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Original investigation

Orthodox and Unorthodox Uses of Electronic Cigarettes: A Surveillance of YouTube Video Content

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Abstract

Introduction: Open electronic cigarette (e-cigarette) systems are customizable by consumers and often allow for potential "unorthodox" use of the product; that is, use not as intended by the manufacturer. Little is known about the types and prevalence of unorthodox uses and how these practices are transmitted via popular social media.

Methods: Monthly searches of YouTube were conducted from June through November 2016 using the following search terms: "e-cigarettes," "vaping," and "e-juice." After collecting static and dynamic data on the 150 videos identified, two coders independently coded videos for general information, unorthodox use behaviors, health claims, and production quality and characteristics for orthodox and unorthodox use. Intercoder reliability was high (Cohen's κ 0.81, $p < .001$).

Results: One hundred fifty videos were included in the study with a total of 115 551 563 views. We identified nine categories of unorthodox uses of e-cigarettes. Unorthodox use was three times as prevalent as orthodox use. Seventy-seven percent of the unorthodox use videos included recreational e-cigarette use, 57% included modification of mechanical parts and components, and 44.6% included unorthodox substance application (dripping). There were more than twice as many social media links in videos depicting unorthodox compared to orthodox use, but the level of engagement was lower for unorthodox use.

Conclusions: E-cigarette unorthodox use on YouTube is more prevalent than orthodox use, suggesting the need to further investigate the prevalence of unorthodox use among e-cigarette users and the influence of social media on consumer uptake of unorthodox and orthodox uses of e-cigarettes.

Implications: The US Food and Drug Administration has regulatory authority over e-cigarettes, parts and components. Many e-cigarettes currently marketed are open systems. Closed systems may allow less manipulation and may influence the safety of these products. This study provides valuable information on ways that open system e-cigarettes are used and it can inform safety tests that can be conducted by the US Food and Drug Administration to determine whether or not these products should remain on the market. In addition, our definitions of unorthodox use can be incorporated into the Population Assessment of Tobacco on Health Study to better understand the prevalence of these behaviors.

Introduction

Electronic cigarettes (e-cigarettes) are a class of tobacco products that use an electrically powered heating element to heat a liquid that often contains nicotine; users inhale the resulting aerosol. The three primary e-cigarette types on the US market today include disposable "cigalikes," rechargeable "cigalikes," and rechargeable cartridge- or "tank"-based systems.[1] The cartridge- and tank-based systems require the user to place several milliliters of liquid into them before use and can be refilled many times. They appeal to consumers, in part, because they are customizable: users can modify components (eg, change tanks and/or heating elements) to manipulate the amount of aerosol and/or alter the user's sensory experience.[2] Across all tobacco products, e-cigarette use has rapidly increased among US young adults and adults.[3–6] In 2014, 21.6% of young adults aged 18–24 reported ever using an e-cigarette and were more likely than older adults to have used these products,[7] with rates increasing to 24.3% of all e-cigarette users in 2016.[8] Also in 2014, nearly 13% of adults had tried an e-cigarette and use was higher among current cigarette smokers (22%).[7,9,10]

In response to a marked increase in use, several studies have examined consumers' reasons for using e-cigarettes. Among adults, the most commonly cited reason for using e-cigarettes was as a method to reduce or quit smoking.[10] Users consistently report beliefs that e-cigarettes are healthier than cigarettes, can reduce cravings, and alleviate symptoms of nicotine withdrawal.[10] Research has also shown that manufacturers/distributors/retailers market e-cigarettes as safe alternatives to cigarettes and/or an effective method for cessation despite little evidence to substantiate these claims.[10] The breadth of literature on consumers' reasons for using e-cigarettes combined with findings that they are frequently marketed as substitutions for cigarettes has helped to illuminate what consumers and researchers consider to be "orthodox use" of e-cigarettes.

To protect the health of the public, in 2016 the US Food and Drug Administration (FDA) began to regulate the manufacturing, distribution, and marketing of e-cigarettes and their parts and components.[11] "Parts and components include software or an assembly of materials intended or expected to change the performance, composition, constituents, or characteristics of tobacco products; or that are used with or for the human consumption of a tobacco product."[11] Importantly, current regulations do not address consumer reconfiguration of parts, components, or liquids intended for e-cigarette use. Many of these parts and components can be modified for use in a manner not intended by the manufacturer (hereafter, "unorthodox use").

The short- and long-term health consequences of e-cigarette use are unknown, though nicotine administration can influence brain development.[5] Equally important, there is growing evidence that e-cigarette aerosols can contain volatile aldehydes, furans, and other known toxicants that are not in the liquid but are formed during the heating process; these can increase as device power increases.[12–17] The extent to which unorthodox use that includes increasing device power (eg, increasing battery voltage or decreasing heater resistance) influences aerosol toxicant yield is unknown. In addition, while premixed and custom-prepared liquids are available to consumers, they can also engage in do-it-yourself preparation wherein consumers can mix and match solutions to suit their preferences for specific nicotine levels and flavors.[18,19] However, mixing liquids also may influence aerosol nicotine and other toxicant yield.

Using data from existing standardized surveillance systems to study e-cigarette unorthodox use behaviors may be challenging given the nature of data collection. Behaviors must first be identified, deemed suitable for the development of a new survey item, and added to questionnaires. By the time this process is completed, the behaviors being measured may have changed and thus neither the initial nor the new behaviors are captured. Although surveys can measure the prevalence of some behaviors, there remains limited information about the diversity in current behaviors, and little opportunity to learn about emerging ones. Other sources of information may aid in this effort. YouTube is the second most-visited Internet Web site in the United States and provides information to billions of people worldwide.[20] Over 800 million people use YouTube and 4 billion videos are viewed daily.[20] The rates of online searches for e-cigarette products and information have increased by 50% in recent years.[21] YouTube is not only a venue for marketing products, but also a vehicle for sharing information about how to customize e-cigarette products.[10] Users can post videos that demonstrate modifications, which makes YouTube a potentially vital source of knowledge for those who wish to use their device in unorthodox ways.[22]

To the best of our knowledge, no study has documented e-cigarette unorthodox use behaviors. Thus, the purpose of this study was to conduct a systematic analysis of YouTube content in order to assess the quantity, reach, and characteristics of videos depicting orthodox and unorthodox uses of e-cigarettes and to examine the various types of unorthodox uses. Given the extensive reach of YouTube,[20] examining unorthodox uses of e-cigarettes and their parts and components can increase our understanding of the potential consumer risk and harm associated with the use of these devices.

Methods

Pilot Study

In May 2016, we conducted a pilot study to inform our search strategies, coding categories, and definitions. We defined unorthodox use as the use of any e-cigarette, its part or component used by a consumer in a manner other than intended or specified by manufacturers; behaviors other than puffing/inhaling from an e-cigarette as assembled/purchased; and use of an e-liquid as produced by a manufacturer/retailer. We completed a preliminary search of YouTube using the terms "electronic cigarettes," "vape pen," and "e-juice." We adopted previously identified terms commonly used by consumers when referring to e-cigarette products.[23] After pilot testing YouTube search terms and procedures, three terms that yielded the most relevant and frequently viewed videos were identified: "e-cigarettes," "vaping," and "e-juice." We retrieved 20 videos per search term (n = 60). Focusing on audio and visual images, two researchers examined 20% of the videos (n = 12) and documented themes related to e-cigarette unorthodox use behaviors.

Initially, our five-member team developed a priori codes and subcodes.[24] Two research team members independently viewed each video twice with the first dedicated to general observations and the second to assess content. We documented existing primary and subcodes observed and/or described in an electronic database. Team members also documented emerging themes not identified in the initial brainstorming session. Emerging themes were discussed and either (1) merged with an existing code, or (2) categorized as a new code. Three coders independently reviewed and coded the remaining videos (n = 48). Subsequently, the full team discussed and refined categories/subcategories and codes.

After reviewing themes and codes, we developed a coding scheme and codebook that included final definitions and examples

of unorthodox uses and parts/components identified in the pilot. Broad categories included general video information, production quality, orthodox and unorthodox behaviors, and health claims. Results from the pilot study yielded nine primary categories and 45 subcategories.

Sampling Method for 6-Month Study

Our sampling methodology was adopted from previous research examining YouTube videos.[21,25–28] Using the general search engine, one team member conducted monthly video searches between June 30 and November 30, 2016, using the terms "e-cigarettes," "vaping," and "e-juice" to retrieve videos. We conducted searches by relevance and view count for each of the three terms. This method was implemented to replicate consumer behaviors by using common terms and the default search engine that lists videos by relevance and captures the most-viewed videos rank ordered by view count. The sample was limited to the first 20 results for each search based on previous research showing that most consumers limit their search and click on the 20 video links listed on first page of YouTube results.[29] After retrieval, a customized Internet data extraction tool (ie, "scraper") was used to collect static and dynamic daily video characteristics. Static data included the video URL, title, and uploader alias. Dynamic data included view counts and the number of likes and dislikes. After scraping, team members manually entered the number of viewer comments into the database. A total of 720 videos were identified over the 6-month period; monthly, we collected 20 videos for each of the three search terms and by relevance (n = 360) and by view count (n = 360).

Exclusion Criteria

Videos were excluded if they were not in English (n = 1) or not relevant (n = 7). Videos were deemed not relevant if e-cigarettes, their parts and/or components were not a primary theme in the overall content. Our criteria for excluding videos based on specific content follow other research showing that consumers spend an average of 1 minute on a given Web site.[29] Videos that mentioned marijuana by the commonly used names of "marijuana," "weed," "MJ," "pot," "grass," "loud," "dabs," "butane honey," or demonstrated marijuana use within the first minute, or included any of the commonly used names for marijuana in the title of video were excluded from the study. Duplicate videos (n = 562) were excluded in order to limit each entry to unique observations. The final sample consisted of 150 YouTube videos depicting orthodox and unorthodox uses of e-cigarettes and their parts and components.

Data Collection and Coding

The data collection/coding team consisted of five members. We selected three coders trained in qualitative research methods and ages 19–24 because they were representative of the group that has had an increased use of e-cigarettes over the past 10 years.[5] We also selected young adult coders because 94% of people aged 18–24 report frequent use of YouTube.[30] The social lens from which these members viewed the video content was necessary to understand the use behaviors, to capture general characteristics, and to assess the perceived age of the main actors in the videos in a way that would reflect other young adults. Two team members independently viewed and coded 150 videos. When there was disagreement, videos were viewed and coded by a third team member. Weekly, the entire five-member team resolved conflicting codes and variables were recoded based on consensus. Intercoder reliability testing for the variables coded showed high agreement (Cohen's κ 0.81, $p < .001$).

Measures

Broad categories of measures for the study included general video information, production quality, orthodox and unorthodox use behaviors, and product/use-related health claims.

General Video Information

For each video, we documented data fields that included the search term ("e-juice," "vaping," or "e-cigarettes"), URL, title, view counts, number of "likes" or "dislikes," alias of the uploader/author, number of comments, upload date, and the video length, all as listed at the time of retrieval. Video view counts, number of "likes," and number of "dislikes" were used as a measure to determine the level of potential appeal, novelty, and interest in the content and/or use behaviors depicted.[31,32]

Orthodox Use Behaviors

Videos coded in this category consisted of segments from television news and daytime talk shows that discussed the increased prevalence and potential safety and harms related to using e-cigarettes. Also included were consumer product reviews of devices, specific devices used for smoking cessation, testimonials for successful quits, and perceptions of the health benefits of e-cigarettes.

Unorthodox Substance Use Behaviors

We coded several behaviors related to the types of substances depicted in the videos. We documented if unorthodox behaviors were observed (yes/no), how the behavior appeared in the video (verbal or visual), the type of product(s) used in the video (e-cigarette, e-liquid, or both), if marijuana was mentioned or used (yes/no), the types of behaviors or modifications observed, the brand(s) of the products that were modified, and if the actors vaped in the video (yes/no).

Codes for unorthodox behaviors were organized into nine categories with 45 subcategories. The nine categories were Airflow Modification, Quality Control, Substance Application, Modified Liquid, Modified Equipment, Modified Quality Enhancement, Modified Mechanical, Recreational Use (RU), and the Reuse of Parts Intended to be Disposed. New subcategories from emerging codes were developed throughout the process when an observed behavior did not fit within one of the existing subcategories.

Video Production Quality and Other Characteristics

We documented the production values of each video under the categories of audio, visual, and lighting (none, professional, or amateur). We also documented human actors in the videos (yes/no), whether the main actor was human (yes, no), perceived gender of the main actor (male, female, or don't know) and perceived age of the main actor (≤40, >40, or don't know).

Health-Related Information

We recorded health-related information conveyed in the videos. Health-related information included verbal warnings (yes/no), descriptive content of the warnings, whether the FDA was mentioned in the video (yes/no), health claims (yes/no), types of health claims (harm reduction or physiological), and outcomes related to the mind or mental phenomena (yes/no).

Analysis

Summary statistics were generated to assess the frequency of unorthodox use behaviors. *t* Tests were used to evaluate engagement differences between orthodox and unorthodox videos. To assess audience involvement with the videos and/or authors, the level of video engagement (views/number of comments) and popularity (likes/views) were calculated. We report results based on the following measures: general video information, categories of unorthodox use behaviors, health claims, and video production quality and characteristics for orthodox and unorthodox use videos. All statistical analyses were performed using SPSS software, version 24.[33]

Results

General Characteristics

YouTube search by relevance and view count for the top 20 listed videos yielded 720 videos over the course of 6 months. The 150 unique videos primarily consisted of those that depicted unorthodox behaviors (n = 112, 75.2%) with considerably fewer videos depicting orthodox behaviors (n = 38, 24.8%).

Video Views, Likes, and Dislikes

Table 1 presents orthodox and unorthodox videos statistics. Videos depicting unorthodox behaviors averaged over 200 000 more views than those depicting orthodox behaviors. A significant portion of the views for unorthodox videos came from one compilation video, "Best Smoke Trick Vines" that garnered 15 120 676 views, 35 774 likes, and 3020 dislikes at the time of this study. Although the video was a compilation of tricks involving other products (eg, hookahs), several of the videos showed the use of vaping devices for the tricks. The second most viewed, but most liked, video was a parody with 7 712 033 views, 264 343 likes, and 35 709 dislikes. The video "VAPE NATION" depicted a male actor portraying a satirical character representing stereotypes of a person who vapes or smokes marijuana that included attempts to "rip fat clouds" and perform tricks with the device. Consistent with the overall and average number of views, videos with unorthodox behaviors had more "likes," "dislikes," and "comments" when compared to orthodox use videos.

Table 1. Video Statistics of YouTube Videos Depicting Orthodox and Unorthodox Electronic Cigarette Uses (N = 150)

	Orthodox (n = 38) *N*	Unorthodox (n = 112) *N*	*p*[a]
Number of views			
Total number	31 880 715	115 551 563	.132
Average	838 966.18	1 041 005.07	
Range	2326–4 456 762	1 048–15 120 676	
Number of likes			
Total	172 878	1 645 518	.006
Average	4 549.42	14 692.12	
Range	0–52 808	47–264.343	
Number of dislikes			
Total	27 971	139 195	.176
Average	736.08	1242.81	
Range	0–12 693	1–35 709	
Number of comments			
Total	56 200	251 076	.135
Average	1 478.95	2241.75	
Range	3–9835	11–46 326	

[a]*t* Tests (continuous).

Video Engagement, Popularity, and Social Media Presence

Our data show that although unorthodox use videos had higher popularity (0.0142) when compared to orthodox use (0.0054), the orthodox use videos had a higher level of engagement (567.27) when compared to unorthodox (460.23). We also found that while a majority of unorthodox videos had a social media presence (64.3%), far fewer orthodox use videos were linked to other social media sites (28.9%).

Categories of Unorthodox Use

Table 2 shows the percentage of videos for unorthodox use behaviors. Nearly 77% of the videos were coded as recreational, followed by "mechanical" modification of parts and components, and "substance application." Approximately 28% of the videos mentioned positive or negative outcomes associated with the behaviors. Of the videos that mentioned a specific outcome, 20.5% were positive and 23.2% mentioned a negative outcome associated with unorthodox use.

Few videos mentioned marijuana, the FDA, or provided warnings about e-cigarette-related diseases (data not shown). About 5.3% of orthodox videos and 14.3% of unorthodox videos mentioned marijuana; 28.9% of orthodox videos compared to 17.9% of unorthodox videos had warnings related to e-cigarettes. The FDA was mentioned in 21.1% of the orthodox videos and 18.8% of unorthodox videos. Of the unorthodox videos that mentioned the FDA (18.8%), the majority of the messages focused on new regulations enacted during the time of the study. These videos often included negative responses to FDA regulations and links to petitions and social movements to oppose new regulations.

Production Quality and Other Characteristics of YouTube Videos Depicting Orthodox and Unorthodox Use

The quality and characteristics of both orthodox and the unorthodox videos are displayed in Table 3. Although the orthodox videos primarily focused on e-cigarette devices (65.8%), the bulk of unorthodox focused on both e-cigarettes and e-liquids (82.1%). The majority of both orthodox and unorthodox videos featured human main actors. Males were the main actors in the majority of the videos and were featured at a similar rate for both orthodox (68.4%) and unorthodox (71%) videos. Nearly 45% of the orthodox videos featured a main actor aged 40 and under, whereas 61.6% in the unorthodox were aged 40 and under.

Nearly 79% of the orthodox videos' sound quality were rated as professional compared to 57% for unorthodox. The same was observed for video production and lighting quality with a greater percentage of the orthodox videos rated as professional quality compared to the unorthodox videos.

Discussion

The purpose of this study was to conduct a surveillance of YouTube in order to assess the quantity, reach, and characteristics of videos depicting orthodox and unorthodox uses of e-cigarettes and to examine the various types of unorthodox uses. Within the 6-month period of this study, unorthodox use was nearly three times as

Table 2. Categories of Unorthodox Uses of Electronic Cigarettes Depicted in YouTube Videos (*N* = 112)

	Definition	Number (*N* = 112)	%
Depiction of unorthodox use in videos[a]			
Verbal	Main actor describes behavior	94	83.9
Visual	Main actor demonstrates behavior	102	91.1
Both		84	75.0
Type of unorthodox use behavior			
Airflow modification	User modifies the motion of air that flows in and/or out of the e-cigarette device	6	5.4
Quality control	User implements procedures to test the quality of their DIY or prepared e-liquid, to ensure it has the desired consistency, taste, and/or smell by using their sensory organs such as tasting the e-liquid on their tongue or vaping it, smelling the e-liquid scent for flavor memory with their nose, touching the e-liquid bottle for temperature control, and/or seeing the visual appearance of color with their eyes to determine if the e-liquid fits their criteria as good quality	31	27.7
Substance application	User applies any type of substance (solid or liquid) to the wick, coil, tank, atomizer, clearomizer, or cartomizer directly	50	44.6
Modified parts/components, liquid	User modifies DIY or prepared e-liquid by incorporating additional substances beyond base	38	33.9
Modified parts/components, equipment	User uses equipment (microwave, crockpot, dishwasher, dropper from medicine, coffee pot, hot-tub basin, etc.) to modify prepared or DIY e-liquids	16	14.3
Modified parts/components, quality enhancement	User improves the quality of the e-liquid to achieve desired taste or smell	25	22.3
Modified parts/components, mechanical	User modifies any mechanical component of the e-cigarette (eg, rebuild, e-liquid container, atomizer, battery, wire, coil, or wick etc.) in order to achieve a positive outcome	64	57.1
Recreational use	Using the e-cigarette for recreation and enjoyment beyond nicotine delivery	86	76.8
Reuse	To use an e-cigarette part or component intended to be disposed of after one use more than one time	2	1.8

DIY= do-it-yourself.

[a]The two different types of depiction, of unorthodox uses, verbal and visual, may have appeared in the same video at least one time.

prevalent as orthodox use, with a total of 115 551 563 views. Some unorthodox behaviors were more prevalent than others. Seventy-seven percent of the unorthodox use videos were classified as recreational and included cloud chasing, "shape," or "trick" vaping. These behaviors cover a range of practices that focus on inhaling varying amounts of vapor that is shaped by the mouth or another external device (eg, glass, metal or plastic tube) on the exhale and slowly dissipates. Other recreational behaviors included "flavor chasing," which describes experimenting with various flavor combinations. We also classified 57% as modification of part and components mechanical (rebuilding) and 44.6% substance application (dripping), which was recently identified as a common form of unorthodox use.[34,35] Although these behaviors may seem benign, manipulation of any part of the device or e-liquid may increase health and safety risks. Considering that behaviors in the unorthodox videos overwhelmingly appeared to be performed by younger adults, these risks should be of concern. The depiction of younger actors in these videos suggests that young people may more be inclined to use e-cigarettes recreationally or for sensory satisfaction than they would for cessation or other therapeutic purposes. Likewise, previous studies have found that young people are less likely than older adults to use e-cigarettes as cessation tools.[5,36] Our findings support the suggestion that young adults tend to use e-cigarettes for different reasons than older adults.[36] Additional studies are needed to further investigate the prevalence of unorthodox use among e-cigarette users and the influence of social media on nonuser uptake.

Recreational as defined here does not imply that there is not only use of the device solely for nicotine delivery, but it also focuses on the prevalence of how the device is used. These types of behaviors are performed with open systems, where the user places the e-liquid inside of the cartomizer or tank for the purposes of cloud chasing, stealth, shape, or trick vaping. E-cigarette users likely practice the recreational behavior repeatedly, which may increase levels of addiction. Furthermore, RU increases exposure to aerosol that contains harmful chemicals.[37] If e-cigarettes are used in various competitions, as we observed, then potential exposure to secondhand e-cigarette aerosol[38,39] as well as thirdhand aerosol exposure may be even greater.[40] Studies have not yet examined the extent to which heavy metals or other carcinogens can be detected or are at harmful levels in the aerosol of recreational users, in their hair, or other surfaces (ie clothes). Additional studies are needed to understand the health implications of RU.

Our findings show 57% of users in the videos modified parts or mechanical components. Open systems allow users to change components such as wicks, batteries, and cartomizers so that the user can customize the device. Users frequently described the importance of using organic cotton as a "safer" material for a wick to transmit the e-liquid through the device to the heating element; however, few demonstrated safety practices to reduce skin exposure to nicotine when handling materials. Similarly, in videos depicting modifications such as drilling holes in cartomizers, few users acknowledged potential risks associated with this practice. Although there are numerous ways to modify them, there is little information on the performance

Table 3. Elements and Quality of YouTube Videos Depicting Unorthodox Electronic Cigarette Use ($N = 150$)

	Orthodox, $n = 38$ (24.8%)		Unorthodox, $n = 112$ (75.2%)	
	Number	%[a]	Number	%[a]
Type of electronic product				
E-cigarette	25	65.8	14	12.5
E-liquid	4	10.5	6	5.4
E-cigarette and e-liquid	11	28.9	92	82.1
Human actors				
Yes	35	92.1	110	98.2
No	3	7.9	2	1.8
Main actor human				
Yes	32	84.2	85	75.9
No	6	15.8	27	24.1
Perceived gender				
None	6	15.8	27	24.1
Male	24	68.4	71	63.4
Female	6	15.8	12	10.7
Don't know	—	—	2	1.8
Perceived age				
None	6	15.8	27	24.1
40 and under	15	44.7	69	61.6
Over 40	15	39.5	12	10.7
Don't know	—	—	4	3.6
Sound production quality				
Professional	30	78.9	57	50.9
Amateur	8	21.1	55	49.1
Video production quality				
Professional	24	63.2	29	25.9
Amateur	14	36.8	83	74.1
Lighting production quality				
Professional	23	60.5	30	26.8
Amateur	14	36.8	80	71.4
None	1	2.6	2	1.8

[a]Column percentages shown.

of modified e-cigarettes. How modification influences addiction, the ability to switch from cigarettes to e-cigarettes, or the impact on health is unknown. Studies are needed to test the various modifications we observed to determine the potential effects on users.

RU and the modifications of e-cigarette devices should raise concerns for the physical safety and the long-term health impact on users. Several reports have identified an alarming prevalence of explosions related to the use of e-cigarettes.[41–43] These reports conclude that the batteries used to power open devices are a primary cause of explosions, devices catching fire, and serious burn injuries to consumers. User manipulation of batteries and other parts/components may impact safety and contribute to the reported malfunctions. Given the prevalence of YouTube videos depicting modifications, an uptick in device manipulation resulting in injury is plausible. Whereas there are not yet any safety standards established for e-cigarettes or their parts (ie, batteries),[41] informing users of the potential risks associated with device modification and continued RU should be a priority.

Nearly 45% of the videos showed users applying a substance to the wick or another part of the device. Dripping, a term used to describe applying e-liquid directly to heated coils within the device, was recently identified as a common unorthodox behavior (ie, RU and modifying mechanical parts) that is of public health concern.[35] One study found that 26% of high school students in Connecticut had used e-cigarettes for dripping.[35] This particular practice is used to produce thicker clouds of vapor, to enhance flavor, produce a better throat hit, and out of curiosity. Males, whites, and dual users were more likely to drip than their counterparts.[35] Prior studies have found higher levels of formaldehyde associated with dripping.[44] Studies are needed to determine the potential exposures and health effects associated with dripping.

We acknowledge limitations to this study. We examined YouTube videos and no other social media. However, YouTube is the second most popular social media platform in the world, and we believe that the definitions of unorthodox use identified have high face validity. We did not examine the prevalence of use and therefore cannot assume that these "promotional" videos directly correlate with broader use behaviors. On the basis of prior literature, this relationship is likely, but future studies are needed to test this hypothesis. We eliminated videos that largely focused on marijuana use, so we may have omitted unorthodox behaviors not captured in our definition. We limited our study to a 6-month period, so we do not know how the behaviors may have changed over time. Given the dynamic nature of social media, and that the design of these products change rapidly, it is possible that similar research conducted at another period of time may yield different results than those presented. Although our team adhered to rigorous and standard methods for qualitative analysis, this approach is not without some level of subjectivity and thus other researchers may code, define, and interpret data differently. Nevertheless, we believe that our nine categories and 45 subcategories capture specific types of behaviors and can be used in future studies to document unorthodox uses in other social media.

Despite limitations, this study is the first to identify nine unique categories of unorthodox uses of e-cigarettes using YouTube, the second most-visited Internet Web site in the world.[20] Unorthodox use was nearly three times as prevalent in the videos as orthodox use, with a total of 115 551 563 views. The popularity of YouTube provides users with broad exposure to e-cigarettes, and specifically unorthodox use, which may have more serious implications for health and safety. Data from this study can be used to inform the FDA of specific categories of unorthodox behaviors and monitored using the Population Assessment of Tobacco and Health Study. A better understanding is needed of the prevalence of various types of e-cigarette use, how social media influences behaviors, and how unorthodox behaviors influence experimentation, initiation, and sustained use.

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Declaration of Interests

TE is a paid consultant in litigation against the tobacco industry and is named on a patent describing a method for measuring electronic cigarette user puff topography.

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