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Linking the content to demographic reach of online advertising of electronic nicotine delivery systems

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ABSTRACT

Introduction Recent studies have separately examined the content and demographic reach of the advertising of electronic nicotine delivery systems (ENDS). No study to our knowledge has linked the two in investigating whether racial/ethnic groups are differentially exposed to the comparative messages conveyed in online ENDS advertisements.

Methods 932 unique ENDS advertisements (6311 total), which were posted on 3435 websites between December, 2009 and October, 2015, were categorized as either comparative or non-comparative with respect to the traditional cigarette. The race/ethnicity of website visitors was obtained from a proprietary source and used in constructing variables for racial/ethnic viewership. The variables for advertising content and website racial/ethnic viewership were then linked yielding a final sample of 551 unique ENDS advertisements (2498 total) on 1206 websites. A two-level hierarchical generalized linear model, used in estimating website racial/ethnic viewership as a predictor of comparative advertising, accounted for the nesting of advertisements (level 1) within 152 ENDS brands (level 2).

Results In contrast to racial/ethnic minorities, a greater proportion of non-Hispanic whites visited websites with ENDS advertisements than the overall proportion of non-Hispanic white U.S. Internet users. Yet, it was the advertisements on websites that appealed to Hispanics that had greater odds of comparing ENDS to traditional cigarettes.

Conclusions The lower exposure to ENDS advertising among racial/ethnic minorities versus non-Hispanic whites is consistent with survey data. Yet, the greater odds of comparative advertising of ENDS on websites that appeal to racial/ethnic minorities (ie, Hispanics) could impact the longterm health of minority smokers.

Implications This study's findings have important implications for the uptake of ENDS among minority smokers. If the comparative advertising yields greater interest and eventual use of ENDS, then minority smokers could either benefit from smoking cessation because they switch to ENDS, or adopt dual tobacco use. The fate of comparative advertising of ENDS versus the traditional cigarette will depend on the Food and Drug Administration enforcement of its deeming rules and the ensuing changes in the ENDS marketplace.

INTRODUCTION

Since 2007, the electronic nicotine delivery systems (ENDS) industry has experienced rapid growth and has been marketed widely through television, radio, magazines, newspapers, retail stores and the internet.¹ The internet has been a

particularly attractive advertising medium to ENDS vendors due to its low cost, unique technological features and precise segmentation of the target audience.² The low cost is especially attractive to small vendors who have tremendous potential for expanding their marketing base. As evidence of this, banner advertisements on websites were cited as the third greatest source of ENDS exposure among US adults.¹

The content of the online advertisements for ENDS is a critical determinant of the advertisements' effectiveness in eliciting purchase behaviours. One facet of advertising content is the comparison between the advertised brand and a competitor. A meta-analysis of studies over a 22-year period indicated that this form of comparative advertising yields greater attention, awareness, information processing, purchase intentions and purchase behaviours than non-comparative advertising.³ The results of this meta-analysis were supported by a recent randomised controlled trial of cigarette smokers.⁴ Pepper *et al*⁴ reported that the advertisements eliciting the greatest interest in ENDS compared the benefits of using ENDS versus traditional cigarettes (eg, harm reduction, greater savings). Although intention does not always lead to the actual behaviour, intention has been reported from meta-analyses to account for 19%–38% of the variation in behaviour.⁵ The findings from the trial by Pepper *et al*⁴ have important implications because comparisons between ENDS and traditional cigarettes are ubiquitous across several media platforms, ranging from retail websites⁶ to YouTube videos.⁷ While the content of ENDS advertising is well documented in the literature, it is not known if vulnerable populations of cigarette smokers are being exposed to the comparative advertising of ENDS.

The messaging in ENDS advertisements could have important public health implications for cigarette smokers from various racial/ethnic groups. As indicated in a comprehensive review,⁸ some randomised controlled trials have reported that marketing is associated with ENDS uptake, which in turn is linked to smoking cessation and cigarette reduction among adult smokers. Another review suggested that evidence for smoking cessation is weak and needs to be complemented by long-term studies.⁹ Online marketing messages pertaining to modified risk claims occur despite the fact that ENDS are not regulated by the Food and Drug Administration (FDA) as therapeutic devices.¹⁰ Researchers need to examine the extent and effectiveness of ENDS advertising in an effort



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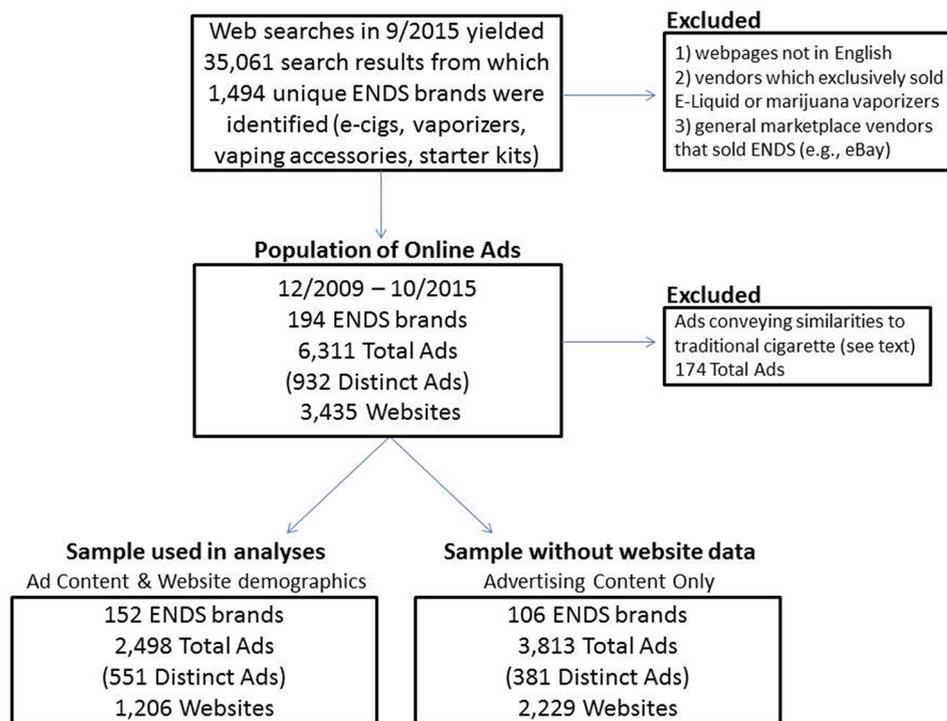


Figure 1 Selection of ENDS brands and their online advertisements. ENDS, electronic nicotine delivery systems.

to minimise the existing disparities in tobacco-related diseases among racial/ethnic minorities. Higher incidence rates of lung, pancreatic and head/neck cancers have been observed in African-American male smokers compared with Caucasian male smokers.¹¹ Some of the cancer disparities could be attributed to lower quit rates in the former versus latter,¹² which could either reflect or be exacerbated by the minority group's infrequent use of nicotine replacement therapy.¹³

Findings from consumer surveys indicate that US adults' awareness of ENDS increased in all sociodemographic groups from 2010 to 2013.¹⁴ Despite the increase across all groups, non-Hispanic whites have consistently reported the highest prevalence of ENDS awareness (eg, 83% were aware in 2013). Thus, we anticipate that more online ENDS advertisements are posted on websites that appeal to non-Hispanic whites than websites that appeal to other racial/ethnic groups. While several studies have separately examined the content and demographic reach of ENDS advertising, no study to our knowledge has linked the two. Our study intends to fill this gap by examining differential exposure to comparative advertising by race/ethnicity.

METHODS

Selection of brands and advertisements

In September 2015, website searches of Google.com, Startpage.com and Bing.com were conducted using the terms 'electronic cigarette', 'e-cigarette', 'ecig', 'personal vaporizer', 'vape', 'vaping' and 'electronic nicotine delivery system'. A total of 1494 unique brands (eg, Blu eCigs), which were identified from website vendors, satisfied the criteria for study inclusion (see figure 1). The large number of brands was attributed to the inclusion of e-cigarettes, vapourisers, starter kits, accessories and other vaping-related products. Furthermore, a number of small e-liquid companies sold starter kits/vaping accessories, thus qualifying for inclusion in our study.

The marketing service WhatRunsWhere.com was then employed to identify the online advertisements placed by each of the 1494 ENDS brands. This marketing service tracks advertising placements on 120 000 websites and provides 5 years of historical data.¹⁵ For each online advertisement, the service provided the advertising creative which included name of the brand, the featured product(s), actors, phrases, slogans, selling propositions (eg, sweepstakes), references to sponsorships and images of the setting of the advertisement (eg, party, holiday event, restaurant, outdoor setting). Most of the advertisements were single-panel images. In addition to the advertising creative, the marketing service provided the website domain where the advertisement was placed, the duration in days of the placement, name of the advertising network (eg, Google AdWords) and a host of other measures. The search of the 1494 ENDS brands yielded 194 brands that ran at least one online advertisement between December 2009 and October 2015; in total, 6311 advertisements were identified, 932 of which were unique. All unique and duplicate advertisements with corresponding website demographic data were included in the analyses.

Advertising content

The advantages of using ENDS relative to the traditional cigarette were coded as smoking cessation, harm reduction, convenience, greater savings, less impact on the environment, social/lifestyle benefits (eg, less odour/more romance) and other benefits.^{6,7} The codes in each advertisement were subsequently grouped into a single category denoting a comparative advantage of using ENDS versus the category denoting no comparison with the traditional cigarette. This categorisation, which served as the basis for our binary dependent variable, was chosen for three reasons: (1) there were too few advertisements highlighting individual attributes of ENDS versus the traditional cigarette (see Results); (2) comparative advertising as a whole

is more effective in generating awareness and purchasing intentions and behaviour than non-comparative advertising³; and (3) in one study,⁴ the mean interest in using ENDS varied modestly across the specific comparative messages. The few ENDS advertisements conveying similarities to the traditional cigarette (look, taste, feel) were excluded because they differed substantively from the other two categories and were not sufficient in number to warrant their own category (figure 1).

Three students (coauthors) at the University of California, Irvine independently coded each of the 932 unique advertisements. Reliability of the coding was assessed by Cohen's kappa statistic to account for chance agreement. Coding discrepancies were resolved by a vote following group discussion of the advertisements in question. The coding reliability was quite high among the three coders as evidenced by the kappa statistic, which ranged from 0.85 for the message of greater savings to 0.96 for the message of less environmental impact.

Racial/ethnic reach and composition

Estimates of race/ethnicity of adult website visitors were obtained from comScore's Plan Metrix.¹⁶ The estimates were derived from approximately 250 000 US-based panellists and reported as the proportion of each racial/ethnic group that visited a given website over a 3-month period (November 2015–January 2016). The website demographics were available for 1206 of 3435 websites (figure 1); the remaining websites were not visited by a sufficient number of panellists to meet comScore's criterion for data reporting. Thus, the sample for primary analyses was restricted to 2498 advertisements (551 unique), which were posted on 1206 websites.

Demographic reach was assessed by comparing the racial/ethnic composition of website visitors with estimates of US internet users from the 2015 Health Information National Trends Survey (HINTS). HINTS served as the reference because its target population of US non-institutionalised civilians (18+) and date of administration (May 2015–September 2015) closely corresponded to comScore's internet panel. The variable race/ethnicity consisted of the categories non-Hispanic whites, non-Hispanic blacks, Hispanics and non-Hispanic Asians. Other racial/ethnic groups, which comprise 3%–4% of the US population,¹⁷ were excluded because of either low internet viewership (eg, Native Alaskans) or a difference between HINTS and comScore in assessment of the category other race/ethnicity. Other race/ethnicity in comScore may have been overestimated relative to HINTS because respondents could indicate both an individual race category and the other category. Limiting race/ethnicity in comScore and HINTS to the four aforementioned racial/ethnic groups yielded estimates of US internet users that were comparable with one another (see Results). For validation of our results using HINTS, the comScore estimates of race/ethnicity from the 1206 websites were compared with comScore estimates of race/ethnicity for all US internet users.

The demographic composition of each of the 1206 websites was characterised by the percentage of website visitors by race/ethnicity. The distribution of percentages for each race/ethnicity was subsequently divided into four quartiles, which were used in characterising the websites as well as predicting comparative advertising in the regression analyses. comScore provided neither the raw number of website visitors by race/ethnicity nor the corresponding SEs of the proportions. Consequently, we could neither document nor account for sampling error that may have varied from one website to another.

Statistical analysis

Hierarchical generalised linear models, which accounted for the non-independence of advertisements (level 1) within 152 ENDS brands (level 2), were developed to assess the demographic composition of websites as a predictor of comparative advertising. Some advertisements appeared on multiple websites, and some websites posted multiple but separate advertisements. A three-level hierarchical model incorporating website domain as a separate level (ie, brand-website domain-advertisement) could not be fit; furthermore, clustering within brands exceeded clustering within website domains. Hence, each advertisement/website pair was distinct and represented the level 1 unit of analysis in a two-level hierarchical model. All regression models incorporated random intercepts.

The first model, the unconditional or empty model,¹⁸ was represented by the equation $\ln(P_{ij}/1-P_{ij}) = \gamma_{00} + U_{0j}$, where P_{ij} is the probability of a comparative advertisement; i is the advertisement/website pair; j is the brand; γ_{00} is the intercept for the average brand; and U_{0j} is the level 2 error term for brand. Four univariate models, corresponding to each of the four racial/ethnic groups, included a variable that comprised the quartiles of the percentages of website visitors. Each model was represented by the equation $\ln(P_{ij}/1-P_{ij}) = \gamma_{00} + U_{0j} + \gamma_{10} X_{1ij}$, where the variable X_{1ij} corresponds to the quartile of the respective race/ethnicity. Given evidence for collinearity, a single multivariable model included all variables for race/ethnicity with the exception of non-Hispanic whites. In the final model, a binary variable for advertising year (2015 vs 2010–2014) was added to the prior multivariable model to account for the trend in greater non-comparative ENDS advertising.¹⁹ All hierarchical generalised linear models were developed using Proc Glimmix in SAS V.9.4.²⁰

RESULTS

ENDS advertisements and hosting websites

The online ENDS advertisements ($n=2498$) had images of either e-cigarettes/e-cigarette accessories (73.5%), images of vapes/e-hookahs/e-cigars (10.3%), images of both ENDS types (2.7%) or no image (13.4%). Most of the advertisements ran for only 1 day (65.7%) and appeared on websites in the years 2013 and 2014 (72%). The top 4 website categories featuring the advertisements, in descending order, were news (eg, <https://villagevoice.com>), entertainment (eg, www.spin.com), lifestyles (eg, www.thefrugalgirl.com) and sports (eg, 247sports.com). Many of the websites appealed to specific racial/ethnic groups as evidenced by the high percentage of website viewers of the given race/ethnicity (table 1). For example, non-Hispanic whites accounted for 98.7% of the visitors to the website ahelicop-termom.com, but accounted for only 67.5% of US internet users.

The advertisements with comparative messages constituted 28% of the 2498 advertisements, which included the messages smoking cessation (12.5%), social/lifestyle benefits (5.4%), convenience (5.0%), less environmental impact (2.0%), harm reduction (1.6%), greater savings (0.6%) and other benefits (0.9%). Example messages in table 1 include smoking cessation ('Consider your resolution resolved') and social/lifestyle benefits ('Tired of smelling like smoke?'). Advertisements that did not reference the traditional cigarette frequently highlighted the quality and popularity of the ENDS relative to other brands (eg, 'See why we are America's favorite e-cigarette').

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Table 1 Examples of ENDS advertisements on websites categorised in the upper quartile for each respective race/ethnicity

Race/ ethnicity	Advertisement comparison*	Percent (%)		
		Websites†	HINTS‡	Advertising slogan
White	No	98.7	67.5	'America's Highest Quality E-Cigarette'§
	Yes	89.9	67.5	'Tired of smelling like smoke?'¶
Black	No	25.9	10.9	'One of the classiest vaporizers around'***
	Yes	17.1	10.9	'An alternative to smoking tobacco'††
Hispanic	No	32.5	15.7	'See why we are America's favorite e-cig'.‡‡
	Yes	36.1	15.7	'Why smoke...when you can vape?§§
Asian	No	23.6	5.9	'Get Vaporised. Buy Now'¶¶
	Yes	12.9	5.9	'Boldness has its rewards'; 'Safe after sex'***

*Advertisements comparing ENDS with the traditional cigarette (yes/no).

†Percentage of website viewers self-identifying as the race/ethnicity.

‡Percentage of US internet users self-identifying as the race/ethnicity according to the national survey HINTS; advertisements posted on the following websites:

§ahelicoptermom.com, ¶gunaction.com, **vibe.com, ††slamonline.com, ‡‡cyndispivey.com, §§K2radio.com, ¶¶logic-puzzles.org and ***idlebrain.com.

ENDS, electronic nicotine delivery systems; HINTS, Health Information National Trends Survey.

Comparisons with US estimates

Participants from the 2015 HINTS who used the internet were composed of 67.5% non-Hispanic whites, 10.9% non-Hispanic blacks, 15.7% Hispanics and 5.9% non-Hispanic Asians. These percentages were quite comparable with comScore's US estimates of 69.0%, 10.5%, 15.2% and 5.3% for the respective racial/ethnic groups. Yet the distributional properties of our sample of websites ($n=1206$) tracked by comScore differed strikingly from the US estimates. The IQRs of percentages of the 1206 websites were 70.8%–84.8% for non-Hispanic whites, 1.6%–7.7% for non-Hispanic blacks, 6.1%–14.6% for Hispanics and 2.6%–6.9% for non-Hispanic Asians. These IQRs, as illustrated in figure 2, indicate that the 25th percentile exceeded the US estimates for non-Hispanic whites, while the 75th percentile did not exceed the US estimates for either non-Hispanic blacks or Hispanics.

A highly significant mean difference between website % race/ethnicity (log-transformed) and the corresponding US estimate from the 2015 HINTS was observed for non-Hispanic whites ($t=25.7$; $p<0.0001$), non-Hispanic blacks ($t=-32.0$; $p<0.0001$), Hispanics ($t=-20.8$; $p<0.0001$) and non-Hispanic Asians ($t=-5.94$; $p<0.0001$). Comparable results were obtained when comparing means between comScore's US internet panel

and comScore's 1206 websites for all racial ethnic groups with the exception of the non-Hispanic Asians ($t=-1.37$; $p=0.17$).

Distribution of advertisements and websites by brand

The results in table 2 show the rationale for a two-level hierarchical model that accounts for the clustering effect of brand on advertising content. The clustering effect is evident from the wide variability in comparative advertising across the top 5 brands (0%–95.3%). Five of the 152 brands accounted for 65.8% of all advertisements, but only 19.2% of the unique advertisements. The unique advertisements for the two most advertised brands, Green Smoke and Juul Vapor, appeared on several websites as indicated by the large number of websites per advertisement. For example, a single advertisement for Green Smoke appeared on 184 different websites. This figure highlights the importance of retaining the duplicate advertisements in the multilevel analyses because the same advertisement could be targeted to several racial/ethnic groups via different websites. Yet, for all brands combined, the median number of websites per advertisement was 1, which was also the case for the median number of advertisements per website.

Multilevel models

Based on the random effect intercept term (U_{0j}) in the unconditional model (table 3), the intraclass correlation coefficient (ICC) was calculated as .633 ($5.7/(5.7+3.3)$). Thus, a larger proportion of variance in comparative advertising occurred across ENDS brands than within ENDS brands. The large number of duplicate advertisements, particularly for the top brands (table 1), likely accounted for the large proportion of brand-level variance. To address this issue, we limited the analysis to unique advertisements ($n=551$) and observed a lower but still substantial ICC (0.307).

The ENDS advertisements on websites that had greater appeal to non-Hispanic whites had significantly lower odds of displaying a comparative message ($OR=0.76$; $\beta=-0.27(.06)$; $p<0.001$). For each increase in quartile of the percentage of website viewers (non-Hispanic white), there was a 24% decreased odds of an advertisement comparing ENDS with the traditional cigarette. In contrast, the advertisements on websites that had greater appeal to Hispanics had significantly greater odds of referencing the traditional cigarette ($OR=1.26$; $\beta=0.23(.06)$; $p<0.001$). Addition of the other race/ethnicity variables in the multivariable model affected neither the magnitude nor statistical significance

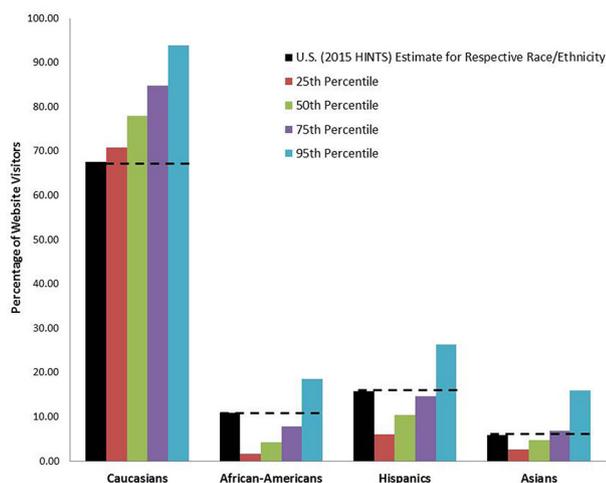


Figure 2 Distribution of the percentages of each racial/ethnic group visiting the 1206 websites, relative to estimates of US internet users from the 2015 Health Information National Trends Survey (HINTS).

Table 2 Characteristics of the online advertisements and websites of the five most frequently advertised ENDS brands (n=2498)

Characteristics	Brands of ENDS						
	All brands	Green Smoke	Juul Vapor	Volcano e-Cigs	Fin e-Cigs	Blu eCigs	Other brands*
Advertisements							
No of total ads	2498	848	330	170	151	144	855
No of unique ads	551	21	3	12	12	58	445
% Comparative	28.0	18.5	0	95.3	0	40.3	37.9
Websites							
No of websites	1206†	542	214	103	89	78	426
No of websites/ad							
25th Percentile	1	1	1	1	3	1	1
50th Percentile	1	27	157	1	10	2	1
75th Percentile	1	61	172	20	16	2	1
100th Percentile	184‡	184‡	172	62	38	15	52
No of ads/website							
25th Percentile	1	1	1	1	1	1	1
50th Percentile	1	1	2	1	1	1	1
75th Percentile	2	2	2	2	2	2	2
100th Percentile	185§	10	3	8	6	18	177§

*147 other brands that advertise on websites tracked by comScore.

†Value is less than the sum of websites by brand (n=1452) due to the websites that advertise multiple brands.

‡Single Green Smoke advertisement, §e-cigarette-forum.com.

ENDS, electronic nicotine delivery systems.

of the regression coefficient for Hispanics. In the final model (not shown in table 3), a negative and highly significant regression coefficient (β (SE) = -2.14(.33); $p < 0.001$) was observed for the variable advertising year. This estimate indicates that online advertising appearing on websites in the year 2015 had a much lower odds (OR=0.12) of referencing the traditional cigarette than online advertising in the years 2010 through 2014.

DISCUSSION

This study found that non-Hispanic whites, in contrast to other racial/ethnic groups, constitute a higher percentage of visitors to websites with ENDS advertisements than their overall make-up of US internet users. This finding is consistent with studies of health surveys reporting demographic differences in advertising exposure,²¹ awareness and ever use of ENDS.¹⁴ For example, Baumann *et al*²¹ observed that among hospitalised smokers, 13% of whites vs 6% of blacks had been exposed to online ENDS advertising. Other research indicates that ENDS companies have

not been targeting racial/ethnic minority groups via online social networks.²² For example, Chu *et al* observed no difference in ENDS advertising on websites appealing to blacks during Black History Month.²

In contrast to our study, some studies have reported that racial/ethnic minorities are being exposed regularly to ENDS advertising.^{23 24} Richardson *et al* observed that non-Hispanic blacks accounted for 8.6% of visitors to websites with ENDS advertisements,²³ an estimate slightly lower than the minority group's make-up of US internet users. Potential explanations for the study discrepancies are differences in sampling methodology and the period of observation. Between the years 2012 and 2013, Richardson *et al* observed only five ENDS online advertisers in their sample of 250 websites. The study by Singh *et al*²⁴ also challenges our assertion that non-Hispanic blacks, relative to non-Hispanic whites, are being exposed to less online advertising of ENDS. But this study examined adolescents from the 2014 National Youth Tobacco Survey, whose online behaviours

Table 3 Regression estimates of quartiles of website racial/ethnic composition as a predictor of comparative advertising in hierarchical generalised linear models (n=2498)

Model	Intercept term (SE)		β Coefficient (SE) for racial/ethnic group			
	Υ_{00} †	U_{0j} ‡	NH§ white	NH black	Hispanic	NH Asian
Unconditional	-1.5 (0.3)**	5.7 (1.6)**	-	-	-	-
Univariate						
NH white	-0.7 (0.3)*	5.4 (1.5)**	-0.27 (.06)**	-	-	-
NH black	-1.6 (0.3)**	5.7 (1.6)**	-	0.05 (.06)	-	-
Hispanic	-2.0 (0.3)**	5.4 (1.5)**	-	-	0.23 (.06)**	-
NH Asian	-1.5 (0.3)**	5.7 (1.6)**	-	-	-	0.02 (.05)
Multivariable						
Three groups¶	-2.1 (0.4)**	5.4 (1.5)**	-	-0.01 (0.06)	0.23 (0.06)**	0.04 (0.05)

* $p < 0.05$, ** $p < 0.01$.

†Fixed effect.

‡Random effect.

§Non-Hispanic.

¶Three racial/ethnic groups: NH black, Hispanic and NH Asian.

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may differ considerably from the adults surveyed in the current study. Irrespective of methodological differences in studies, it is apparent that racial/ethnic minorities are becoming more aware of ENDS products.^{14 25} The increased awareness may be attributed to a host of sources ranging from traditional media (eg, television²⁴) to point-of-sale marketing.²⁶

While online ENDS advertisements are more likely to reach non-Hispanic whites, the advertisements on websites that appeal to racial/ethnic minorities (ie, Hispanics) have greater odds of displaying the comparative messages. Given the effectiveness of comparative advertising,^{3 4} there is no apparent explanation for the lack of uniformity by website race/ethnicity. This finding has important implications for the uptake of ENDS among minority smokers, especially Hispanics.⁴ If comparative advertising yields greater interest and eventual use of ENDS,⁴ then minority smokers could either benefit from smoking cessation because they switch to ENDS or adopt dual tobacco use. These outcomes should be assessed through years of follow-up in longitudinal studies, preferably randomised controlled trials.²⁷

There are multiple factors that could account for the relatively infrequent use of comparative advertising in the current study (28%). First, the online banner advertisement is small in size, and hence does not accommodate lengthy comparative descriptions. Unlike banner advertisements, the majority of ENDS retail websites made health-related comparative claims in the years 2011 (95%⁶) and 2014 (65%¹⁰). The large space on retailers' websites accommodated lengthy customer testimonials on smoking cessation that were observed by Klein *et al.*¹⁰ Interestingly, the decline in health-related claims on ENDS retail websites between 2011 and 2014 mirrors the decline in overall comparative advertising observed in the current study. One likely explanation for the decline was the rapid growth and marketing of specific ENDS brands that supplanted the advertising of ENDS attributes.¹⁹ Another reason for the decline was anticipation that the FDA's deeming rules would prohibit unwarranted claims, notably the modified risk claims.

This study benefited from an objective assessment of the racial/ethnic composition of websites that advertised ENDS products. Yet the use of a proprietary marketing firm for obtaining data on website demographics had its limitations. First, website race/ethnicity could not be tracked over the course of the study (December 2009–October 2015), and thus was selected from an available 3-month period in late 2015. Second, variation in demographic survey questions between comScore and HINTS necessitated the exclusion of the category for other race/ethnicity. While this exclusion may have biased the estimates, the overall findings on the demographic reach of the advertisements are valid. We are confident of this conclusion because the demographic estimates of US internet users from both comScore and HINTS were comparable with one another, but differed substantially from the 1206 websites that advertised ENDS products. A third limitation was the absence of a measure for purchasing behaviour, which is not necessarily a consequence of being exposed to comparative advertising. Lastly, 60% of the websites did not meet comScore's minimum criterion for the reporting of demographic data, raising concern about possible selection bias.

The implications of this study will depend in part on the extent to which ENDS manufacturers can afford the exorbitant costs associated with the FDA's Premarket Tobacco Product Application. It is anticipated that the small manufacturers will not have the resources to undergo the application process, and hence will discontinue their operations. The top 5 brands in our study, which accounted for 65% of all online ENDS advertisements, did not always correspond to the biggest marketing spenders.

For example, the brand Njoy ranked second highest in overall marketing expenditures in 2013,²⁸ but ranked tenth in online advertising in our study. This discrepancy highlights the observation that smaller ENDS companies often reach an audience by online advertising, which is less expensive than other media. The high cost of the FDA's Premarket Tobacco Product Application could have the effect of reducing competition, especially if the small ENDS manufacturers are driven out of business. Perhaps this reduced competition could lead marketers back to their use of comparative messaging of ENDS versus the traditional cigarette. Irrespective of the effect of the FDA's deeming rules on ENDS marketing, it is important to note that the comparative messages have already been disseminated in the online media, and thus could have a long-term impact on consumer behaviour.

What this paper adds

- ▶ Studies have demonstrated comparative advertising of ENDS versus the traditional cigarette across several media channels.
- ▶ No study to our knowledge has examined whether racial/ethnic minorities are differentially exposed to the comparative advertising of ENDS versus the traditional cigarette.
- ▶ While online ENDS advertisements are more likely to reach non-Hispanic whites, the advertisements on websites that appeal to racial/ethnic minorities (ie, Hispanics) have greater odds of displaying the comparative messages.

Correction notice This paper has been amended since it was published Online First. Owing to a scripting error, some of the publisher names in the references were replaced with 'BMJ Publishing Group'. This only affected the full text version, not the PDF. We have since corrected these errors and the correct publishers have been inserted into the references.

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Contributors DT, DN and CP developed the research question and study methodology. JGC, SC and MS coded the online ENDS advertisements and compiled information on website racial/ethnic appeal and other website characteristics. DT conducted most of the analyses, and DT and DN wrote the manuscript. CP was instrumental in editing the manuscript and providing input on the marketing aspects of the study.

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