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## On the popularity of the USB flash-drive shaped electronic cigarette Juul

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Introduced in mid 2015, Juul is currently the most popular electronic cigarette (e-cigarette) with a market share of 49.6% (last four weeks as of 01/27/2018) and YoY growth of nearly 700% based on Nielsen market data [1]. Juul is a compact closed system device charged via USB (Figure 1) and comes with disposable flavored *pods* each of which contains 0.7ml with 5% nicotine by weight. Each pod is nearly equivalent to one pack of cigarettes or 200 puffs according to official Juul documentation (from [www.juulvapor.com](http://www.juulvapor.com)), which also states that Juul is specifically “designed with smokers in mind” and is “for adult smokers seeking a satisfying alternative to cigarettes.” To order Juul online, age verification (+21) is required and implemented through a third party verification service provider. The purpose of this letter is to describe initial observations of recent Juul related messages on two different social networks (Twitter and Reddit) and traditional media.

### Juul messages on Twitter

We collected 250,873 tweets mentioning the word “juul” and its variants “juuling” and “juuled” from 10/19/2017 and 02/14/2018 using Twitter’s free streaming API service. Due to rate limits imposed by Twitter Inc. on free data collection using their API, this dataset does not represent an exhaustive set of tweets matching our keywords during that period. This is also a filtered set and excludes tweets generated by organizations and users whose user name contains “juul” (potentially part of their actual name). Only a third of the data (84,729 tweets) represent unique tweets, the rest arising from the retweet mechanism. The duplicates from the top ten retweeted messages account for 29% of the full dataset (72,521 retweets). Next, we make some observations that highlight the nature of Juul tweets’ contents based on regular expression based searches on the dataset.

1. Juul was frequently used as a verb (e.g., “trying to juul in the bathroom”) including the gerund form “juuling.” Using a natural language parser [2], we identified that nearly 7380 mentions (unique: 3288) of Juul are as a verb, describing its use as an activity. Although there are many e-cigarette brands, to our knowledge, this is the first time a specific e-cigarette name is directly being used as a verb.
2. Juul mentions were often associated with school sites and concealed places in those locations. 18,319 tweets (unique: 4361) mentioned the words school, class,

lecture, library, dorm, cafeteria, food court, or campus; 2050 tweets (unique: 1084) mentioned bath/rest rooms, toilets, or locker rooms. Variants of relevant key phrases with and without spaces (bath room vs bathroom) were also used in the search process (e.g., “bath[]?room|rest[]?room|toilet| locker[]?room”).

3. Juul’s resemblance to a flash drive led to nearly 2519 tweets (unique: 696) mentioning thumb/flash drives with one particular tweet (“a kid just asked me for a hit from my flash drive thinking it was a juul”) prompting over 1285 retweets (in our dataset); using Twitter’s Web interface we see that this popular message has been retweeted over 12,000 times.
4. Juul’s popularity is also evidenced by its portrayal as a holiday costume or requested gift. Several tweets describe the tweeter as contemplating to “go as Juul” for Halloween parties. There were pictures of young people (who appear underage) dressed up in Juul costumes. We found 7863 tweets (unique: 1193) mentioning Christmas (and variants xmas/x-mas) and 350 tweets (unique: 227) discussing Valentine’s day (and variants vday/v-day). There were examples of tweets where tweeters were hoping for or requesting Juul pods as Christmas/ Valentine’s day gifts. There were also amusing ways in which the product name was used for word play (e.g., “wondering if Juul be my valentine” occurred in 40 tweets [unique: 29]).
5. We also wanted to see if nicotine dependence related terms were used by users and found that 31,492 tweets (unique: 1777) included terms crave/cravings/ addiction/addicted/addict. Upon manual examination, there were several disclosures from tweeters that they are addicted to Juul (but mentioned in a lighthearted manner) and others saying they are glad they are not.
6. Among flavors mint (total: 1083, unique: 576) was most frequently mentioned followed by cucumber (total: 876, unique: 421), mango (total: 722, unique: 527), and crème brulee (total: 112, unique: 66).

The seven-day running average for the number of tweets for the nearly four-month duration of our collection timeframe is shown in Figure 2. At least for this short duration, we clearly see a steady increasing trend in tweet volume with noticeable bumps during the weeks before Christmas and Valentine’s day further confirming Juul’s growing popularity on Twitter.

## Juul messages on Reddit

Reddit is an online forum that allows for longer messages and focused discussions around specific themes. A subreddit is a focused community within the Reddit platform with users discussing a specific topic where posts and comments/replies can be upvoted and downvoted by other Reddit users. A custom ranking, which takes into account the time elapsed since post time and the post’s upvotes and downvotes, automatically ranks the posts, thus maintaining a dynamic list of trending popular posts. Reddit is also well known for ‘throwaway accounts’ where users can create dummy accounts to participate in an

anonymous fashion. As of 03/28/2018, the Juul subreddit had over 15,208 members discussing Juul related themes.

It was alarming to notice a Juul focused subreddit for underage users (<https://www.reddit.com/r/UnderageJuul/>) that started in July 2017 and had close to 1000 members before it was banned on 01/18/2018. Based on the snapshot from 11/4/2017 with 235 members, this group grew at the rate of nearly eight new members per day before it was banned. The rule list for the underage Juul subreddit included: “Do not reveal any information about anyone that could get them in trouble in any way. Do not judge people based on their age - this subreddit is specifically meant for underage JUUL”. On this subreddit we observed explicit exchanges of messages between users about retailers that do not require age verification. We also noticed older people offering “discreet shipping” to underage users’ homes by taking upon the responsibility of ordering from Juul’s website with slightly higher online payments via PayPal/Venmo. This is a way for private older citizens to make a profit off of underage users’ Juul dependence by charging them higher prices and helping them get access to the products. This subreddit’s messages also included tips on how to not get caught at school, at airports, and on airplanes with Juul devices. The forum was also used to exchange “serial numbers” of purchased Juul products that are still under warranty so that people with those serial numbers can order replacement products for defective devices/pods even if they are actually not damaged (given Juul Vapor trusts the user). Through this process, a user may be able to buy a product and sell/share the serial code of the purchased product to a different user who can then claim a replacement product, thus enabling the use of two devices for the price of one. Although the underage Juul subreddit is banned, there could be other more private online forums where similar information can be exchanged among underage users posing a major challenge for surveillance. While it was active, the underage subreddit provided a peek into the inner workings of how social networks can lead to easier access to tobacco products.

The traditional media is also highlighting Juul as an emerging e-cigarette product encouraging circumspection (instead of promoting) about the product. Several campus newspapers at universities across the US (e.g., University of Michigan [3], University of Washington [4], New York University [5]), the national public radio [6], and some local news stations [7–9] have recently highlighted Juul’s penetration into college and high school campus locations and dorms raising concerns about clear signs of underage usage.

In this letter, we highlighted how online platforms appear to contribute to Juul’s popularity and how some enable ways to circumvent the age verification process in obtaining the product. In the light of these findings, we conclude that online surveillance of Juul and similar products is essential to monitor marketing of this new e-cigarette product and the strong potential of underage use that can inform public health regulations. Specifically, we propose the following future research directions:

- We will utilize recent advances in computational methods for predicting demographic attributes (gender, age, race) of Twitter users to conduct analyses of tweets authored by users from particular vulnerable segments.

- From the perspective of leveraging automated surveillance methods, a future direction is to explore potential collaborations with researchers at the FDA to gain insights into usage patterns and attitudes of underage users toward Juul-like products and to design suitable social media campaigns both in terms of contents of the messages and ways to maximize the exposure of such messages to target audiences.

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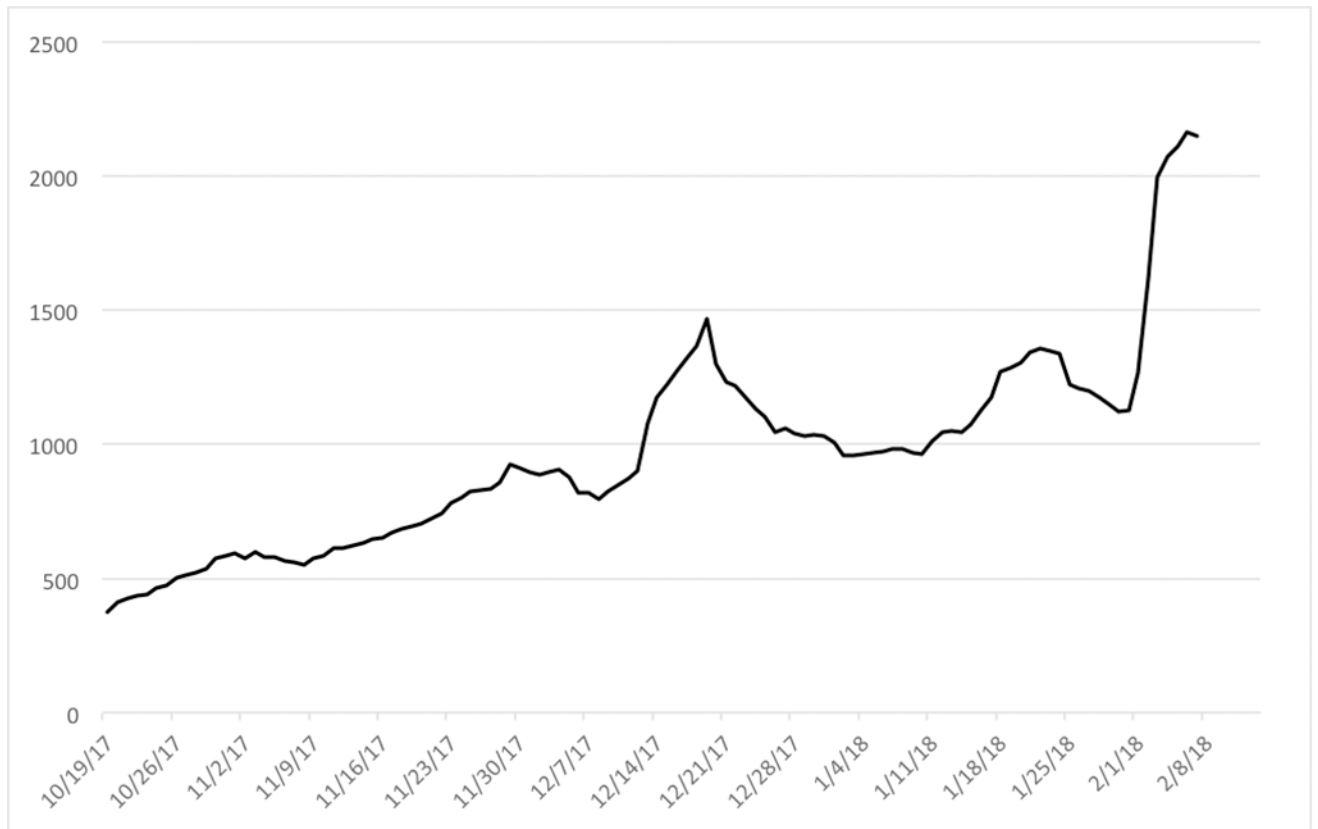
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**FIGURE 1.**

(A) Juul device as it fits in a palm (courtesy: UW Daily). (B) Juul connected to a MacBook Air via a USB charger (courtesy: Juul Labs website).



**FIGURE 2.** Seven-day running average of numbers of unique tweets with the start date of each window on x-axis and the average number of tweets on the y-axis.