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Heat not burn tobacco promotion on instagram

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1. Introduction

Heat-not-burn (HNB) tobacco products are entering the marketplace outside of the United States (U.S.; Caputi, 2016). HNB products heat tobacco leaf soaked in glycerol and propylene glycol to about 500 °F to create an inhalable aerosol (Caputi, 2016). Philip Morris's (PM) HNB product named "IQOS" was initially on the market in Japan, Italy, Switzerland, and South Korea (Caputi, 2016) and is now available in 37 countries as of April 2018. British American Tobacco's (BAT) HNB device named 'Glo' was released in Russia, Romania, Canada, Switzerland, Japan, and South Korea in 2017 (British American Tobacco - Developing less risky products, 2018). In the U.S., the Food and Drug Administration (FDA) began reviewing Modified Risk Tobacco Product (MRTP) applications from PM in the summer of 2017 for the IQOS and other HNB products (Center for Tobacco Products, 2017), and BAT plans to submit an application for 'Glo' in 2018 (Chaudhuri, 2017). HNB products are internationally available and merit attention by public health researchers.

Health implications and prevalence of HNB use have not yet been thoroughly studied. Japanese and British researchers found about 1% to 2% of respondents reported ever use of HNB products in 2015 and 2017, respectively (Brose, Simonavicius, & Cheeseman, 2018; Tabuchi et al., 2016). It is likely that HNB use will increase as they become more popular in current and enter new markets. While the health consequences of HNB use are unknown, some research has examined HNB emissions. PM International's (PMI) science website reports that IQOS aerosol has over 90% lower levels of harmful or potentially harmful constituents compared to cigarettes (Levels of HPHCs measured in Platform 1 THS 2.2 | PMI Science, 2017). Research not commissioned by PMI, found lower levels of most toxic compounds in IQOS emissions compared to cigarettes, but cautioned use due to significant

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Contributors

All authors conceived of the study design. Mr. Kreitzberg conducted analyses with guidance from Dr. Murthy. Mr. Kreitzberg conducted the literature review and wrote the first draft of the manuscript. All authors critically reviewed the methodology and manuscript. All authors contributed to and approved of the final manuscript.

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Conflict of interest

None to declare

emissions of several organic compounds (Ruprecht et al., 2017). Another health concern is the nicotine itself, which has been shown detrimental for the developing brain (England, Bunnell, Pechacek, Tong, & McAfee, 2015). While little is known about the prevalence and health consequences of HNB use, promotion of HNB products has yet to be examined.

Although HNB products have been introduced in a limited number of markets, their reach is likely transnational given promotion on the internet. Instagram is a mobile-based visual storytelling social media application that allows users to post photos and short videos that currently boasts more than 800 million international users (About Us Instagram, 2017; Jang, Han, Shih, & Lee, 2015). While HNB promotion has yet to be examined on Instagram, previous research has used Instagram's Application Programming Interface (API) to collect data on posts that included hashtags associated with e-cigarettes, and examined differences in content between account types (Laestadius, Wahl, & Cho, 2016) and user interactions (Chu, Allem, Cruz, & Unger, 2016). Moreover, recent research has found an association between exposure to tobacco promotion on social media and tobacco use among adolescents (Hébert et al., 2017) and young adults (Unger et al., 2018). Given the potential behavioral influence of exposure to tobacco promotion on social media, it is important to understand how HNB content are shared on Instagram including health, cessation, flavors, and other messages pertaining to public health. Due to its visual storytelling capacity, Instagram is particularly well suited for examining both how people discuss and use HNB products in their photos compared to more text driven social media platforms. The proposed study will use Instagram's API to examine image content of HNB posts, general textual topics and larger themes related to these textual topics, public health relevant topics, and different types of Instagram users who post HNB tobacco content.

2. Methods

Following previous research on e-cigarettes (Chu et al., 2016; Laestadius et al., 2016) and cigarillos/little cigars (Allem, Escobedo, Chu, Cruz, & Unger, 2017), data were gathered from the Instagram API using a hashtag keyword search term method. A list of hashtags related to HNB products was generated via a 'snowball' method (Goodman, 1961), which began with an API request for the hashtag #IQOS. Next, qualitative analysis of #IQOS results was used to generate more hashtag search terms until the research team deemed the list of useful terms were saturated. The final list of hashtags included: #IQOS, #Heatnotburn, #Heatstick, #IQOSBlack, #IQOSClub, #IQOSFamily, #IQOSFriends, #IQOSShop, #IQOSStyle, and #IQOSWhite. The Instagram API was queried with Netlytics, a third party social media API access tool that has been used in previous research (Allem et al., 2018; Gruzd, 2016). Individual hashtags were queried with a maximum rate of 10,000 posts and corresponding comments per request with one request every hour from September 27–October 4, 2017. Data from Instagram's API included each post's metadata, description, and comments. The authors' university Institutional Review Board verified a review of study procedures was unnecessary as Instagram content are publicly published information.

The raw Instagram HNB hashtag dataset consisted of 15,471 posts and comments. After removing posts with dead links, the final number of posts and comments were 12,774, including 7027 with #IQOS, 254 with #Heatnotburn, 1256 with #Heatstick, 30 with

#IQOSBlack, 208 with #IQOSClub, 3195 with #IQOSFamily, 338 with #IQOSFriends, 121 with #IQOSShop, 158 with #IQOSStyle, and 187 with #IQOSWhite. The proportion of retained posts and comments ranged from 3.2% to 92.6% per hashtag. Dates of publication ranged from May 23, 2016 - October 4, 2017. The final dataset included 4629 unique posts and 6402 unique users. Users outnumbered posts because some users only commented on other user's posts rather than authoring posts. Posts were translated from their original language into English using the Google Cloud Translate API (Google Cloud Platform, 2018).

2.1. Analysis

The 10 most frequent words and public health relevant topics were found using R (R Core Team, 2017). Public health relevant topics were based on e-cigarette user perceptions and marketing messages (de Andrade, Hastings, & Angus, 2013; Willis, Haught, & Morris II, 2016). Latent Dirichlet Allocation (LDA) was used for topic modeling, a mathematical algorithm for clustering words associated with topics (Silge & Robinson, 2017). Additionally, LDA has been found to adequately handle inconsistencies produced by Google Cloud Translate (Kuzar & Navrat, 2010; Liu, Boisson, & Chang, 2013). For the purposes of LDA analysis, each post was considered as one document. Text were cleaned by removing numeric values, symbols, stop words, and word stems (Bouchet-Valat, 2014). LDA analysis was conducted using the "TopicModels" package in R with ten topics specified (Silge & Robinson, 2017). Topics were discovered with an iterative method and to reduce additional noise in the LDA topics, a list of common non-relevant terms were removed (e.g. "iphone") including each hashtag term used to query Instagram's API. LDA topics were treated as codes from which larger themes were developed based on the grounded theory (GT) approach to text analysis (Strauss & Corbin, 1990). Specifically, Instagram posts with terms associated with each LDA topic were qualitatively analyzed to develop larger themes and find exemplar posts.

Inductive qualitative analysis of posts and user Instagram accounts were used to develop user types. Common terms used in posts and user names were used to differentiate types of users (see Table 1). After user types were coded, data were collapsed by user name and duplicate codes were checked. A total of 518 users were given two or more user type codes, these accounts were reviewed to determine their appropriate user type. Of the users given more than one user type, 61 users were unable to be verified and were dropped from user type analyses leaving a total of 6341 unique users.

For each individual post (n = 4629), image content including web-entities and labels were extracted as structured data using Google Cloud Vision API (GCV; Google Cloud Platform, 2018). GCV was used to complement the textual analyses and gain a general understanding of the content of the HNB related images posted on Instagram. GCV uses machine learning that improves in accuracy as more images are introduced to the API. Labels and web-entities are derived with "confidence scores" by comparison with other images used to train the API (labels) or hosted on Google Image Search (web-entities; Google, 2018). Label confidence scores are standardized (0 to 1), labels below 0.80 were dropped from the analysis, a cut-point used in previous research (Hyam, 2017). Web-entity confidence scores are not

standardized, and a cut-point was not used. Instagram's terms of use prohibit automated means of accessing content hosted on their platform (Instagram Inc, 2017). Therefore, we developed a method of manually taking screenshots of posts and uploading these images to the GCV API. The top ten categories of web-entities and identified labels were found using R (R Core Team, 2017). Posts identified as containing top image content categories were qualitatively analyzed to strengthen discussion of the results.

3. Results

3.1. Textual analysis

The top most frequent words related to HNB products included “tobacco”, “smoke”, “cigarette”, “marlboro”, and “Glo” (see Table 1). Public health relevant topic terms were found in 512 (11.1%) of posts. The 10 LDA topics were comprised of five words each and topic labels were chosen to best represent each cluster of words including “Style”, “Custom”, “Kid”, “Fashion”, “Glo”, “Marlboro”, “Shop”, “Japanese/Hong Kong”, “Accessories”, and “Sale” (see Table 2). The following themes were derived from qualitative analysis of posts with LDA topic text: “Appearance”, “Brand Names”, and “Marketing”.

Posts under the “Appearance” theme included words clustered in the LDA topics “Style”, “Fashion”, “Kid”, or “Custom” (see Table 2). Under this theme, users posted about fashion choices, including pairing clothes with different HNB components including colored caps and device skins (decorative stickers). For instance, after reviewing posts with “#kid”, it was clear this hashtag referred to a specific brand of HNB skins. In addition to skins, users posted customized accessories, such as HeatStick (rolled tobacco leaf used in IQOS) cases, bags, and ashtrays to reflect their interests beyond tobacco use and contribute to a stylized aesthetic associated with HNB products on Instagram. One such post featured a matching IQOS case and ashtray decorated with a luxury vehicle brand skin (see Table 3 and Supplementary Fig. S1). This post was generated by a self-described IQOS “fan community” account that frequently posted images of IQOS cases adorned with designer clothing brands, marijuana, cartoons, makeup, and videogames. Moreover, hashtags were used as a means of associating HNB products with “#luxury” and “#superiority”. For example, an account that solely posted images of cartons of HeatSticks used terms including “#cabaret”, “#sex”, “#status”, and “#boast”. In sum, the “Appearance” theme featured posts of customized HNB products indexed under fashion products on Instagram.

The LDA topics labeled, “Japanese”, “Sale”, “Accessories”, and “Shop” were included under the larger theme entitled, “Marketing” (see Table 2). These posts were characterized with sales, retailers' contact information and location, or a combination of these. Hashtags were commonly used to indicate a shop's national location such as “#IQOSPhilippines” and “#MarlboroIqosPhilippines” which enabled other users looking to purchase HNB products to easily find retailers (see Table 3). Descriptions in these posts were used to promote pricing and accessibility with terms like “ship free within Italy”. Location was important for signifying the quality of product or local pride such as “the Japanese version IQOS” or skins “made in Italy” (see Table 3 and Supplementary Fig. S1). To summarize, a unifying component of the “Marketing” theme was the use of Instagram posts to generate sales of HNB devices and accessories.

The “Brand Names” theme was developed from the LDA topics “Glo” and “Marlboro” (see Table 2). This theme was comprised of more generic HNB product terms than the other themes. Often these posts were used to showcase or critique HNB products. For example, one HNB user posted an image of their IQOS next to a carton of purple menthol and described the flavor (see Table 3 and Supplementary Fig. S1). Other posts compared HNB products to cigarettes and suggested HNB were useful for smoking cessation. Posts associated HNB with a healthy lifestyle and reiterated the 90% reduction in harmful constituents, a finding touted by PMI (see Table 3). Other posts under this theme included curated images of HNB products with various products, models, and locations. These posts overlapped with the “Appearance” theme, but hashtag terms used in the “Brand Names” were used to attract HNB users and more related to tobacco content than fashion. Overall, posts under the “Brand Names” theme were more general than the other two themes and used to describe HNB products rather than sell or associate with other content on Instagram.

3.2. Visual content analysis

GCV analysis, conducted in February 2018, identified 1274 labels and 4473 web-entities among 3963 posts (666 posts were unable to be analyzed). The identified label categories were more generic than web-entities. For example, the most common label “product” is a broad class of object that may include posts with products other than HNB (e.g. smartphones) while the most common web-entity was “IQOS” (see Table 4). However, there was some overlap between labels and web-entities. For instance, “product” was identified in 753 posts as a label and 1046 posts as a web-entity, 41.2% of the posts labeled as “product” were also considered a “product” web-entity. Therefore, it was useful to refer to both labels and web-entities to get an overall feel of the variety of image content in our Instagram HNB hashtag dataset.

Results of the visual content analysis generally corresponded with the textual analysis (see Table 4). For example, 34.9% of posts with the word “electronic” were identified with the “electronic cigarette” web-entity. Further, 59% of images labeled as “fashion accessory” had at least one word associated with the appearance text theme. Most web-entities and tags identified refer to HNB products. For instance, an image of a HNB device was categorized as “IQOS”, “cigarette”, “marlboro”, “product”, “product design”, “technology”, “gadget”, “heat-not-burn tobacco product”, “tobacco”, and “electronic cigarette”. Additionally, the labels “purple”, “text”, and “blue” and the web-entity “font” refer to the prominent colors and text on IQOS packaging. The “electronic cigarette” web-entity referred only to posts with HNB products not other types of e-cigarettes (e.g. disposable e-cigarettes). Additionally, “technology”, “electronic device”, and “electronics” were commonly identified in posts solely with HNB products. The “beauty” label encompassed posts of selfies and images of females modeling HNB products. The “social group” category included friends displaying HNB products or at IQOS sponsored events. “Photography” labeled posts featured groups of friends with a stylized filter on the image.

In sum, the top web-entities identified by GCV API identified more specific content associated with HNB products while the top labels were more broad categories associated with HNB products. Further, most content categories identified were descriptive of

characteristics of HNB products in general terms (e.g. “design” and “tobacco”) while other categories were more specific such as “purple”.

3.3. Types of users

Qualitative and textual analyses of 6341 unique users identified general posting behavior of the following user types: HNB user (n = 2249), IQOS retail employee (n = 251), fan community (n = 32), and online retailer (n = 3809). HNB users posted images of themselves and customized IQOS devices with hashtags to describe the brand of skin and HNB device. IQOS retail employees posted images of models or themselves modeling, IQOS sponsored events, and of themselves working at kiosks selling IQOS with terms such as “IQOSTeam” (see Supplementary Fig. S1). With no official manufacturer accounts observed, these users acted as content creators on behalf of the HNB manufacturer. Fan community accounts posted images of HNB cases in various locations and adorned with a variety of designs. These users primarily reposted curated stylized images of people using HNB devices paired with vehicles, alcohol, luxury items, food, and models. Online retailers used hashtag terms to market and associate their accounts and HNB devices within broad categories of content on Instagram including luxurious, fashionable, and customizable products. These accounts typically posted images of HNB devices or accessories for sale with contact information and prices.

The prevalence of health terms in posts among the different types of users included: 9.4% of fan community users, 4% HNB users, 3.6% online retailers, and 2.8% IQOS retail employees. Similarly, 8.3% of HNB users, 6.5% of online retailers, 6.3% of fan communities, and 3.6% of IQOS retail employees posted terms associated with smoking cessation. The prevalence of users who posted regarding the smell of using HNB products was relatively even across user types including 6.9% of HNB users, 6.7% of online retailers, 6.3% of fan communities, and 4.8% of IQOS retail employees. Finally, the convenience of HNB products was emphasized by 7.4% of HNB users, 6.3% of fan communities, 5.8% of online retailers, and 1.6% of IQOS retail employees.

Among only users who posted using public health relevant topic terms, the proportion of posts corresponded with the prevalence of the user type in our dataset. For example, online retailers, who make up 60% of users, consistently represented about 60% of users who posted under each public health topic followed by HNB users (about 36%), IQOS retail employees (about 3%), and fan communities (about 1%). Thus, while the proportion of users posting with public health relevant terms may be similar across the different user types, the majority of posts with these terms were by online retailers and HNB users.

In summary, four types of users were identified in this study’s HNB Instagram hashtag network including: HNB user, IQOS retail employee, fan community, and online retailer. There were far more online retailers and HNB users than IQOS retail employees and fan community accounts represented in the HNB dataset and these users, due to their prevalence, accounted for the majority of posts with public health relevant topics.

4. Discussion

The purpose of this study was to examine the promotion of HNB products and we did so by studying HNB content on Instagram. Many of our results we expected: HNB users posted images of their HNB devices on Instagram and fan communities were dedicated to posting images of HNB devices. However, textual and GCV analyses of HNB posts on Instagram helped us to discover a popular aspect of HNB devices are the ability to customize the HNB cases, tips, and skins and the framing of these devices as fashion accessories. Moreover, the GCV label categories “social group”, “beauty”, and “photography” indicate HNB posts feature stylized images of friend groups and models that suggest social acceptability and normalcy of HNB products. Further, a large proportion of users posting about HNB devices are online retailers who use Instagram as a vehicle to reach potential customers and sell HNB devices and accessories. While not very widespread (about 4% to 7% of posts), online retailers and HNB users promoted HNB devices as convenient, healthy, less smelly, flavorful, and for smoking cessation. These public health relevant topics, commonly used in e-cigarette marketing, indicate early perceptions among users and marketing messages used among retailers that are important for tobacco control efforts. In addition to accessibility of HNB products via Instagram, youth exposure to messages that normalize and tout HNB products as healthy alternatives to smoking is concerning as these products become more available.

The present study extends previous research with analysis of visual content, textual topics and themes, public health relevant topics, and types of users associated with HNB content on Instagram. For example, Allem et al. (2018) found a large proportion of e-cigarette liquid posts on Instagram were by manufacturers (67.8%), similar to HNB online retailers in the current study (60%). Chu et al. (2016) identified “advertisement”, defined as “...a professional photo edited with embedded text of a company name”, as a common theme of e-cigarette Instagram posts. This theme is like retailer posts categorized under the current study’s theme “Marketing” that featured retailer contact information pasted over an image of a HNB device. Moreover, the “Appearance” theme and the GCV label “fashion accessory” in this study are similar to LDA discovered topics named “Fashion/beauty” and “Product” from a corpora of general Instagram posts collected in 2015 (Jang et al., 2015) and fashion has been described as a general category of posted content on Instagram (Hu, Manikonda, & Kambhampati, 2014). “Appearance” themed posts from “fan communities” and “IQOS retail employees” were indexed under a general Instagram theme to attract users who may not seek tobacco related content on Instagram.

Should the FDA’s Tobacco Products Scientific Advisory Committee (TPSAC) secretary determine the IQOS as a MRTP, PM will be able to market the IQOS as less harmful than cigarettes, a sentiment already shared by users on Instagram (see Table 3). It is important to surveil the influence of HNB promotion messages found in this study on vulnerable populations such as adolescents. Instagram has a large proportion of young users and the terms of use allow users 13 years and older (Instagram Inc, 2017; Jang et al., 2015). Of primary concern is exposure to HNB promotions may influence use of these products by youth and transitions to combustible tobacco use, as has been found among adolescent e-cigarette users (Barrington-Trimis et al., 2016; Wills et al., 2016).

4.1. Limitations

Data were collected for this study using Instagram's API. It is unclear what proportion of all published posts, that included the hashtags used to query Instagram's API, were collected and posts with more than one of the hashtags may have been included in the LDA analysis multiple times. Therefore, generalizability of this study's findings is influenced by an unavoidable limitation of collecting data through Instagram's API, which has been severely restricted since June 2016 (Emersonthis, 2016). Further, the user type categories are not exhaustive and there could be other types of users who post HNB content such as friends of HNB users. However, our study's sampling and analysis methods have been used in previous research specifically for examining tobacco promotion on Instagram (Allem, Chu, Cruz, & Unger, 2017). In sum, we are confident our data included a variety of HNB content on Instagram and the analyses were sufficient for our study's purpose.

4.2. Conclusions

HNB are the newest class of tobacco product that may be appealing to the core demographics of Instagram users - young, interested in style/fashion, and active consumers (Jang et al., 2015). Our study demonstrated, HNB promotion on Instagram is overwhelmingly online retailer and HNB user generated buoyed by fan communities and IQOS employees (Richardson, Ganz, & Vallone, 2015). The prevalence of online retailers, indexing HNB under style/fashion categories, and use of health, flavor, and cessation terms are important to consider when these products enter the U.S. market as underaged youth may have access to HNB products and exposure to biased messaging through Instagram. Moreover, exposure to tobacco content on Instagram may normalize tobacco products and increase the social acceptability of tobacco use (Chu et al., 2016). If not an outright ban, Instagram could limit exposure to tobacco content among users ages 13 to 18. Findings from this study should inform health promoters and surveillance among regulators to prevent circumvention of tobacco control regulations as has been found with other tobacco products (Allem, Ayers, Althouse, & Williams, 2016; Williams, Derrick, & Phillips, 2017).

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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HIGHLIGHTS

- Heat not burn tobacco products are widely promoted on Instagram.
- Posts associated HNB devices with a healthy lifestyle
- Posts compared HNB devices with cigarettes and suggested use for smoking cessation.
- Posts associated HNB products with ‘#luxury’, ‘#fashion’, and ‘#superiority’.
- HNB textual themes included “Appearance”, “Brand Names”, and “Marketing”.

Table 1

Top ten most frequent words used in descriptions and comments (n = 12,774), prevalence of public health topics, and different types of users from Instagram posts with hashtags associated with Heat Not Burn tobacco products.

Top words	Frequencies	Unique posts (n = 4629)
Smoke	2363	633 (13.7%)
Cigarette	2245	1056 (22.8%)
Electronic	948	43 (0.9%)
Tobacco	948	673 (14.5%)
Shop	795	647 (14%)
Marlboro	639	587 (12.7%)
Please	593	462 (10%)
Japan	571	633 (13.7%)
Bomb	550	208 (4.5%)
Glo	508	404 (8.7%)
Public health relevant topics	Terms	
Health	health; harmless; clean	236 (3.7%)
Cessation	I-quit-original-smoking; I-quit-ordinary-smoking; stop; quit; smoke-free; better-than-cigarettes; not-burn; no-more-smoke	47 (7.1%)
Smell	odor; stench; stink; smell	423 (6.7%)
Convenience	use-everywhere; anywhere; convenience	394 (6.2%)
Flavor	flavor; purple-menthol; aroma; taste; menthol; blueberry-flavor; flavorful	554 (8.7%)
Type of user	Differentiating terms	Proportion of unique users (n = 6341)
HNB user	No terms	2249 (35.5%)
IQOS retail employee	IQOSTeam; IQOSFamily	251 (4%)
Fan community	No terms – use of “IQOS” in the account’s name	32 (0.5%)
Online retailer	Whatsapp; sale; \$; shipping; www; shop; available; cost	3809 (60%)

Note: Post descriptions and comments were collected from 4629 unique posts via Netlytic (Gruzd, 2016), a third party social media API access tool, between September 27th and October 2nd of 2017. Post publication dates ranged from May 23rd 2016 to October 4th 2017. Hashtags used to query Instagram’s API included #IQOS, #Heatnotburn, #Heatstick, #IQOSBlack, #IQOSClub, #IQOSFamily, #IQOSFriends, #IQOSShop, #IQOSStyle, and #IQOSWhite. The top 10 frequently used words were found using the “Tidytex” package in R. Authors were considered “HNB users” if they were not coded as a “IQOS retail employee”, “Fan community”, or “online retailer”, 61 authors were unable to be verified and were dropped from the user analyses.

Table 2

Topic models and themes related to words used in descriptions and comments ($n = 12,774$) from Instagram posts with hashtags associated with Heat Not Burn products.

LDA Topic Labels (%) ^a	Topic Text (n) ^b	Themes (%) ^c
Style (13.1%)	beautiful (273) love (356) heet (330) follow (204) fashion (438)	Appearance (34.8%)
Custom (11.1%)	decorate (49) cost (501) custom (403) cute (220) seal (197)	Appearance
Kid (14.2%)	kid (239) blah (130) smoke (2363) cool (244) bag (178)	Appearance
Fashion (17.7%)	supreme (179) fashion custom color (412) please (593)	Appearance
Glo (30.4%)	smoke tobacco (948) cigarette (2245) laugh (383) glo (508)	Brand Names (33.6%)
Marlboro (26.6%)	smoke bomb (550) marlboro (639) cigarette green (155)	Brand Names
Shop (16.4%)	shop (795) sticker (334) hangover (204) philipmorris (341) hangoversmartskin (152)	Marketing (39.3%)
Japanese/Hong Kong (16.8%)	japanese (344) kong (362) hong (360) shop glo	Marketing
Accessories (17%)	smoke clean (329) charger (168) marlboro kit (249)	Marketing
Sale (26.9%)	cigarette smoke sell (456) electronic (948) sale (475)	Marketing

^aLatent Dirichlet Allocation (LDA) was used for topic modeling with the "TopicModels" package in R with 10 topics specified and 5 words per topic. Labels were chosen to best represent each topic's texts. The percentage reported are number of unique posts ($n = 4629$) that include at least one of the topic's text. The percentages are not independent because texts repeat across LDA topics and do not sum to 100.

^bNumeric value in parentheses represent frequency the word appeared in the HNB Instagram dataset not necessarily the number of posts that included the word (words can repeat per post). To simplify, frequencies were not repeated for the same word across multiple LDA topics (e.g. smoke).

^cLDA topics were treated as codes from which themes were developed with Grounded Theory analysis of posts including the topics' texts. The percentage represents the proportion of all posts with at least one text from the theme. Because texts repeat between themes (e.g. "smoke" is in all three themes) the percentages do not sum to 100.

Table 3

Exemplar heat not burn instagram posts' description text by textual theme and user type.

Textual Theme	User Type	Post Description Text*
Appearance	Fan Community	Rolls Royce case #iqos #iqosLover #iqosTeam #iqosWorld #iqosClub #iqosLovers #IloveMyIqos #HeatNotBurn #iqosColors #iqosCustom #iqosFan #iqosStyle #iqosSpace #iqosPeople #iqosCase #iqosStore #iqosRussia #iqosItalia #iqosFamily #アイコス (icos) #電子たばこ (ElectronicCigarette) #電子タバコ (ElectronicCigarette) #拡散希望 (SpreadingHope) #タバコ (tobacco) #PhilipMorris #喫煙 (smoking) #禁煙 (NonSmoking) #ライフハック (LifeHack) #お洒落好きな人と繋がりたい #お洒落さんと繋がりたい (I want to connect with fashionable people) #canon #BottegaVeneta #iqos #FollowForFollow #fashion
Appearance	HNB User IQOS Retail Employee	Стяга [name removed] придёт завтра к нам в гости и расскажет как быть стильными и индивидуальными. На повестке для сложные и самодостаточные цвета: красный и синий. #IQOS приглашают вас на мастер-класс «Red&Blue»: Завтра! Вход свободный! Я расскажу о том, как наиболее выигрышно комбинировать красные и синие вещи с другими цветами гардероба, а также о том, как составить стильный офисный образ для любого времени года. Жду #iqosfriends #iqosrussia #iqosfriends #iqosRussia (The geek [name removed] will come tomorrow to visit us and tell [us] how to be stylish and individual. On the agenda are complex and self-sufficient color: red and blue... #iqosfamily #iqosTeam... #IQOS invite you to the workshop «Red & Blue»! Tomorrow! Entrance is free I will tell you how to combine red and blue things with other colors of the wardrobe, and how to make a stylish office image for any time of the year.)
Appearance	Online Retailer	大切な人へプレゼント、還暦祝い、貴品などにもピッタリです。赤はsupreme等のストリートブランドにもよく用いられるカラーですので、洋服好きの皆様も服や靴と合わせてコーディネートしやすいです。レッドカラーは、IQOSが爆発的な人気になる前にIQOSストアで限定販売されました。(Gifts to loved ones, sixtieth birthday celebration... red a color which is often used in street brands such as supreme, [for] everyone loving clothes also easy to coordinate together with clothes and shoes. Red color has been sold exclusively in IQOS store before IQOS becomes explosive popularity.)
Brand Names	Online Retailer	現貨JP日版iqos電子煙PKIT set有navy(深藍)同white(純白)両色。想食得健康又想身邊既人健康齊轉用IQOS啦。IQOS係唔需要明火點燃。所以係唔會有煙灰。原理係電加熱產生既高溫將煙既尼古丁同蒸氣釋出。而有香煙既口感相比起傳統煙既有害物質減少左九成。冇錯係九成。完全冇焦油。吸食後既濾嘴依然是白色的。尼古丁含量相係等於一支傳統煙既十份一。產生出黎既都只係蒸氣。空氣污染部少D呀。正所謂保護地球人人有責呀嗎。仲唔快D拉大隊一齊轉用IQOS。歡迎inbox / whatsapp 56943196查詢。#marlboro #iqos代購 #iqos煙彈 #萬寶路煙彈 #heatstick #iqos

Available product in stock JP Japan Edition Iqos E-cigarette PKIT set having navy(navy) and white(pure white)Two colors (using this IQOS product) can keep yourself healthy as well as people in your social circle. IQOS doesn't require open fire so it will not produce ashes the magic behind this product is to heat the air

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to steam nicotine, making it similar to smoke real cigarette. 跟 conventional smoking product, this one can reduce 90% of toxic byproducts, 100% no tar at all!! After using the product for a while, (you can find that the filter tip is still brand new. 跟 it only contains one ten of nicotine in comparison with traditional products, since it only utilizes steam. 😊 it can reduce air pollution, helping us protect mother earth. 跟 let us switch to IQOS together 跟 welcome inbox / whatsapp contact for more info 跟 #iqoshk # Japan Edition #marlboro #iqos purchasing agent #iqos smoking # Marlboro smoking #heatstick #iqos I feel like I used mouthwash after trying this new flavor. holy menthol!

Brand Names	HNB User
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Marketing	Online Retailer
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#iqos #HeatNotBurn #PurpleMenthol #marlboro #CarbonFiber
 歐洲版 #iqos #現貨 發售 全新未開, 有藍色同白色, 慶祝開店 成本價發售! \$1088 一部, 數量有限! 賣晒優惠就要去返\$1288 一部喇喇! #iqoshk #iqos #iqoshkstore #電子煙 #電子煙 #heatstick

Europe Edition #iqos # product in stock, brand new and sealed, blue or white color, on sale for celebrating the first day of opening! \$1088 per product limited stock! if you post your purchase on social media there will be a rebate for \$1288!

Marketing	Online Retailer
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#iqoshk #iqos #iqoshkstore #E-cigarette product # E-cigarette #heatstick
 現貨 \$7502.4Plus \$950WhatsApp 旺角 屯門 面交 或順豐速遞 正貨保證 兩日包換 是 Philip Morris International 在 2014 年下半年推出的新產品 · 無須明火點燃, 不產生煙灰 · 時刻保持你的形象 · IQOS 套裝包括: 加熱棒本體, 充電盒, 清潔棒, 清潔器, USB 充電線和充電插頭。 (不含煙彈)WhatsApp 查詢更多劇IQOS 2.4 kit set - brand new, sealed, originalColour: dark navy (black) Or whiteIQOS holder + pocket charger + cleaning sticks + cleaning tool + USB cable + two pin socket (Heatsticks excluded)Message us for details,WhatsApp No Smoking, IQOS only #Myiqos #hkMyiqos #iqos #iqoshk #iqoshongkong #hkqiqos #iqosstore #iqosjapan #heatstick #iqosplus #marlboro #heets #iqosph #iqosthai #iqosuk #iqosid #iqosjakarta#iqos24 #iqoskorea #iqostaiwan #iqosmacau #heatnoburn #iqos日本 #iqos香港 #iqos煙彈 #iqos代購 #iqos 電子煙 #萬寶路 #戒煙神器 #電子煙

Things on sale \$ 7502.4Plus \$950WhatsApp Can meet face if you purchase the product in Mong Kok or Tuen Mun. Otherwise (we can) use Shunfeng Express. Certified product, free exchange within two days IQOQ is a new product promoted by Philip Morris International in 2014, no open fire is needed, no ashes, you can leave a good impression in front of others. The IQOS package includes heat stick, charging box, cleaning stick, scrubber, USB charger. (No smoke)WhatsApp Looking for more information) IQOS 2.4 kit set - brand new, sealed, originalColour: dark navy (black) Or white(IQOS holder + pocket charger + cleaning sticks + cleaning tool + USB cable + two pin socket (Heatsticks excluded)Message us for details,WhatsApp No Smoking, IQOS only #Myiqos #hkMyiqos #iqos #iqoshk #iqoshongkong #hkqiqos #iqosstore #iqosjapan #heatstick #iqosplus #Marlboro #Heets #iqosPH #iqosThai #iqosUK #iqosID #iqosjakarta #iqos24 #iqosKorea #iqosTaiwan #iqosMacau #HeatNoBurn #iqosJapan #iqosHongKong#iqosSmoke #iqosPurchasingAgent #iqos E-cigarette #Marlboro #quit smoking tool #E-smoke

Top ten most frequent web entities and labels detected within the visual content of Instagram posts with hashtags associated with Heat Not Burn tobacco products (n = 4629).

Table 4

Top web entities	n(%)	Mean confidence (min, max) ^a	Top labels detected	n (%)	Mean confidence (min, max) ^b
IQOS	1078 (23.3%)	1.4 (0.2, 5.6)	Product	753 (16.3%)	84.4% (80%, 94.1%)
Product	1046 (22.6%)	0.6 (0.2, 0.9)	Electronic device	261 (5.6%)	86.1% (80%, 92.3%)
Heat-not-burn-product	886 (19.1%)	0.7 (0.2, 0.9)	Technology	249 (5.4%)	85.7% (80%, 92.8%)
Product design	859 (18.6%)	0.7 (0.2, 0.9)	Fashion accessory	105 (2.3%)	85.3% (80.2%, 92%)
Design	812 (17.5%)	0.5 (0.1, 0.9)	Text	114 (2.5%)	90.8% (85.1%, 97.3%)
Tobacco	634 (13.7%)	0.6 (0.2, 0.7)	Purple	108 (2.3%)	87.1% (80%, 96%)
Electronic cigarette	617 (13.3%)	0.6 (0.2, 0.9)	Social group	107 (2.3%)	93.3% (89.2%, 97.8%)
Cigarette	389 (8.4%)	0.6 (0.2, 0.9)	Beauty	107 (2.3%)	88% (85.1%, 95.6%)
Marlboro	360 (7.8%)	0.6 (0.2, 0.9)	Blue	102 (2.2%)	96.8% (96.8%, 96.8%)
Font	367 (7.9%)	0.6 (0.1, 0.9)	Photography	86 (1.9%)	82.4% (80%, 99.2%)

Note: Visual content including web entities (information about the post's image based on other images on the internet) and identified labels (e.g. objects) were analyzed using Google Cloud Vision API in February 2018. The top ten web entities and labels detected were found using the "Tidytext" package in R.

^aWeb entity confidence scores are unstandardized and do not represent a percentage of confidence.

^bLabel confidence scores are standardized between 0 and 1 and represent percent confidence. A cut point was used to restrict the top labels to those at or above 80% confidence.