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Characterizing JUUL-related posts on Twitter

Jon-Patrick Allem[a,*], **Likhit Dharmapuri**[b], **Jennifer B. Unger**[a], **Tess Boley Cruz**[a]

[a]Keck School of Medicine, University of Southern California, Los Angeles, CA 90033, USA

[b]Department of Computer Science, University of Southern California, Los Angeles, CA 90095, USA

Abstract

Background: As vaping rapidly becomes more prevalent, social media data can be harnessed to capture individuals' discussions of e-cigarette products quickly. The JUUL vaporizer is the latest advancement in e-cigarette technology, which delivers nicotine to the user from a device that is the size and shape of a thumb drive. Despite JUUL's growing popularity, little research has been conducted on JUUL. Here we utilized Twitter data to determine the public's early experiences with JUUL describing topics of posts.

Methods: Twitter posts containing the term "JUUL" were obtained for 1 April 2107 to 14 December 2017. Text classifiers were used to identify topics in posts (n = 81,689).

Results: The most prevalent topic *wasPerson Tagging* (use of @username to tag someone in a post) at 20.48% followed by *Pods* (mentions of JUUL's refill cartridge) at 14.72% and *Buying* (mentions of purchases) at 10.49%. The topic *School* (posts indicative of using JUUL or seeing someone use JUUL while at elementary, middle, or high school) comprised 3.66% of posts. The topic of *Quit Smoking* was rare at 0.29%.

Conclusions: Data from social media may be used to extend the surveillance of newly introduced vaping products. Findings suggest Twitter users are bonding around, and inquiring about, JUUL on social media. JUUL's discreetness may facilitate its use in places where vaping is prohibited. Educators may be in need of training on how to identify JUUL in the classroom. Despite JUUL's branding as a smoking alternative, very few Twitter users mentioned smoking cessation with JUUL.

Keywords

JUUL; Vaping; Twitter; Social media; Electronic cigarettes

[*]Corresponding author at: 2001N. Soto Street, 3rd Floor Mail, Los Angeles, CA, 90032, USA., allem@usc.edu (J.-P. Allem).

Contributors

Jon-Patrick Allem and Likhit Dharmpuri conceived of the study and analyzed the data. Jon-Patrick Allem drafted the initial manuscript. Tess Cruz, Jennifer Unger, and Likhit Dharmpuri revised the manuscript for important intellectual content. Tess Cruz and Jennifer Unger received funding for the study. All authors have approved the final manuscript.

Conflict of interest

No conflict declared.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.drugalcdep.2018.05.018.

1. Introduction

The use of electronic cigarettes (e-cigarettes) or "vaping" continues to grow in popularity in the United States (U.S.) and elsewhere (Singh et al., 2016; Schoenborn and Gindi, 2015). While long-term health consequences are not yet known, there is evidence of some risk from vaping, e.g., exposure to potentially toxic substances (National Academies of Sciences, Engineering, and Medicine, 2018). As vaping rapidly becomes more prevalent, social media (e.g., Twitter, Instagram, YouTube) data can be harnessed to quickly capture and describe the context in which individuals reflect on e-cigarette products and discuss the social and environmental settings in which vaping occurs. Researchers across disciplines are continually turning to social media data to fill information gaps providing timely insights that serve as a starting off point to address issues of great import (Leas et al., 2016; Ayers et al., 2016). Posts on social media can reflect the attitudes and behaviors of the public without the prime of a researcher or instrument bias while being captured in near real-time and at relatively low costs (Ayers et al., 2017; Allem et al., 2017a, 2017e).

Social media data has been used in the study of e-cigarettes and other tobacco-related products and behaviors (Allem et al., 2017a, 2017e; Chu et al., 2015; Sanders-Jackson et al., 2015; Myslin et al., 2013). For example, Chu and colleagues analyzed e-cigarette-related posts on Instagram and found that images often showed individuals blowing large clouds of aerosol in addition to users' preferred devices (Chu et al., 2016). Ayers and colleagues used tweets to identify reasons for why people used e-cigarettes with results indicating that people liked the social image that vaping portrayed (Ayers et al., 2017). Allem and colleagues used hashtags to identify themes of e-cigarette-related conversations on Twitter finding that vaping was often discussed in conjunction with other tobacco products (dual tobacco product use) as well as other substances (polysubstance use) (Allem et al., 2017b).

The JUUL vaporizer, from JUUL Labs (https://www.juulvapor.com/), is the latest advancement in e-cigarette technology, which delivers nicotine to the user from a device that is the size and shape of a thumb drive. According to the company website, the JUUL vaporizer "has regulated temperature control and uses nicotine salts as found in the tobacco leaf rather than free-base nicotine, unlike standard e-cigarettes." Despite a large and diverse market of vaping products, at the end of 2017, JUUL had captured close to 33% of the e-cigarette market share reflecting year-over-year growth of about 700% (Levy, 2017). While JUUL Labs' vaping device currently has a larger market share than similar products from tobacco industry giants like BAT, Altria, and Imperial Tobacco, (Levy, 2017) little research has been conducted on JUUL (e.g., product appeal, characteristics of users, correlates of use). In the present study, we demonstrated the utility of collecting data from Twitter to document and describe JUUL-related conversations. Our goal was to determine the public's early experience with JUUL including understanding the social and environmental context in which people use JUUL. Findings from this study should inform tobacco control policy and prevention efforts and demonstrate the utility in using Twitter data for rapid surveillance of health behaviors and newly introduced products like JUUL.

2. Methods

Twitter (https://twitter.com/) posts containing the term "JUUL" were obtained for 1 April 2107 to 14 December 2017. There was a total of n = 274,400 posts during this time. We removed re-tweets and analyzed the remaining n = 97,302 unique posts. "Juul" is used in Nordic languages and can be part of words in other languages such as in names. In order to clean the data, we removed tweets from the corpus that contained "Juul" in the middle of a word, when posts were in other languages aside from English, when the account responsible for the tweet was identified as a social bot (Allem and Ferrara, 2016; Allem and Ferrara, in press), and when the post was from known spam, advertisements or from promotional Twitter accounts resulting in a final analytical sample of n = 81,689, representing tweets from 52,098 unique users. The final sample was prepared for analysis, which included the process of basic normalization (e.g., lower case all text, remove punctuation), stop word removal (e.g., words such as "a," "the," etc.), normalization of Twitter user mentions (e.g., "@johnsmith" is converted to "@person"), lemmatization (e.g. "dog," "dog's," and "dogs'" are all converted to "dog"), and non-printable character removal (e.g., emojis and symbols from other languages) (Allem et al., 2017c). All analyses relied on public, anonymized data, adhered to the terms and conditions, terms of use, and privacy policies of Twitter, and were performed under Institutional Review Board approval from the authors' university. To protect privacy, no tweets were reported verbatim in this report.

Initially, we analyzed the tweets using word frequencies (of single words and double-word combinations also known as one gram and bigrams) and visualized the data through word clouds to identify common topics (See Supplementary material). From this assessment we deduced several topics including *Flavors* (use of the words "Mango" "Mint" "Flavor" etc.), *Pods* (mentions of JUUL's refill cartridge known as pods), *Person Tagging* (the use of @username to tag someone in a post), *School* (words indicative of using JUUL or seeing someone else use JUUL while at elementary, middle, or high school), *College* (words indicative of being on a college campus or college student), *Buying* (mentions of purchasing JUUL), *Lost & Found* (mentions of misplaced JUUL), *Wanting JUUL* (mentions of wanting to use or try JUUL), *JUUL Use* (mentions of using JUUL while tweeting), and *Charger* (mentions related to JUUL's charger or battery). Additionally, JUUL Labs brands its vaporizer as an alternative to smoking combustible cigarettes. As such, we included words indicative of smoking cessation to represent the topic of *Quit Smoking.*

Next, we used FastText, an open-source library by Facebook that allows users to learn text representations for creating text classifiers (Mikolov et al., 2017). FastText is a technique that creates embeddings (e.g., numerical representations of words that helps capture meaning, semantic relationships, and context) for text by using each word in a corpus to predict the words that usually surround it. In other words, FastText creates word embeddings where semantic relationships between words are preserved. For example, one advantage of this technique is that words that are synonyms will have similar embeddings whereas words that are antonyms will have dissimilar embeddings. Similarly, in the FastText representations of words, the relationship between 'king' and 'queen' is equal to the relationship between 'man' and 'woman'.

We used FastText to find similar words for the one gram and bigrams that we identified per topic in the word cloud stage. This process, along with visual inspection and manual edits, allowed us to expand our word list per topic by identifying words that appeared, in posts, in a similar context as our original keywords. For example, through this process, we found that the words “teenager,” “teen,” “elementary,” “bathroom,” “recess,” “library,” etc. all commonly co-occurred in posts with the word “school.”

Classification was done by checking for the presence of any one of the keywords (one gram and bigrams) in a tweet. If a tweet consisted of any of the keywords associated with a topic, the tweet was classified as part of that topic. After we classified all tweets into the above topics, we repeated the analysis on the subset of tweets identified in the *School* and *Person Tagging* topics, respectively. This allowed us to gain further insight into what elementary, middle or high school aged users talked about regarding JUUL as well as understand what users discussed with friends regarding JUUL. For the *School* subset, apart from the previous topics discussed above, we discovered a new topic *Place of Usage* (bathroom, cafeteria, library, gym, etc.) describing where students used JUUL on school grounds. Since the *College* and *School* topics were mutually exclusive, *College* is not included as a topic in the *School* tweets subset analysis. Additionally, for the *Person Tagging* subset, we discovered three new topics *Birthday Wishes, What is JUUL* (e.g., “Do you know what JUUL is?”), and *Video Tagging* (a link to a video of JUUL use). For each analysis, we present findings in a confusion matrix where the diagonal line indicates the prevalence of a topic and the off-diagonal lines indicate topic overlap. For example, a hypothetical post such as “I lost my JUUL at recess” could be classified under *Lost & Found* and *School*. The number of posts containing both contents would be found at the intersection of the matrix for these two topics.

3. Results

The total coverage of the 11 topics we identified constituted 56.41% of all tweets in the corpus (Fig. 1). The remaining 43.59% of tweets were too varied to be classified into a single topic with meaningful coverage (coverage of each subsequent topic would be less than 1% of total tweets). The most prevalent topic was *Person Tagging* at 20.48% followed by *Pods* at 14.72% and *Buying* at 10.49%. About 3.66% of the corpus was *School* representing 2988 unique tweets. The least common topic was *Quit Smoking* with 0.29% of all tweets or 233 unique tweets.

We identified 13 topics in the *Person Tagging* subset of tweets (Fig. 2). This covered 36.41% of the total 16,731 *Person Tagging* tweets. The most prevalent topic in this subset was *Pods* at 10.12%, followed by *JUUL Use* at 8.22% and *Buying* at 7.59%. In the *School* subset, we identified 10 topics (Fig. 3) that covered 68.01% of the total 2988 tweets. The most prevalent topic in this subset was *Place of Usage* 42.00% followed by *JUUL Use* 16.10% and *Pods* 9.07%.

4. Conclusion

The topics identified in this corpus of tweets provided a number of direct insights into the public's early experience with JUUL. The most prevalent topic was *Person Tagging* or an individual Twitter user directly communicating to another user (likely a friend) about JUUL. This suggests that Twitter users share their thoughts, attitudes, and behaviors regarding JUUL with a specific Twitter user in mind. When we examined the subset of *Person Tagging* tweets, we found that the most common topics were *Pods, Buying*, and *JUUL Use,* suggesting users are notifying select friends when buying and using JUUL. Additionally, this subset of tweets contained topics such as *Video Tagging* containing links to videos of JUUL use in addition to *What is JUUL?* indicating Twitter users will ask specific friends about this new product. Earlier research suggested select Twitter users requested JUUL as a gift from their friends on their birthdays and holidays (Kavuluru et al., 2018). Taken all together, these findings suggest that Twitter users are bonding around, and inquiring about, JUUL on social media, potentially nor-malizing JUUL use (Allem et al., 2017b).

The present study identified discussion about JUUL among Twitter users in elementary, middle, or high school. When we examined the subset of School tweets, we found that the most common topic was *Place of Usage*, suggesting JUUL use was taking place on school grounds po-tentially in classes, bathrooms, libraries, and gyms during school hours. The JUUL vaporizer is the size and shape of a thumb drive, and its discreetness may facilitate its use in places where vaping is prohibited. These findings may be of importance to school administrators, teachers, prevention programmers and tobacco product regulators. Educators may be in need of training on how to identify JUUL in the classroom. School administrators may consider installing vaping detectors in bathrooms and classrooms to deter the use of JUUL on school grounds.

The present study found that college students talked about using JUUL or of peers using JUUL on their college campuses. This is un-surprising given that a recent national online survey reported that 12% of participants 18–24 years of age reported JUUL use in their lifetime (Willett et al., 2018). The present study also identified several of JUUL's design features that may be appealing to users including flavors, which is similar to earlier research (Ayers et al., 2017; Kavuluru et al., 2018). Posts indicative of JUUL's design features also included mentions of its pods and charger and posts about misplaced devices due to their small size. Future research should focus on the appealing characteristics of JUUL's design in order to inform regulatory policies that will reduce appeal for adolescents while maintaining appeal for adults who could use JUUL in place of combustible cigarettes. Despite JUUL's branding as a smoking alternative, very few Twitter users mentioned quitting cigarette smoking along with JUUL. Users that comprised this corpus of tweets may be young and uninterested in cessation or only experimenting with JUUL and is an area of future research. If JUUL's ultimate goal is to create a smoking alternative for adults, designing a product that maximizes appeal to adult smokers while minimizing appeal to youth and nonsmokers would be important to consider in the future.

4.1. Limitations

Data collection relied on Twitter's Streaming API which prevented the collection of tweets from private Twitter accounts. As a result, findings may not represent the attitudes and behaviors of individuals with private accounts. Twitter does not make its users' demographic information (e.g., age) public in order to protect user privacy. As such, it is difficult to determine the exact age of users contributing to topics such as *School* and *College.* However, the words that comprised these topics were conservative and consisted of words that had a strong face and concurrent validity, e.g., "elementary," "middle," and "high" along with "school," and the names of specific colleges, colleges' abbreviations, and the mentions of professors, etc.

This study documented that youth are using JUUL as a discreet way to use nicotine in and around the school. Additionally, users are posting about social factors, such as tagging people using JUUL. JUUL does not appear to be thought of by its users as a cessation device. These findings highlight a clear benefit of using social media data in public health surveillance. Data from social media can serve as an early warning system informing public health researchers about new tobacco products or ways in which products are appealing to the public. By using social media data, researchers can document ways in which users experience new tobacco products, identifying their dislikes and likes in addition to the ways in which these products are marketed to consumers as promotions emerge in near real-time (Allem et al., 2017d). Taken together, public health researchers and tobacco control practitioners could utilize data from social media to fill knowledge gaps quickly and more readily plan policy and educational initiatives for the populations they serve.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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(Number) / (% of total)										
Person Tagging	**(16731) / (20.48%)**									
Pods	(1693) / (2.07%)	**(12023) / (14.72%)**								
Buying	(1270) / (1.55%)	(2517) / (3.08%)	**(8573) / (10.49%)**							
Juul Use	(1375) / (1.68%)	(206) / (0.25%)	(201) / (0.25%)	**(6512) / (7.97%)**						
Flavors	(680) / (0.83%)	(3318) / (4.06%)	(667) / (0.82%)	(145) / (0.18%)	**(4716) / (5.77%)**					
Want Juul	(664) / (0.81%)	(652) / (0.80%)	(258) / (0.32%)	(248) / (0.30%)	(73) / (0.09%)	**(3922) / (4.80%)**				
College	(317) / (0.39%)	(397) / (0.49%)	(352) / (0.43%)	(404) / (0.49%)	(126) / (0.15%)	(101) / (0.12%)	**(3555) / (4.35%)**			
School	(279) / (0.34%)	(271) / (0.33%)	(182) / (0.22%)	(481) / (0.59%)	(108) / (0.13%)	(45) / (0.06%)	(0) / (0.00%)	**(2988) / (3.66%)**		
Charger	(104) / (0.13%)	(63) / (0.08%)	(264) / (0.32%)	(6) / (0.01%)	(20) / (0.02%)	(150) / (0.18%)	(37) / (0.05%)	(23) / (0.03%)	**(1577) / (1.93%)**	
Lost & Found	(91) / (0.11%)	(165) / (0.20%)	(67) / (0.08%)	(10) / (0.01%)	(34) / (0.04%)	(11) / (0.01%)	(31) / (0.04%)	(28) / (0.03%)	(61) / (0.07%)	**(970) / (1.19%)**
Quit Smoking	(80) / (0.10%)	(10) / (0.01%)	(41) / (0.05%)	(18) / (0.02%)	(5) / (0.01%)	(27) / (0.03%)	(8) / (0.01%)	(3) / (0.00%)	(1) / (0.00%)	(1) / (0.00%)
	Person Tagging	Pods	Buying	Juul Use	Flavors	Want Juul	College	School	Charger	Lost & Found

Fig. 1.

Prevalence of Topics.

Note: The bold diagonal line indicates the prevalence of the 11 topics identified. The off-diagonal lines indicate topic overlap. For example, a hypothetical post such “I lost my JUUL at recess” could be classified under *Lost & Found* and *School*. The number of posts containing both content would be found at the intersection of the matrix for these two topics or 0.03%.

(Number) / (% of total)													
Pods	**(1693) / (10.12%)**												
Juul Use	(44) / (0.26%)	**(1375) / (8.22%)**											
Buying	(364) / (2.18%)	(38) / (0.23%)	**(1270) / (7.59%)**										
Want Juul	(438) / (2.62%)	(38) / (0.23%)	(86) / (0.51%)	**(680) / (4.06%)**									
Flavors	(76) / (0.45%)	(39) / (0.23%)	(34) / (0.20%)	(9) / (0.05%)	**(664) / (3.97%)**								
Birthday Wishes	(83) / (0.50%)	(62) / (0.37%)	(66) / (0.39%)	(9) / (0.05%)	(3) / (0.02%)	**(561) / (3.35%)**							
Video Tagging	(62) / (0.37%)	(5) / (0.03%)	(1) / (0.01%)	(36) / (0.22%)	(9) / (0.05%)	(0) / (0.00%)	**(411) / (2.46%)**						
College	(19) / (0.11%)	(27) / (0.16%)	(32) / (0.19%)	(12) / (0.07%)	(14) / (0.08%)	(11) / (0.07%)	(8) / (0.05%)	**(317) / (1.89%)**					
School	(14) / (0.08%)	(29) / (0.17%)	(18) / (0.11%)	(4) / (0.02%)	(2) / (0.01%)	(8) / (0.05%)	(17) / (0.10%)	(0) / (0.00%)	**(279) / (1.67%)**				
What is Juul?	(10) / (0.06%)	(69) / (0.41%)	(2) / (0.01%)	(4) / (0.02%)	(2) / (0.01%)	(0) / (0.00%)	(0) / (0.00%)	(7) / (0.04%)	(2) / (0.01%)	**(263) / (1.57%)**			
Charger	(3) / (0.02%)	(2) / (0.01%)	(8) / (0.05%)	(0) / (0.00%)	(8) / (0.05%)	(2) / (0.01%)	(6) / (0.04%)	(1) / (0.01%)	(2) / (0.01%)	(0) / (0.00%)	**(104) / (0.62%)**		
Lost & Found	(17) / (0.10%)	(1) / (0.01%)	(8) / (0.05%)	(2) / (0.01%)	(0) / (0.00%)	(0) / (0.00%)	(0) / (0.00%)	(1) / (0.01%)	(1) / (0.01%)	(0) / (0.00%)	(7) / (0.04%)	**(91) / (0.54%)**	
Quit Smoking	(0) / (0.00%)	(4) / (0.02%)	(1) / (0.01%)	(0) / (0.00%)	(4) / (0.02%)	(0) / (0.00%)	(52) / (0.31%)	(1) / (0.01%)	(0) / (0.00%)	(0) / (0.00%)	(0) / (0.00%)	(0) / (0.00%)	**(80) / (0.48%)**
	Pods	Juul Use	Buying	Wanting Juul	Flavors	Birthday Wishes	Video Tagging	College	School	What is Juul?	Charger	Lost & Found	Quit Smoking

Fig. 2.

Prevalence of Topics within Person Tagging.

Note: The bold diagonal line indicates the prevalence of the 13 topics identified in the subset of tweets for the Person Tagging topic. The off-diagonal lines indicate topic overlap.

(Number) / (% of total)										
Place of Usage	**(1255) / (42.00%)**									
Juul Use	(190) / (6.36%)	**(481) / (16.10%)**								
Pods	(86) / (2.88%)	(29) / (0.97%)	**(279) / (9.34%)**							
Person Tagging	(69) / (2.31%)	(4) / (0.13%)	(14) / (0.47%)	**(271) / (9.07%)**						
Buying	(39) / (1.31%)	(5) / (0.17%)	(18) / (0.60%)	(71) / (2.38%)	**(182) / (6.09%)**					
Flavors	(29) / (0.97%)	(2) / (0.07%)	(4) / (0.13%)	(81) / (2.71%)	(14) / (0.47%)	**(108) / (3.61%)**				
Want Juul	(17) / (0.57%)	(8) / (0.27%)	(2) / (0.07%)	(7) / (0.23%)	(1) / (0.03%)	(0) / (0.00%)	**(45) / (1.51%)**			
Lost & Found	(8) / (0.27%)	(0) / (0.00%)	(1) / (0.03%)	(2) / (0.07%)	(3) / (0.10%)	(0) / (0.00%)	(0) / (0.00%)	**(28) / (0.94%)**		
Charger	(7) / (0.23%)	(0) / (0.00%)	(2) / (0.07%)	(0) / (0.00%)	(0) / (0.00%)	(0) / (0.00%)	(2) / (0.07%)	(0) / (0.00%)	**(23) / (0.77%)**	
Quit Smoking	(0) / (0.00%)	(0) / (0.00%)	(0) / (0.00%)	(0) / (0.00%)	(0) / (0.00%)	(0) / (0.00%)	(0) / (0.00%)	(0) / (0.00%)	(0) / (0.00%)	**(3) / (0.10%)**
	Place of Usage	**Juul Use**	**Pods**	**Person Tagging**	**Buying**	**Flavors**	**Want Juul**	**Lost & Found**	**Charger**	**Quit Smoking**

Fig. 3.

Prevalence of Topics within School.

Note: The bold diagonal line indicates the prevalence of the 10 topics identified in the subset of tweets for the *School* topic. The off-diagonal lines indicate topic overlap.