; however, more whites reported advertisements in stores 43%, in contrast to 34% for Black people, and the internet at 13% in comparison to 6% for Black people. Newspaper and magazine advertisements did not differ between different racial groups for exposure (Baumann et al. 2019, 5).

Finally, in the last study reviewed titled "Strategies to find audience segments on Twitter for e-cigarette education campaigns" by Chu et al., the study explores the relationship between online health education campaigns on Twitter. The methods of the study were a social network analysis, which is a tool that understands how people or organizations are connected, finds hidden social structures within these networks and also identifies potentially important actors within the network (Chu et al. 2019, 3). The study uses two metrics, modularity which describes how well a network can be divided into smaller clusters, or modules that are useful in finding community structure; and clustering coefficient which assess how people in a social network tend to cluster together. The study consisted of two phases, the first where 376k tweets were analyzed over a month during October 2015 using the words vape and e-cig. The tweets were labeled with the Twitter name of the user who retweeted the message and the original poster of

the tweet (Chu et al. 2019, 4). This information was used to design the retweet network which forms the basis of quantifying district clusters.

Of these tweets there were 251,000 tweets and 297,000 retweet connections between those of the analyzed network. The modularity detection algorithm detected 580 distinct modules and clusters within the network. The clustering coefficient was calculated for each cluster, ranging from zero to one where high value represent a more connected cluster. Twenty clusters were chosen, ten groups with the highest clustering coefficient and ten groups with the lowest clustering coefficient were selected to code for electronic cigarette user sentiment. The sentiment was needed in order to figure out if groups were distinctly different. (Chu et al. 2019, 4). For each group of high and low clustering coefficients, one hundred retweets were randomly sampled which provided a total of 2,000 retweets for sentiment coding. The sentiment coding was coded as positive, negative or neutral based upon overall impression. Statistical analysis, specifically Pearson correlations were used to assess consistency amongst coding, and association between clustering coefficient and sentiment. Mixed linear models were utilized for each sentiment outcome. For all analyses, p values of <0.05 were considered statistically significant (Chu et al. 2019, 5). The findings suggest that social network analysis identified groups on Twitter with high clustering coefficients. The current data provided supports the notion that health communication planners could benefit from collaborating with data analytics to identify clustering characteristics.

NHANES Secondary Data Analysis

This paper conducted a secondary data analysis of NHANES data to better understand how national health survey data measures tobacco-related health disparities and e-cigarette use

patterns. The race and ethnicity variable RIDRETH 3 from NHANES, represented six racial groups which were: Mexican American (MA), Other Hispanic (OH), Non-Hispanic White (NHW), Non-Hispanic Black (NHB), Non-Hispanic Asian (NHA), and other Non-Hispanic (ONH). The results of our secondary analysis are as follows: one hundred and fifty-three (14%) of Mexican Americans participants have used electronic cigarettes while nine hundred and eleven (85.6%) have not used electronic cigarettes. One hundred and three (12.9%) of other Hispanic have used electronic cigarettes while six hundred and ninety-five (87.1%) have not used electronic cigarettes. Four hundred and twenty-three (22.1), Non-Hispanic White have used an electronic cigarette while one thousand four hundred and eighty-nine (77.9%), have not used an electronic cigarette. Two hundred and forty (19%) of Non-Hispanic Black people have used electronic cigarettes while one thousand and twenty-four (81%), have not used an electronic cigarette. Seventy-one Non-Hispanic Asian (9.8%) have used electronic cigarettes while sixty hundred and fifty-five (90.2%), have not used electronic cigarettes. Seventy-four (32.9%) of Other Non-Hispanic have used electronic cigarettes while one hundred and fifty-one (67.1%), did not use electronic cigarettes. This descriptive data follows similar findings in the literature that non-Hispanic White generally have higher use of electronic cigarettes compared to their ethnic counterparts. For statistical analyses the values of the chi-square test $X^2 = 114.3$, df=5, p-value = < 0.001 and the results are as follows.

Table 1: Statistical Analysis of NHANES Data

Significant Pairs	Adjusted Chi Square Pairs
MA and NHW	<0.001
MA and ONH	<0.001
OH and NHW	<0.001
OH and NHB	0.006
OH and ONH	<0.001
NHW and NHA	<0.001
NHW and ONH	0.006
NHB and NHA	<0.001
NHB and ONH	<0.001
NHA and ONH	<0.001
MA and NHB	0.06
MA and NHA	0.07
MA and OH	non-significant
OH and NHA	non-significant
NHW and NHB	non-significant

The results showed that the six groups differed significantly overall in the proportion of electronic cigarette use.

Twitter Analysis

Data collection included 9,682 twitter posts over the 1-year study period. The oldest post collected was posted on July 21, 2018 at 12:33 am and the latest post was collected on July 21, 2019 at 4:26 pm. The vape keyword contained 5,473 tweets, vaping contained 2,491, and Hookah contained 1,718 tweets. A sample of 2,000 tweets were taken from the topics of vape and vaping, and all tweets from the topic hookah were manually coded, which resulted in a total of five thousand seven hundred and eighteen tweets being manually coded. Results from the content analysis are broken up into findings describing the three parent classifications of behavior detected: initiation or use, transition and cessation. Initiation or use is described as someone mentioning they will start vaping or trying a new product or already using a vaping

product, transition is described as someone who mentions they have switched from one tobacco product to another, and cessation is described as them quitting their tobacco product.

One hundred and twenty-five tweets were retrieved and coded as associated with initiation (2.2% of all posts in the study). Examples of tweets classified as initiation are "I'm really glad I bought a vape cause I'd be drinking myself to death otherwise", "My anxiety has been so bad lately (Redacted Name) bought me a Vape & I can actually say it works!!! I feel so calm physically and mentally" and "I finally bought an actual vape so I don't have to use my juul anymore because the amount of nicotine it has makes me sick and I'm so excited for it to come". The reasoning behind classifying these tweets as initiation or use is because the user and original poster of the tweet are indicating they have either started vaping or continue to vape because they were curious, were gifted a vape, or are just using it in general.

One hundred and forty-four tweets were retrieved and coded as transition behavior. This comprised 2.5% of all the posts in the study. Examples of tweets classified as transition of use are "1 year ago I took this picture and that's one year that I've been smoke free. I am also down to 3mg nicotine from 6! My little eGo is still chugging along. I don't miss cigs at all. Only difference from a year ago is I enjoy a fruit vape more than dessert ones", "Seems to be a popular opinion and one that is just whining. Does this make you feel better? I was against it but I was also a heavy smoker... Now I've quit and just vape here and there throughout the day in my house and car. Which is worse smoking or vaping? and "Day 9. Using a vape which is helping me but makes me feel a bit queezy. I'm not nicotine-free but other than a few over the weekend I've been cigarette-free." The reasoning behind classifying these tweets as transition is because the user and original poster of the tweet are specifying that they have transitioned from one particular product to another. Example one demonstrates that the user has transitioned from

cigarettes to vaping six milligrams and are now at three milligrams. Example two demonstrates the user has also quit smoking traditional cigarettes and now vapes occasionally. Example three demonstrates that a user is on day nine of not smoking cigarettes and their electronic cigarette has assisted in that.

Seventy-three tweets were retrieved and coded as related to cessation comprising of 1.3% of all posts in the study. Examples of tweets classified as cessation of use included: " Day 2 so far looking good of no cigs or vape we cold turkey quitting I'm taking care of my new teeth.

", "Pretty proud of myself rn because I've been under so much stress these past couple weeks but not once have I picked up my vape or smoked a cigarette. I haven't touched nicotine since EDC.   " and "Full disclosure I'm attempting to quit Marlboro 27s via vaping.. I quit once for a year with vaping but went back to cigs when my vape broke. I can't relate to opiates but I can w/ nicotine. Addiction sucks. This time I want to quit the vape before it quits on me". Examples one and two demonstrates the user and original poster has quit vaping and cigarettes. Example three demonstrates that the user has tried in the past to quit and is now making an effort to quit. While not necessarily pertinent to the question on hand, other patterns in the data were detected around dual use and flavorings.

In addition to the results of the tweets two maps were added to decipher where the tweets, conversations and users of electronic cigarettes were located.
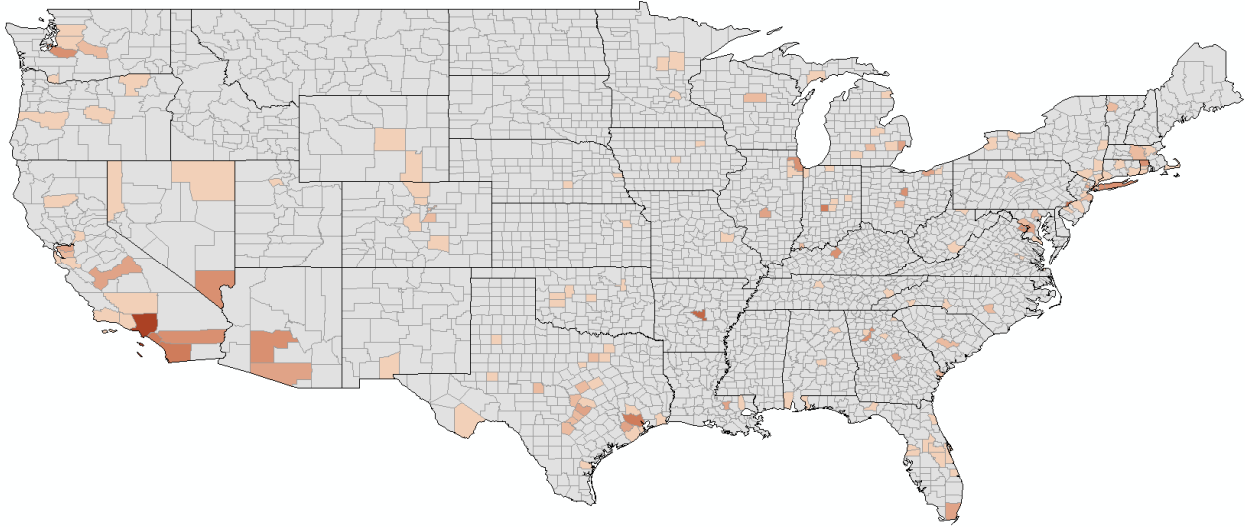
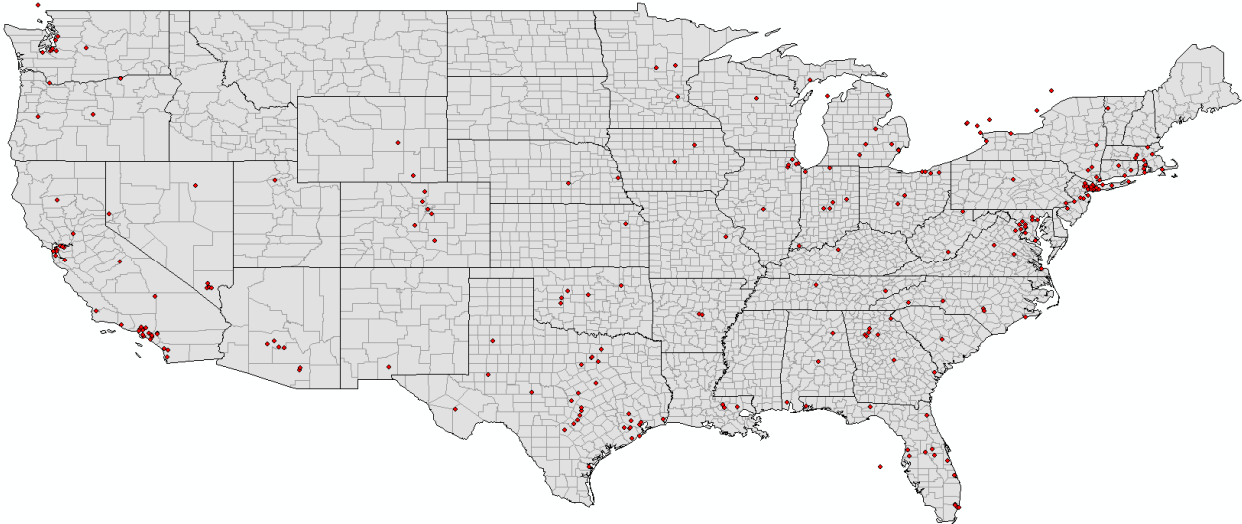**Figure 1: Choropleth map of signal tweets**

Figure 2: Point map of signal tweets

The map showed that most of the tweets were scattered across the United, States with most density being in California, specifically southern California (see **Figure 1** and **2**). Figure one and two refers to the location of where the user tweeted from. Based upon the United States population statistics, most African American and Black people tend to live in the Southern Region of America. We see that most of the tweets are scatted throughout the United States with

most being in Southern California, which is considered a racially diverse state. There is also high clustering in other metropolitan areas such as New York, Los Angeles, and Southern Arizona. However, from the data collected in this study, there was not a large amount of user discussion surrounding behavior in the South. This data when coupled with findings from the literature review demonstrates that there are differences amongst different racial groups however, white people still tend to utilize electronic cigarettes at a higher rate than marginalized people, specifically Black people.

DISCUSSION

By examining the published literature, national survey data, and social media conversation, valuable insights into user alternative and emerging tobacco use behaviors amongst specific communities can be identified in a more holistic approach. While the literature review identified specific tobacco-related health disparities associated with the African American community, such as the use of menthol flavoring for both combustibles and vaping flavor, greater use of e-cigarettes when exposed to marketing messages, and higher levels of intent to use e-cigarettes for cessation, secondary data analysis from NHANES only served to confirm that many minority groups did not use e-cigarettes at higher rates compared to combustibles and to their white user counterparts.

Specifically, the National Health and Nutrition Examination Survey revealed racial disparities amongst the six groups when analyzed. We see there were differences between other Hispanic and non-Hispanic black respondents, differences amongst non-Hispanic white and other non-Hispanic people, and differences amongst Mexican American and Non-Hispanic Black people, and Mexican American and non-Hispanic Asian people. Therefore, this pattern of use

appears to be associated with racial and ethnic behaviors, as some groups tend to utilize electronic cigarettes more than other groups. While behavior is not necessarily negative, disparities between use can pose potential health threats to marginalized communities as health gaps continue to widen. As health disparities widen, it is crucial to intervene ahead of time before it is too late.

Social media analysis revealed three specific thematic areas of vaping user behavior discussion, but though this self-reported behavior confirmed certain insight in the literature, it did not provide enough structured data to make inferences about tobacco disparity-related characteristics. Nevertheless, some important insights were identified in the social media analysis which we detail below.

Online many vapers and electronic cigarette users create communities across social media platforms in order to learn vape tricks from one another, review products, and even learn about new sales, discounts or vape shop locations. This type of organic user generated discussion allows for social media to be used as a platform for public health interests, as they may inform public health researchers of trends or patterns as they arise. As trends and discussions arise, the hope is to mitigate potential harm by intervening. This analysis of a year of social media posts were collected to gather a variety of tweets associated with vaping and electronic cigarette behavior. The findings indicate that there is a high volume of tweets related to vaping in general, however there was a low volume of tweets in regard to user behavior, which was observed. From here we can gather that various discussions are happening around vaping but not all relate to self-reported behavior

User behavior in regard to the initiation results demonstrate the reason why people begin to use electronic cigarettes. People begin to vape due to individualized reasons such as anxiety,

pure curiosity, marketing messages such as "less harmful than cigarettes", flavoring or because they saw someone else use them. Many people who began vaping often did not smoke cigarettes prior to the rise in popularity of electronic cigarettes. Although they have been purported to be used as a tool to help traditional cigarette smokers quit smoking, online they are often associated with lifestyle. Therefore, initiation to smoking electronic cigarettes is often not due to making healthier smoking/nicotine choices. Transition of use is imperative; from the results, users tweeted that since switching to electronic cigarettes they no longer use combustible cigarettes and their percentage of nicotine use has decreased over time. However, some users specified that they would still utilize other tobacco products in conjunction with cigarette use (i.e dual or poly tobacco use). Dual use is practiced for both social and physical reasons. From the literature we learned some smokers utilize both because the electronic cigarette does not satisfy their cravings, reasons related to finances and convenience, and smoking in public and nonsmoking areas.

Social and physical cues are also attributed to dual use. From the example tweets of transition behavior, we see that some people have often tried vaping in the past and have failed and are now trying it again. This is due to inauthenticity, reduction of smoking, finances, and social norms of when smoking is appropriate. Conversations surrounding transition on social media were slightly higher than those for initiation. This could mean that people take to social media to learn about new products, to receive input, or even support and praise for making the transition. Which is inferred as some users included the number of days of their switch to electronic cigarettes in their tweets.

In contrast, cessation was the least detected behavior discussed. This could mean that people were less likely to discuss quitting nicotine use over the internet or specifically in the context of vaping and electronic cigarette products when compared to combustible cigarettes

(which were not purposefully sampled in this study). Of the cessation results, many users

discussed a strong sentiment to quit electronic cigarettes. Users decided to quit cold turkey, even

though they experienced stress for a prolonged period of time. Others expressed their frustration

with how hard it is to quit vaping, although they self-reported that they will keep trying until they

are successful. Additionally, it is imperative to explore the relationship between menthol and

successful cessation, as it has been proven cessation rates are lower for those who use menthol

flavored products. This is imperative as menthol is also a pathway to chronic disease (Alexander

et al. 2016, 5-6) and African Americans use menthol flavored nicotine products at higher rates in

comparison to other races (Villanti et al. 2017, 3).

The literature review described the reasons behind user behavior of electronic cigarettes.

African Americans/Black people have a greater desire to quit smoking however, they often have

a more difficult time at successful cessation, despite the fact that they tend to smoke less than

their counterparts (Smiley et al. 2017, 2). This can be attributed to the flavoring of tobacco

cigarettes with menthol in addition to the structural barriers Black people face within addiction

and healthcare services. This includes things such as access and preference to cessation tools,

health education, promotion and communication messages. While Black people are less likely to

smoke electronic cigarettes there is a greater desire to quit, which can represent both an

opportunity for better cessation outcomes, but also lead to higher risk of transition of use back to

combustible products if cessation is unsuccessful. Current literature surrounding electronic

cigarettes as cessation devices is still unclear, particularly given that their safety profile and

health impact due to long-term exposure is largely unknown given their novelty and the

substantial different types of vaping products that are available on the market. Highlighting this

risk, in fall 2019, the United States announced EVALI as an epidemic, with most of the cases

being linked to THC devices that contained vitamin e acetate. The EVALI illness also points to the overall problem of lack of understanding of the long-term health risks of vaping and products and lack of policy regarding the unregulated market of electronic cigarette and vaping products.

Therefore, it is imperative to continue to conduct research in this field and protect the health of electronic cigarette smokers, specifically African American/Black smokers as these minority populations already face existing health disparities. Policies such as a flavor ban would directly affect the Black community. The flavor ban is not effective for the purpose it tries to serve. The ban only covers flavorings considered to be kid friendly such as dessert and fruit flavors, on specific devices such as cartridges and pre-filled pod devices. Under this ban menthol and tobacco flavorings would still be available. The ban only aims to address a specific population which is youth. This ban does not include all populations vulnerable to flavorings and electronic cigarettes use; it ignores the crucial component of race and ethnicity. As noted in the results, menthol flavored tobacco and nicotine flavored products are particularly favored by African American and Black people. Hence, if bans like these do not consider how these flavors affect specific groups of users of electronic cigarettes, these policies may exacerbate or place certain disparity impacted groups at higher risk.

Furthermore, from the twitter surveillance findings in this study, many users often cited that flavors were a main reason they either decided to initiate or transition to use of electronic cigarettes, directly in response to the flavor ban that was implemented at the time such as represented by the tweets "jokes on them mint is my fave", "All of the fruit flavors are trash anyways. Mint and only mint so it's all good", while some users also mentioned stocking up on flavors before they are prohibited. This demonstrates that the link between flavoring and

electronic cigarettes influences behavior. In fact, flavorings can be seen imperative to all three behaviors studied, initiation, transition, and cessation.

Additional analysis of geocoded tweets also provides potential insights into how users are engaging with each other. The geographical locations of the tweets show us that although the tweets do not come from predominantly Black neighborhoods and counties, this does not mean they are not at risk to the potential harm of electronic cigarettes. In fact, it could imply the antithesis of that. If African American and Black people are not discussing electronic cigarette use online, then they could be more susceptible to not knowing the health implications of electronic cigarettes. This is essential for health disparity-related health promotion and communication matters. Public health promotion and health communication leveraging social media is a critical strategy to improve health outcomes (Welch et al. 2016, 10-11). It can be used to raise awareness, combat misinformation, monitor public health, research, and can be used to engage with those that directly use the platform (Moorhead 2013, 6).

The user behavior detected in this study, while limited, provides insights into what users are discussing online. Typically, users engage with people they know, however users can interact with all types of content even outside of their social network. People often rely on the internet and social media for their health information needs. Users also utilize their social networks to spread information which also extends to online based social media platforms. Integrating social media into health communication campaigns would allow for users to engage in conversation and with the communities they are a part of. Digital health communication can also improve availability of information, because users can engage with the messages at their own convenience and it allows for greater accessibility of those who may not be able to receive information in traditional ways. Intervening online provides a direct connection to users that are

discussing their health behaviors. It could also be a way to mitigate health misinformation on a complex topic such as vaping. Overall public policies and health communication should be tailored and inclusive to all communities it aims to serve. Without that vital component, patterns of disparities will continue, and health gaps will widen. As new products enter the market it is imperative to remain vigilant to the harms they may pose. The field needs to be especially adaptive to emerging tobacco products, as they aim to replace preceding products and could introduce new and unknown harms such as EVALI.

Exposure to targeted marketing encourages the use of electronic cigarettes. In order to decrease risk of use, it is necessary to develop more effective tools to foster and create health promotion concerning electronic cigarettes that is targeted at specific minority groups and their representative communities. Counter marketing and providing education, resources, and tangible strategies to assist those who face addiction, could help achieve this. It is necessary to create a platform that works at prevention before use is initiated, but to also know that treatment and care must be accessible for those who need it. Policies surrounding electronic cigarettes can have negative repercussions that sometimes force users to return to traditional cigarette smoking. Taxing electronic cigarettes and flavor bans are both examples of policies that can lead to unintended consequences for transitions of use. In consideration that users utilize social media platforms to discuss behaviors, social media and health communication can be engines where users feel comfortable with engaging with health communication models.

The results from the study complement the existing literature, however this study is preliminary and future studies should more purposefully attempt to identify expressions of health disparities and tobacco and e-cigarette use as they are disseminated, discussed, and potentially modulated on social media. Further limitations include that only one social media platform was

surveilled, and the users on this platform could be skewed towards communities and races that could impact study bias. There is also missing demographics of who may be absent from social media participation or may prefer other social media platforms other than twitter, particularly in the context of bias towards users of certain ethnic and minority backgrounds. Additionally, although many people were conversing about vaping, many other users did not discuss initiation of use, transition of use, and cessation of use. Further research is necessary to better elucidate how social media acts as an environment to address tobacco-related health disparities, both in a positive or negative way. Future studies should explore the use of application software, other potential cessation methods, and further behavioral relationships between menthol flavored nicotine products and cessation.

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