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# Vaping associated with healthy food words: A content analysis of Twitter

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## ABSTRACT

E-cigarettes were initially introduced as a less harmful alternative to combustible cigarettes, but marketing efforts may now be exceeding these claims by associating e-cigarettes with words related to healthy foods. These associations could mislead people to assume vaping is a healthy practice. Tweets from January to March 2017 were obtained from the Twitter Streaming Application Programming Interface (API) to assess content about vaping linked to healthy food words. Tweets were classified into one of nine categories along with their source (marketer vs. non-marketer). We content analyzed original English language public postings on Twitter that included vaping-related keywords and at least one of eight co-occurring healthy food-related labels (e.g., ‘natural,’ ‘vitamin,’ ‘vegan,’ and ‘organic’) ( $N = 1205$ ). Chi-square analyses compared themes by message source. Findings suggest vaping is being marketed in ways that could paradoxically lead consumers to believe that e-cigarettes are health-enhancing. We found more tweets representing vaping as *health-enhancing* (9%) than referring to it as a *smoking-cessation device* (1%). The largest category of tweets referred to vaping as *harmless* (28%) and therefore compatible with a healthy lifestyle. Tweets presenting vaping as *harmless* or with a *sensation* theme were more likely to be authored by marketers than by non-marketers. Food and drug regulation needs to be more vigilant to prevent misleading advertising from e-cigarette marketers.

## 1. Introduction

During the commercialization of electronic cigarettes, there were discussions in the popular media that they were a less harmful alternative to combustible cigarettes and that they could serve as a potential smoking cessation tool (Ayers et al., 2017; Grana & Ling, 2014). However, the use of e-cigarettes has not been established as an evidence-based smoking cessation strategy (Halpern et al., 2018) and long-term use of e-cigarettes could cause harm (Etter, 2018; <https://www.surgeongeneral.gov/library/2016ecigarettes/index.html>) so the main American organizations combatting cancer (e.g., American Association for Cancer Research and the American Society of Clinical Oncology) do not recommend their use (Tomashefski, 2016). Nevertheless, evidence has emerged suggesting that consumers are not only perceiving e-cigarettes as healthier than combustible cigarettes (Kim, Davis, Dohack, & Clark, 2017; Modesto-Lowe & Alvarado, 2017; Pepper & Brewer, 2014; Peters, Meshack, Lin, Hill, & Abughosh, 2013) but that they believe e-cigarettes can help reduce symptoms of negative health and improve physical fitness (Pokhrel, Herzog, Muranaka, & Fagan, 2015).

Some e-cigarette companies presently claim their devices deliver vitamins rather than nicotine (Basáñez, Majmundar, Cruz, Allem, & Unger, *In Review*). Social media platforms are advertising vaping

devices with packaging/skins containing images of salads or open avocados (<https://www.itsaskin.com/products/juul-100-71?variant=51366622100>). Social influencers on YouTube are using names like “Absolute Gourmet Organic” for e-juice reviews, and vaping product brands use names like Yogi E Juice and e-juice flavors that include fruits and cereals as options ([https://www.instagram.com/p/Bg4p21150i/?hl=en&taken-by=vape\\_organics](https://www.instagram.com/p/Bg4p21150i/?hl=en&taken-by=vape_organics)).

It is unclear whether adolescents believe fruit flavored e-liquids actually contain health-promoting ingredients but there is evidence indicating they prefer e-juice *fruit* flavors more than any other flavors (Morean et al., 2018). This is cause for concern because some e-liquid fruit flavors have been found to be particularly cytotoxic (Leigh, Lawton, Hershberger, & Goniewicz, 2016; Ratajczak, Feleszko, Smith, & Goniewicz, 2018).

Evaluative conditioning refers to the phenomenon of associative learning by which a positive or negative attitude towards a well-known object or stimulus (e.g., vitamins) becomes transferred to a second and lesser known stimulus (e.g., e-cigarettes) by repeatedly pairing the two attitude objects. Because evaluative conditioning effects play a large role in the development of attitudes (De Houwer, 2009; Walther & Langer, 2008) it matters to monitor the implicit associations that marketers could be trying to cultivate with regards to electronic

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cigarettes. Over time, consumers could develop positive attitudes about e-cigarettes and vaping products if they are frequently exposed to social media content in which these products are associated with healthy foods.

There is a growing consumer appeal for foods with labels containing words like ‘organic’ or ‘natural’ (Bénard et al., 2018; Dyett, Sabaté, Haddad, Rajaram, & Shavlik, 2013). E-cigarette marketers may be taking advantage of this opportunity by promoting their products with ads that use such words, associating their products with foods prototypically perceived as healthy. When consumers read that e-cigarettes are natural, they might assume that the known risks associated with smoking are natural too (McDaniel & Malone, 2007; Swanson, 1977) much like drowning is a risk associated with swimming. In the past, tobacco companies have engaged in similar misleading marketing practices to promote tobacco and menthol products by claiming they could produce fresh and natural sensations (Anderson, 2011; Baig, Byron, Lazard, & Brewer, 2018; Epperson, Henriksen, & Prochaska, 2017; Gratale, Maloney, Sangalang, & Cappella, 2017; Moran, Pierce, Weiger, Cunningham, & Sargent, 2017). If there is systematic evidence that healthy food terms are now being used in advertising to promote e-cigarettes, then such marketing practices would be a potential subject for U.S. Food and Drug Administration (FDA) regulation.

The 2009 Tobacco Control Act gave authority to the FDA to regulate false and misleading statements in the marketing of tobacco products. In 2016, the Deeming Rule expanded FDA's regulatory power by deeming that manufacturers of newly regulated tobacco products need to receive marketing authorization from the FDA by first showing that their products “meet the applicable public health standard set by the law” (<https://www.fda.gov/ForConsumers/ConsumerUpdates/ucm506676.htm>). The new rule “lets the FDA regulate the products based on the most current scientific knowledge.” Since there is presently no evidence that inhaling food flavors is health-enhancing or even free of harm, the FDA should evaluate and then enforce regulation if manufacturers and retailers are making false and misleading health claims.

One way to evaluate shared information about e-cigarettes is to monitor social media platforms like Twitter – which in 2017 had approximately 328 million active monthly users worldwide and is used regularly as a promotional tool by electronic cigarette manufacturers and retailers (Chu et al., 2015; Chu, Allem, Cruz, & Unger, 2016; McCausland, Maycock, & Jancey, 2017). Compared with other platforms that rely on images and music, Twitter is better known for its use of text, allowing a more objective analysis of posted information.

Twitter makes it possible to observe comments expressed in a realistic/organic setting (Abril, Szczyпка, & Emery, 2017), so it is a useful platform to explore what conversations about electronic cigarettes/vaping are being held in combination with words related to healthy foods. Thus, we did a content analysis of tweets that contained this kind of blend terms.

### 1.1. Aim of the present study

Our goal was to specifically examine the following questions: (1) Are tweets in which vaping is linked to healthy food descriptors (e.g., words ‘organic,’ ‘vegan’) generally critical of e-cigarette smoking (e.g., ridiculing it) and trying to persuade traditional smokers to use e-cigarettes to quit smoking, or conversely, are they representing vaping as trendy, harmless/compatible with good health or health-enhancing? (2) Are these healthy food descriptors being authored by marketers more often than by non-marketers/general consumers? To answer these questions, we first classified tweets using nine thematic categories and then determined if they were posted by marketers.

If the general public does not yet perceive vaping as a healthy food – in spite of marketing efforts already promoting it as such (<https://www.fda.gov/tobaccoproducts/newsevents/ucm605729.htm>; Basáñez et al., Under Review), then we can expect non-marketers to engage less in social media conversations that disseminate those messages, compared

with marketers. If marketers are more likely to be the ones portraying e-cigarettes and vaping in association with healthy foods, then this has implications for regulation. The FDA could not regulate consumers' tweets but could regulate that the information being disseminated by marketers and manufacturers adhere to evidence-based knowledge about the safety of their products. Early detection of misleading marketing practices is an important advantage for health communication specialists and health advocates wishing to deter cigarette smoking as it can enable the delivery of effective and timely public health interventions.

## 2. Method

### 2.1. Study design and criteria for inclusion

The process for collecting tweets for coding and analysis is specified in Fig. 1. All procedures were approved by the Institutional Review Board (HS-13-00618). Past research has identified 17 common keywords used in Twitter content about vaping (Allem, Ferrara, Uppu, Cruz, & Unger, 2017; Ayers et al., 2017; Lienemann, Unger, Cruz, & Chu, 2017). We searched for those tobacco-related keywords appearing in text or as hashtags (e-cig, e-cigs, ecig, ecigs, electroniccigarette, vape, vapers, vaping, vapes, e-liquid, ejuice, eliquid, e-juice, vapercon, vapeon, vafepam, vaperation) as criteria to download Twitter content. The search strategy included downloading tweets posted beginning January 20th, 2017. The estimated universe of tweets from Jan 20, 2017 to March 13, 2017 was approximately 24.52 billion tweets (based on the Twitter average of 340 million per day in 2012). We limited data collection to stop at one million tweets containing those terms, so by March 13th 2017, we had reached one million. After those tweets were downloaded from the Twitter Streaming Application Programming Interface (API) we filtered the content to select only tweets containing any of the following eight healthy foods words: *natural*, *organic*, *vegan*, *gluten free*, *non-GMO*, *vitamin*, *vegetarian*, and *nutritious*. These words were chosen based on consultation with experts on tobacco product marketing (Allem, Escobedo, Cruz, & Unger, 2017; Kirkpatrick et al., 2017) and on monitoring of social media platforms like Instagram and YouTube in which e-cigarettes and vaping were described using those words.

Tweets written mainly in a language other than English or Spanish were excluded from the analytical sample. However, four tweets had parts of the text in a foreign language but contained enough English words (e.g., words in a hashtag) so that English speakers could understand the meaning of the message about vaping/e-cigarette in association with healthy food words, so those tweets were included in the analytical sample. We found 3009 tweets that contained at least one of the healthy food words (‘Natural’  $N = 1010$ ; ‘Vegan’  $N = 683$ ; ‘Vitamin’  $N = 646$ ; ‘Organic’  $N = 585$ ; ‘Gluten free’  $N = 52$ ; ‘Vegetarian’  $N = 21$ ; ‘non GMO’  $N = 6$ ; ‘Nutritious’  $N = 6$ ).

Before conducting the content analysis, a decision was made to also exclude retweets and duplicates from the final analytical sample to increase the likelihood that the themes examined would reflect original content produced by a variety of users. Duplicates differ from retweets because original tweets can be retweeted only once per user. However, users can re-write tweets (i.e., duplicate them) as if they were producing new/original content, so they can post duplicates of the same content multiple times. This difference matters because even if followers do not consider a message worthy of re-tweeting, marketers/authors who want their message to be seen by users at different moments of the day can duplicate it and post it at different times to increase the likelihood that their followers see it. The process of removing retweets and duplicates brought the analytic sample to 1205 tweets.

### 2.2. Content analysis: classifying tweets into one of nine categories

Tweets were classified as belonging to one of the following nine

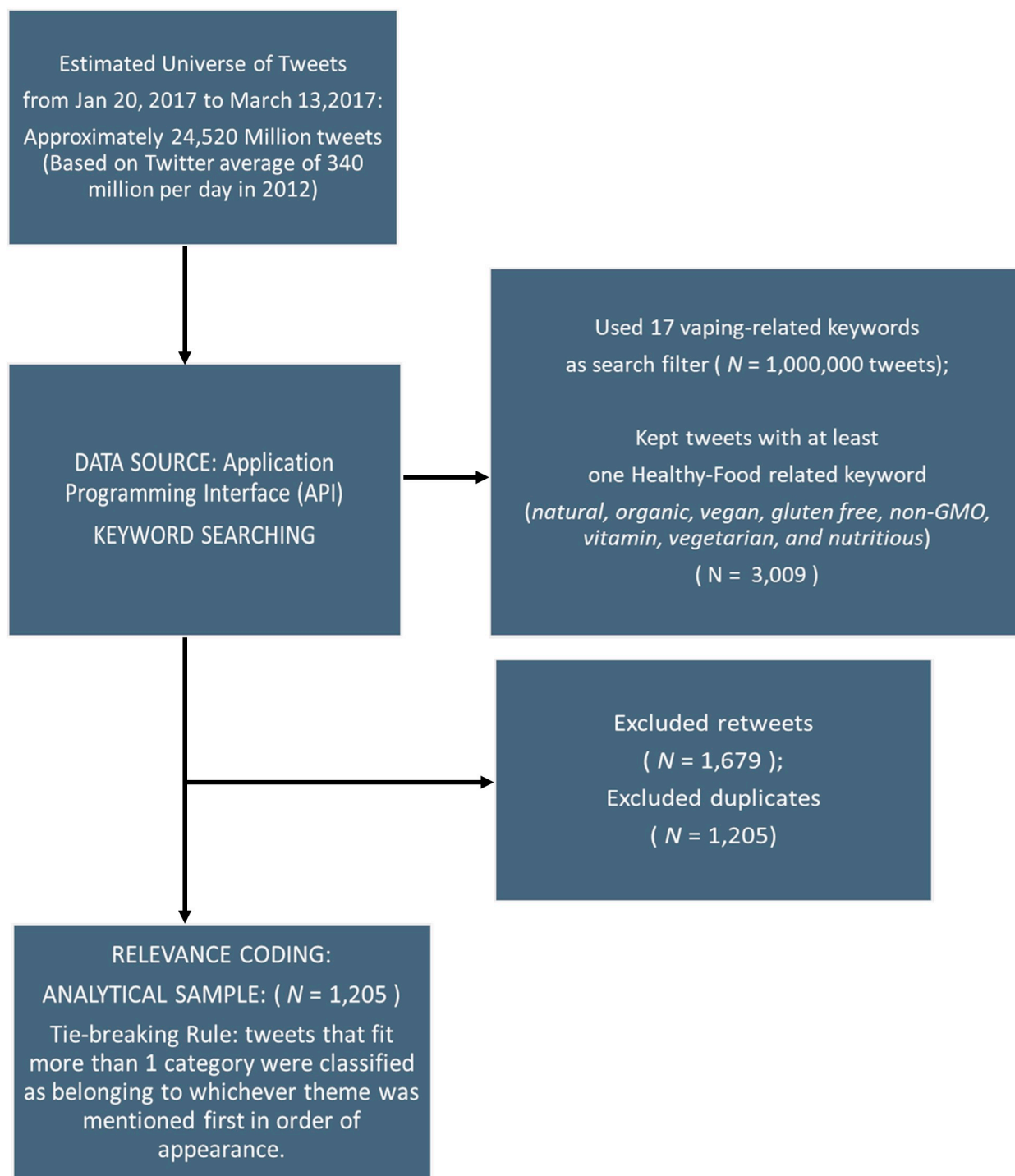


Fig. 1. Overall process for collecting tweets for content analysis.

categories based on a review of related literature (Allem, Ferrara, Uppu, Cruz, & Unger, 2017; McCausland et al., 2017; Rose et al., 2017):

- 1) *Health-enhancing*: Tweets stating or implying that e-cigarettes or vaping can improve health. This category includes tweets arguing that vaping involves an intake of vitamins, or that vaping is like medicine, or that it can cure an ailment.
- 2) *Harmless*: Tweets stating or implying that vaping is compatible with good health and healthy lifestyles. It includes associating vaping or e-cigarettes with health-related words and with physical activities that are typically linked to notions of good health. This category includes

questions or neutral statements about vaping and words related to healthy foods/lifestyle because simply by pairing them together they reinforce the association, and thereby end up representing vaping as harmless. It also includes tweets that use healthy food or healthy lifestyle words to describe parts of the e-cigarette devices. Content that clearly or explicitly criticizes the pairing of vaping and healthy food/lifestyle words are not included in this category.

- 3) *Less Harmful Than Cigarettes/Other inhaled substances*: Tweets stating or suggesting that e-cigarettes are better or a more natural alternative than combustible cigarettes and other inhaled substances (but not completely harmless).

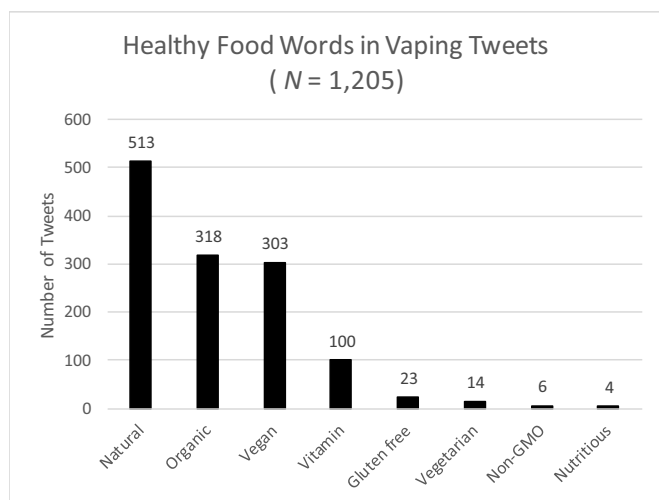


Fig. 2. Sample of Twitter content about vaping that used healthy food words (Jan 20–March 13, 2017).

- 4) *Youth-Resonant*: Tweets that present vaping as trendy/hipster, fashionable, caring about attracting others, and which seem designed to appeal to young people. They convey the notion that vaping is a fun activity and that everyone is actively engaged in it while making friends/attracting others/love, being with friends or in social groups or clubs.
- 5) *Sensations*: Tweets that refer to flavors and smells which thereby highlight sensory experience.
- 6) *Humorous non-critical*: Tweets that joke about vaping or try to be funny but do not clearly criticize it.
- 7) *Humorous Critical*: Tweets that explicitly criticize or ridicule vaping or make fun of people who vape;
- 8) *Smoking Cessation*: tweets that convey the idea that e-cigarettes are a smoking cessation device or that vaping can help people quit smoking;
- 9) *Other*. This category included tweets that could not be classified into any of the other categories and the healthy food words were not describing e-cigarettes nor the act of vaping.

### 2.3. Classifying tweets by source (marketer vs. non-marketer)

Apart from classifying the content of all tweets by theme, we also coded whether each tweet was likely to originate from a marketing (vs. non-marketing) source. Tweets were only classified as marketing if they promoted vaping products by directly providing a sales link to a payment method, not if they only shared information about a promotion. Our study was a content analysis of text, not images, so links were only clicked if we had doubts about how the tweet should be categorized or doubts about whether the tweet had a sales purpose.

### 2.4. Statistical analyses

Two independent coders rated tweets per the coding categories. Interrater Reliability was calculated and Cohen's Kappa for all categories was above 0.8, indicating strong inter-coder agreement, except for coding category 'Other' which had a Kappa of 0.7, indicating a moderate and acceptable level of agreement. Percentage agreement for each category was as follows: Health-enhancing: 97%; Harmless: 93.3%; Less Harmful Than Cigarettes/Other inhaled substances: 100%; Youth-Resonant: 97.1%; Sensations: 98.8%; Humor non-critical: 96.7%; Humorous Critical: 99.1%; Smoking Cessation: 100%; Other: 95.5%.

Finally, we did two sets of chi-square analyses. First, to answer our first research question, we classified all thematic categories into two broad groups to separate tweets for which the underlying intention

overall seemed to be smoking prevention (i.e., those that had been classified as *critical* of vaping or as referring to vaping as a *cessation device*) away from those that seemed to represent vaping as youth-resonant/sensations/harmless/health-enhancing. Since the purpose of this was to assess which of these two broad categories was more likely to be authored by a marketing source, we used chi-square tests to compare the two. Then, to answer the second research question, chi squares were calculated for each thematic category to assess which specific categories were more likely to originate from a marketing source vs. a non-marketing source.

## 3. Results

From the list of 3009 tweets that were produced between January 20 and March 13, 2017 containing vaping and healthy food related words, we excluded retweets and found there were still 1679 tweets in which at least one of the eight healthy food words were still present. The final analytic sample ( $N = 1205$ ) was arrived at after removing 1330 retweets and 474 duplicate tweets. It was the sample used for the content analysis and the one used to discern if tweets were authored by a marketing or non-marketing source. Fig. 2 illustrates the relative frequency of each type of word after eliminating retweets and duplicates.

Table 1 presents a summary of the frequency of tweets in each coding category. From the total number of tweets, we identified that 54% of all tweets were authored by marketers. After classifying all tweets, we found 38% referred to vaping as either *harmless*, or as *health-enhancing* (combining the two categories). In contrast, only 7% were either *critical* of smoking/vaping or mentioned vaping as a smoking *cessation device*. The most common single category was *harmless* (28%).

### 3.1. Result from Chi-square test

Tweets classified as '*smoking cessation*' and '*humorous critical*' (i.e., oriented towards vaping prevention) were significantly more likely to originate from a non-marketing source than from a marketing source – compared with tweets classified as *health-enhancing*, *harmless*, *youth-resonant*, or referring to *sensations* (i.e., those that seemed oriented towards promoting vaping): ( $\chi^2(8, N = 1205) = 294.48, p < .001$ ). To hone in on the differences between each thematic category, a second set of chi-squares was calculated (Table 1). We found that again, tweets classified as *critical* and those classified as *humorous non-critical* were more likely to be authored by a non-marketer than by a marketer ( $\chi^2 = 64.92, p < .01$  and  $\chi^2 = 151.64, p \leq .01$  respectively). However, only tweets classified as *harmless* and those classified as *sensations* were more likely to be authored by a marketer than by a non-marketer ( $\chi^2 = 18.67, p < .01$  and  $\chi^2 = 96.35, p < .01$  respectively) (Table 1).

### 3.2. Tweet examples by topic

Examples of tweets, by theme, are provided in Table 2 with paraphrases (in the table and text) to protect the identity of their authors. The '*Other*' category included tweets like the following paraphrase: "saw this girl walking on campus with something in her mouth so naturally I thought she was brushing her teeth... She was just vaping."

In addition to the health terms used to form the sample, we found other food-related words that were frequently mentioned such as "gourmet," "energy drink," "nectar," and "extracts." We also noticed several tweets described their products as being made in the USA (e.g., 'Dragon's Premium #ELiquid - 100% MADE IN THE USA! All natural without preservatives!'; 'Menthol eLiquid is made in the US with all-natural domestic ingredients') and several that referred to vaping as compatible with physical activities like Crossfit.

**Table 1**  
Summary of results based on content analysis of tweets about vaping.

Sentiment about vaping	Number of tweets (N = 1205)	(%)	Marketing source of the tweet (frequency)	Non-marketing source of the tweet (frequency)	Chi-square (comparing each category against all others, by source of the tweet)
Health enhancing	110	(9%)	68	42	2.54, N.s.
Harmless	343	(28%)	221	122	18.67, $p < .01$
Less harmful than cigarettes/other inhaled substances	28	(2%)	17	11	0.43, N.s.
Youth-resonant	128	(11%)	68	60	0.13, N.s.
Sensations	276	(23%)	222	54	96.35, $p < .01$
Humorous non-critical	127	(11%)	4	123	151.64, $p < .01$
Humorous critical	68	(6%)	5	63	64.92, $p < .01$
Smoking cessation	12	(1%)	5	7	0.82, N.s.
Other	113	(9%)	48	65	
		Total	658	547	

Note. N.s. = not statistically significant per the Chi-square distribution table. At 1 degree of freedom the critical value for the chi-square statistic is 6.63 for statistical significance  $p < .01$ ; and 3.84 for  $p < .05$ .

#### 4. Discussion

We documented the presence of vaping tweets associated with healthy food labels by exploring realistic content regarding e-cigarettes. In a sample of one million tweets about vaping posted to Twitter during the first two and a half months of 2017, a small but important proportion included healthy food terms. Of these, almost one third promoted the idea that vaping is *harmless*, and almost one fourth referred to smells and flavorings. We found more tweets suggesting that vaping is *health-enhancing* than tweets about vaping as a *smoking cessation tool*. Overall, smoking-promotion content was more likely to originate from

Twitter authors who were marketers rather than from non-marketers. If such content represents a deliberate marketing strategy, then this phenomenon could be worthy of attention from the Food and Drug Administration (FDA).

As there is no longitudinal evidence supporting the claim that electronic cigarettes are harmless or health-enhancing, e-cigarette companies have traditionally focused marketing efforts arguing that their products are less harmful than cigarettes or can be used as smoking cessation devices. However, in our healthy food terms sample we found nine times more tweets conveying the notion that electronic cigarettes have health-enhancing properties (9%) than tweets claiming

**Table 2**  
Examples of vaping tweets categorized by theme.

	Examples
<i>Health-enhancing (N = 111)</i>	<ol style="list-style-type: none"> <li>1 E-cigs maybe better for you than organic produce!</li> <li>2 Put vitamins into vape juice so teens get their nutrients</li> <li>3 100% Natural #medicine E-cig #HealthyLiving #killcancer</li> </ol>
<i>Harmless (N = 343)</i>	<ol style="list-style-type: none"> <li>1 I vape since its gluten free</li> <li>2 In this image you can see the ingredients of e-liquid they are completely harmless to us and natural</li> <li>3 If someone vapes and is a vegan, which one do they tell you about first? Trick question! The answer is Crossfit.</li> </ol>
<i>Less harmful than combustible cigarettes/other inhaled substances (N = 27)</i>	<ol style="list-style-type: none"> <li>1 – Hey, you're so unhealthy, – Well at least I organic vape.</li> <li>2 He wants to vape with something known to be more natural (kicks the tobacco)</li> <li>3 Switching From Smoking to Vaping Reduces Your Carcinogens #Organic #Health #Cooking #Food A new study in X</li> </ol>
<i>Humorous critical (N = 68)</i>	<ol style="list-style-type: none"> <li>1 Why are people suddenly vaping vitamins? Can someone explain? Is this really stupid or am I getting old?</li> <li>2 Yuck! My future husband vapes? WTF?</li> <li>3 I met a vegan vaping millennial Crossfitter. Where did humankind go wrong?</li> </ol>
<i>Smoking cessation (N = 12)</i>	<ol style="list-style-type: none"> <li>1 #tea #bath #vape #cook #bale #smoke FOR #organic #spiritual #conscious SO U CAN #quitsmoking #yoga #herbalism #spliffspliff</li> <li>2 #StopSmoking and #BlowLiquidKloudz #Vape #Mississippi #LiquidKloudz #eJuice is #AllNatural</li> <li>3 @veganXXX I feel you man, that's why I vape. I always got insomnia when I tried to quit and jimmy legs.</li> </ol>
<i>Youth-resonant (N = 130)</i>	<ol style="list-style-type: none"> <li>1 We'll pick up organic vape fluid from mind, body, geode and get cage-free tapas, suh dude u in?</li> <li>2 Taste Rainbows - #vitamins #natural #smoke #alternative #vape</li> <li>3 Inhale The Future - #vitamins #natural #smoke #alternative #model #fashion #vape</li> </ol>
<i>Sensations (N = 275)</i>	<ol style="list-style-type: none"> <li>1 Freshly Picked e-liquids in a vibrant collection of balanced, natural fruit flavors</li> <li>2 Hope you got my email. Let's vape organic cold filtered coconut juice in Gastown sometime soon.</li> <li>3 Are there any flavored vapes that are organic and free of vg and pg? Saw some that are cookies n cream flavored and want</li> </ol>
<i>Humorous non-critical (N = 128)</i>	<ol style="list-style-type: none"> <li>1 I'm a vegan transgender atheist German engineer who vapes organic decaffeinated compressed soy milk on the regular, and I'm offended</li> <li>2 Get me more non-GMO organic quinoa vape juice. Just finished a batch with my surrogate mother and my rabbi.</li> <li>3 She would also call a burp an organic vape</li> </ol>

Note. These are paraphrases to protect the identity of Twitter authors.

that electronic cigarettes can be used to quit smoking (1%). In prior research, the proportion of tweets reported to mention vaping as smoking cessation strategy ranged from 9% between February 2012 and January 2013 (Rose et al., 2017) to as low as 3% in November 2014 (Sowles, Krauss, Connolly, & Cavazos-Rehg, 2016). Our study may have found a smaller proportion of tweets about smoking cessation because we only selected tweets that contained healthy food words for analysis.

Some tweets in our sample included hashtags with words like ‘natural’ and ‘organic’ but were critical of vaping, so they were classified as critical. However, those tweets could still be perpetuating the myth that vaping is healthy – by associating the notion of vaping with the words natural and organic (Albarracín, Kumkale, & Vento, 2017). Based on evaluative conditioning research (Walther & Langer, 2008) and sleeper effects, people might only remember vaping was paired/associated with things that are healthy. Thus, health researchers monitoring the effect of e-cigarette marketing should pay attention to all the information in the content of messages regardless of the purported intention.

We found many tweets associating vaping with healthy lifestyle activities (e.g., being vegan or doing Crossfit). It is an empirical question for future research to determine if a proportion of vegans or people actively pursuing a healthy lifestyle have adopted vaping for health reasons, and if so, how they reconcile the social identity of their healthy lifestyle and vaping. So far, we discovered some companies using potentially false and misleading health claims about healthy foods to advertise e-cigs as harmless or health-enhancing. If marketers persist by making such claims about their products, then they could end up influencing consumers. FDA should have evidence that e-cigarettes can in fact add nutritional benefits, but instead the evidence indicates that inhaling vitamin supplements may pose a risk (Gaby, 2015; Middha, Weinstein, Männistö, Albanes, & Mondul, 2018; Shinton & Singh, 1967). In the absence of data suggesting that vaping is healthy, the FDA should regulate/prohibit these types of advertisements.

Some of our coding categories have regulatory implications. The category identifying youth-resonant terms contains marketing messages that may contribute to initiation of e-cigarettes among youth with long term health implications. Messages with special appeal to youth could be the focus of FDA regulation, similar to restrictions in the 1998 U.S. Master Settlement Agreement which eliminated cartoons in cigarette advertising. It was not within the scope of the present study to examine reasons why people are interested in specific e-cigarette flavorings but since one out of every five tweets in our sample was categorized under the sensations category, it would be important for future studies to focus on that content more deeply and compare if consumers mistakenly believe fruit flavors are more natural and healthier than explicitly artificial flavors (e.g., cotton candy). The topic matters because strawberry flavored e-liquids have been found to be particularly cytotoxic (Leigh et al., 2016) and decline in respiratory function as well as bronchiolitis obliterans (i.e., “popcorn lung disease”) have been traced back to inhalation of diacetyl-containing e-liquids – which are commonly found in buttery flavorings like caramel and marshmallow but also in fruit flavors of almost every kind (Allen et al., 2016; Farsalinos, Kistler, Gillman, & Voudris, 2015). Thus, it would be important to assess if people are mistakenly assuming fruit flavors are safer because they associate them with more natural foods.

## 5. Conclusion

In conclusion, there is evidence that posts about vaping on Twitter are using terms that suggest it is harmless, health enhancing, and resonant with a youthful lifestyle. FDA and other regulatory agencies worldwide are advised to evaluate the marketing practices of e-cigarette manufacturers and retailers that associate their products with healthy foods. FDA needs to enforce the 2009 Tobacco Control Act and the 2016 New Tobacco Rule regulating the use of unsupported claims about the safety of new tobacco products. Regulators should also

determine if health campaigns counteracting these new marketing practices are needed to educate the public about the truth, since there is presently no conclusive evidence indicating that it is safe to inhale food flavors from e-cigarettes.

## Conflicts of interest

All authors declare that they have no conflicts of interest.

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