Perceptions of nicotine in current and former users of tobacco and tobacco harm reduction products from seven countries

Sarah Rajkumar, Nada Adibah, Michael Jonathan Paskow and Brian Eric Erkkila

Abstract

Purpose – *Nicotine is widely known as a tobacco constituent and for its use as a tobacco cessation aid. The development of new devices for nicotine delivery in recent years has led to uncertainty among consumers regarding the health risks of nicotine relative to tobacco. The purpose of this study was to discover if current and former consumers of tobacco and tobacco harm reduction (THR) products could distinguish between ''nicotine'' and ''cigarettes'' and examined the preceding media dialogue to determine if conflicting messages by the media influence public perceptions.*

Design/methodology/approach – *A quantitative survey was administered online in Norway (NO), Japan (JP), the United Kingdom (UK) and the United States (US), while face-to-face computer-aided interviews were conducted with randomly selected samples in India (IN), Greece (GR) and South Africa (SA). Participants were between 18 and 69 years of age and either current users of tobacco and THR products or previous users who quit within the past five years. Questions assessed beliefs about harmfulness of nicotine. Nicotine and other products and substances were also independently rated for harmfulness on a scale of 1–10 and subsequently compared. In addition, the authors examined the media dialogue of top media outlets in four countries to assess the potential influence on people's beliefs.*

Findings – *A total of 54,267 participants (NO: 1,700, JP: 2,227, UK: 2,250, USA: 2,309, IN: 41,633, GR: 1,801, SA: 2,359) were sampled with the percentage of women participants ranging from 14.8% (IN) to 53.8% (UK). Between 68.3% (men, IN) and 88.7% (men, USA) of current consumers believed nicotine is harmful. Current consumers who agreed with the statement that nicotine is the primary cause of tobacco-related cancer ranged from 43.7% (men, UK) to 78.0% (men, SA). In six countries nicotine was rated nearly as harmful as cigarettes and alcohol, while other substances such as sugar, salt or caffeine, were usually rated as less harmful.*

Research limitations/implications – *A large proportion of consumers across all surveyed countries view nicotine and cigarettes similarly. Clearer communication on the harmful properties of both by the media is needed to help consumers make informed decisions about products across the continuum of risk. Messaging to consumers, especially via the media, propagates misinformation about the relative harms of tobacco and nicotine through reporting that is often incomplete and biased toward more negative aspects.*

Originality/value – *This study specifically assessed public perceptions of nicotine as opposed to products containing nicotine, which is the focus of previous studies. Apart from showing that consumers often incorrectly perceive nicotine and cigarettes as similar in terms of harmfulness, the authors highlight the need for more accurate and complete reporting by the media to clarify widespread misunderstandings and mitigate public uncertainty.*

Keywords *Media, Perceptions, Tobacco, Tobacco harm reduction, Nicotine, Global survey*

Paper type *Research paper*

Background

Nicotine is best known as a constituent of tobacco and for its use as a tobacco cessation aid (National Center for Biotechnology Information, 2004). Burning tobacco releases

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thousands of substances, many of which can increase a user's risk for disease including cancer, respiratory disease and cardiovascular diseases (Reitsma *et al.*, 2017). Research on nicotine specifically is more limited; while the majority of work has been on potential harmful effects some researchers believe that exploring therapeutic applications involving nicotine could lead to new discoveries (Bertrand and Terry, 2018). Studies that focused on potential negative consequences of nicotine reported on brain development in adolescents and on the developing fetus of pregnant women consuming nicotine in any form Sailer *et al.* (2019), Yuan *et al.* (2015). In terms of therapeutic applications, extensive research on nicotine to treat Parkinson's or Alzheimer's diseases consistently showed promising initial results, but so far most leads faltered during the clinical trial phase (Newhouse, 2019).

There has been a recent increase in nicotine research coinciding with the increased availability of alternate methods of nicotine delivery via ecigarettes and other tobacco harm reduction (THR) products. Many users of THR products are smokers who are trying to quit, but there has also been a marked uptake by adolescents, renewing concerns over nicotine's potential adverse effects (National Academy of Sciences Engeneering and Medicine, 2018). Article 14 from the framework convention on tobacco control (FCTC) calls upon members to promote tobacco cessation and to support tobacco users in quitting by implementing effective measures (World Health Organization, 2003). An ongoing emotional debate surrounding THR products has so far kept many governments from promoting THR products to lessen the burden of disease caused by tobacco. Article 12 from the FCTC requires parties to raise public awareness on health risks of tobacco through all available media channels. A reason why users of tobacco and THR products around the world find it hard to distinguish between the health risks of smoking and nicotine use may be due to conflicting messages from the media that deviate from the most recent scientific evidence base, overemphasize certain opinions or omit findings that do not align with their readers' beliefs. In light of the debate around THR products, it is vital for the public to be aware of what exactly nicotine is and how it can affect a person's behavior and health via consumption. A study published by the Royal Society for Public Health in 2015 reported that more than three quarters of smokers and non-smokers in the United Kingdom (UK) believe nicotine is harmful to health (Royal Society for Public Health, 2015). A study in the United States (US) reported that about half of all men and women believed that nicotine causes cancer, with a quarter of the population being unsure (O'Brien *et al.*, 2017). Most studies on risk perceptions involving nicotine focus on THR products, very low nicotine content cigarettes or nicotine replacement therapies (NRTs), not on the substance itself. A poll in 13 countries commissioned by the Foundation for a Smoke-Free World in 2017 reported that in many countries a vast majority of consumers tend to use the terms "nicotine" and "cigarettes" interchangeably, thereby suggesting a lack of awareness that nicotine consumption via THR products may not carry the same health risks as when smoking combustible tobacco (Riahi *et al.*, 2019).

We conducted a survey with current and former users of tobacco and THR products in seven countries and asked them about usage patterns and risk perceptions of nicotine. To put results into context, we also examined the media dialogue leading up to the poll in four of these countries to estimate the extent to which public opinion may have been influenced by media messaging.

Methods

Study population

The survey was conducted in seven countries, namely, Greece (GR), India (IN), Japan (JP), Norway (NO), South Africa (SA), the UK and the US between June and September 2019 by Nielsen, a global measurement and data analytics company. Nielsen was chosen as a partner from a pool of applicants following a competitive request for proposals. The margins of error for the sample sizes at a 95% confidence interval ranged from 0.5% (IN) to 2.6%

(GR and NO). The survey captured participants' demographic data, their habits and perceptions regarding tobacco and THR products and their experiences around quitting tobacco products. Adults between 18–69 years of age (20–69 for JP) who were current users of any tobacco or THR product and quitters who quit within the past five years were eligible to participate. The survey was administered online in NO, JP, UK and the US, countries with more uniform internet penetration. Face-to-face computer-aided interviews were performed in IN, GR and SA using a stratified random sampling method. Full details on the sampling methodology have been published elsewhere (Foundation for a Smoke-Free World, 2019).

Internal Review Board (IRB) exemption in the US was obtained from solutions IRB (protocol 2019/06/4 foundation for a smoke-free world global poll 2019) according to 45CFR46.101 (b) as this research was not of a clinical nature and no identifiable data was collected. Authorities in the remaining countries confirmed that for anonymous surveys no ethics approval was required.

Survey development

Nielsen conducted a total of 69 pilot interviews for cognitive testing of the survey, ensuring that participants understood the survey and translations of the questions. Further details on the pilot interviews can be found in the Appendix (Table A4). A large portion of the survey was extracted from pretested social surveys (Hamilton *et al.*, 2011; *International Tobacco Control Policy Evaluation Project*, 2020). Language-specific changes were implemented following the pilot phase.

Response rates

Response rates for the online surveys were calculated by dividing the number of complete interviews by the number of times the survey link had been opened and the questionnaire started. Other participants were either screened out or left the questionnaire incomplete. Response rates for the face-to-face interviews were not recorded.

Risk perceptions

To assess risk perceptions of nicotine, we asked survey participants if they believed nicotine is harmful, if they thought that tobacco-related cancer is primarily caused by nicotine and if they thought that NRTs and nicotine in e-cigarettes cause cancer. Subjects estimated the harmfulness of several consumer products, namely, cigarettes, coffee, tea, soda drinks, wine/beer/spirits and candy on a scale from 1 (not at all harmful) to 10 (very harmful). In addition, we asked them to rate some substances that are commonly known ingredients of these products, namely, salt, sugar, caffeine, nicotine, fat and alcohol.

Variable creation

Demographics. Select responses to the survey questions were merged into fewer categories to simplify analyzes. Participants not identifying with either sex were excluded from the present analysis due to the inadequate sample size. Participants were grouped into low (no degree at all including those who completed some high school), middle (a high school degree, job-specific training after high school or some college education but no college degree) and high (at least a college degree) education levels. Nielsen income brackets were used to group participants into low, middle or high socioeconomic status (SES) as seen in Appendix Table A1. Employment response options were dichotomized into "employed" (including housekeepers and students) or "unemployed" (including temporarily laid-off individuals, permanently or temporarily disabled or sick people, women on maternity leave and retired individuals) groups. Relationship status was also dichotomized into

"single" (including separated, divorced or widowed) or "in a relationship" groups. Participants were also categorized as either living in a household with at least one child below 14 years of age or not.

User groups. Participants were categorized into user groups based on the types of tobacco or THR products they use and the frequency with which they use them. We created six user groups for both current users and quitters. Exclusive daily combustible users used only combustible products and at least one of those products on a daily basis. Combustible products include factory-made cigarettes, tubed cigarettes, rolled cigarettes, capsule/flavored cigarettes, cigars and cigarillos, water pipes, hookahs, shishas, pipes and bidis. For IN, this group was further divided into daily users of bidis only and daily users of the remaining combustible products with at least one used daily. Exclusive daily non-combustible users used only vaping products (with or without nicotine) or heat-not-burn tobacco products with at least one used daily. Exclusive daily smokeless users used only smokeless tobacco products, which included moist smokeless tobacco, loose leaf chewing tobacco, dry snuff, snus, dissolvable tobacco products, gutka and other chewing tobacco. Daily dual/poly users used any number and combination of the aforementioned products, as well as NRT products with at least one product used daily. Non-daily users used any number and combination of the previously mentioned products, but none on a daily basis. Non-users are individuals who did not qualify for any of the previous groups (i.e. they used any product type or combination of products less than monthly or were unsure of how frequently they used it).

Data analysis

Data were analyzed using stata/SE 15.1 (statacorp LP, college station, TX) and R version 3.6.1 (R foundation for statistical computing, Vienna, Austria). All data collected were summarized using descriptive statistics. Participants who preferred not to answer a question or responded with "I do not know" were excluded from that particular statistic unless otherwise mentioned.

Media dialogue assessment

To obtain earned coverage, i.e. free media coverage, pertaining to mentions of "nicotine," a master search query was set up for English language publications in IN, SA, the UK and the US. The goal of each country-specific search query was to perform data collection across the various top tier media outlets (publications with at least one million unique monthly visitors). Only releases between May 1 and July 31, 2019 were included. Given the common use of the word "nicotine," exclusions were set up by filtering out any mentions of "nicotine" in press releases, earnings and stock news and market research reports. Quantitative and qualitative analyzes were conducted upon data collection to determine the share of voice (SoV) by measuring the volume of mentions for each country, social amplifications (top shared articles in each country), types of mentions of "nicotine" (e.g. headline mentions v/s mentions in the body) and perception of nicotine and themes pertaining to it. The SoV for each country was calculated by dividing the country-specific outcome by the sum of all analyzed countries.

Results

We surveyed a total population of 54,279 participants, 11,350 women, 42,917 men and 12 persons not identifying with either sex. There were 46,220 current users and 8,047 participants who had quit using any tobacco or THR product within the past five years. Response rates in the online surveys were 8.7% for JP, 25.8% for NO, 9.0% for the UK and 23.5% for the US. In all countries except the UK our sample of men was larger than that of women. The mean age ranged from 36.7 [Standard Deviation (SD), 15.1; NO]to 45.2 years

(SD, 12.6; JP) in women and from 35.2 (SD, 12.7; IN) to 50.7 years (SD, 11.7; JP) in men (Table 1). SES distribution was fairly even between low, middle and high classes in the UK and US, while in the other surveyed countries, the high SES class was less represented by our sample.

In all countries, a large fraction of current users were exclusive daily combustible tobacco users (Table 2). IN had a large group of exclusive smokeless tobacco users, especially among women (58.5%), with NO being the only other country with the proportion of exclusive smokeless tobacco users above 10%. (11.0% women and 10.5% men). Dual and poly users who used at least one product on a daily basis were widespread in all countries except in GR and SA, especially US women more often tended to use several product types daily. Among quitters, the distribution of groups was similar with a few exceptions.

Beliefs on the harmfulness of nicotine were similar among women and men in all countries. The majority of respondents in all countries stated that nicotine is harmful; this number was lowest in IN [69.9% women, 68.3% men (Figure 1)]. Between 43.7% (UK men) and 78.0% (SA men) incorrectly agreed that nicotine is the primary cause of cancer from tobacco (Figure 2). Around half the US and Indian study population of current users believed that NRTs cause cancer while in other countries this fraction was smaller (Figure 3). Between 55.7% (UK) and 91.5% (IN) of those who thought nicotine was harmful also stated that it is the primary cause of tobacco-related cancer (Appendix Table A5). Among the group stating that nicotine is the primary cause of tobacco-related cancer, between 42% (UK) and 75.5% (IN) believed that nicotine in NRTs or e-cigarettes causes cancer (Appendix Table A5). Among quitters, similarly, the majority in all countries believed that nicotine is harmful. The proportion of quitters who believed that nicotine is the primary cause of cancer was slightly higher than among current users in all countries.

When stratifying the above estimates by user groups, several subgroups in many countries were too small to analyze meaningfully, especially among former users. There were few clear trends visible between the groups.

When estimating the harmfulness of a range of consumer products and the substances contained therein, all current user groups rated cigarettes the most harmful [7.4 (SD 1.9) in Norwegian men to 8.9 (SD 1.7) in UK women (Figure 4)]. In NO and IN, alcohol and wine/beer/spirits, in GR and JP, nicotine and fat and in SA, the UK and the US, nicotine and alcohol were generally rated higher on the products and substances harmfulness scales. JP had the lowest overall ratings for products and substances among current users. The top three rated products and substances were the same for current users and quitters.

Media dialogue

The US led the coverage on nicotine in top tier media outlets with 1,992 mentions and 77% SoV while the UK (327 mentions; 13% SoV) and IN (244 mentions; 10% SoV) were a distant second and third, respectively. Of the total 2,573 top tier media articles that mentioned nicotine, only around 5% had "nicotine" in their headline. The tonality of the coverage pertaining to nicotine skewed largely negative with almost 30% of all mentions including a reference to the addictive nature of the substance and the dangers of dependency. The world no tobacco day on May 31 saw a spike in mentions of nicotine in IN though not specific to a particular type of tobacco. Firstpost, an Indian news and media website, ran a story on May 31, that advocated for the increase in the use of e-cigarettes as a means for getting over tobacco addiction (*The smoker's guide to why vaping is the first step in the road to quitting cigarettes*, 2019), but on the same day the Times of IN reported that the state of Maharashtra was banning e-cigarettes claiming they were as harmful as tobacco products (Maharashtra bans ecigarette, says use as harmful as tobacco, 2019). In the US and the UK, the San Francisco e-cigarette ban story in June caused a major spike in mentions related to nicotine and nicotine addiction and was covered in outlets from the other countries as well. While there

Table 1 Participant characteristics

		GR		IN		JP		NO		SA		UK		US	
		Women	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*
Total	*N*	741	1,060	6,142	35,489	724	1,503	794	905	666	1,692	1,210	1,039	1,073	1,229
Age	Mean, SD	43.4, 14.1	43.9, 14.8	43.5, 14.5	35.2, 12.7	45.2, 12.6	50.7, 11.7	36.7, 15.1	39.9, 12.9	38.3, 13.5	37.1, 13.0	39.2, 13.7	41.6, 13.8	43.4, 14.9	39.1, 12.9
Education															
High	*N*(%)	242 (32.7)	300 (28.3)	479 (7.8)	5,556 (15.7)	340 (47.0)	959 (63.8)	512 (64.5)	689 (76.1)	25 (3.8)	93 (5.5)	519 (42.9)	582 (56.0)	424 (39.5)	580 (47.2)
Middle	*N*(%)	425 (57.4)	643 (60.7)	954 (15.5)	8,415 (23.7)	355 (49.0)	519 (34.5)	234 (29.5)	179 (19.8)	340 (51.1)	916 (54.1)	589 (48.7)	364 (35.0)	596 (55.6)	598 (48.7)
Low	*N*(%)	72 (9.7)	116 (10.9)	4'451 (72.5)	21'140 (59.6)	27 (3.7)	23 (1.5)	45 (5.7)	34 (3.8)	301 (45.2)	680 (40.2)	84 (6.9)	90 (8.7)	51 (4.8)	50 (4.1)
SE status															
High	*N*(%)	77 (10.4)	77 (7.3)	232 (3.8)	1,545 (4.4)	75 (10.4)	201 (13.4)	118 (14.9)	128 (14.1)	63 (9.5)	212 (12.5)	222 (18.4)	380 (36.6)	301 (28.1)	398 (32.4)
Middle	*N*(%)	250 (33.7)	428 (40.2)	3,659 (59.6)	24,041 (67.7)	276 (38.1)	697 (46.4)	497 (62.6)	575 (63.5)	224 (33.6)	665 (39.3)	579 (47.9)	405 (39.0)	363 (33.8)	395 (32.1)
Low	*N*(%)	218 (29.4)	246 (23.2)	1,870 (30.5)	7,891 (22.2)	296 (40.9)	483 (32.1)	143 (18.0)	174 (19.2)	283 (42.5)	572 (33.8)	349 (28.8)	233 (22.4)	338 (31.5)	331 (26.9)
Marital status															
Single	*N*(%)	247 (33.3)	373 (35.2)	953 (15.5)	10,379 (29.2)	278 (38.4)	498 (33.1)	341 (43.0)	206 (22.8)	386 (58.0)	1,067 (63.1)	432 (35.7)	338 (32.5)	424 (39.5)	583 (47.4)
In a relationship	*N*(%)	481 (64.9)	666 (62.8)	5,115 (83.3)	24,836 (70.0)	445 (61.5)	1,003 (66.7)	451 (56.8)	695 (76.8)	274 (41.1)	621 (36.7)	777 (64.2)	700 (67.4)	648 (60.4)	643 (52.3)
Children <14 y in household															
None	*N*(%)	518 (69.9)	796 (75.1)	2,077 (33.8)	12,025 (33.9)	547 (75.6)	1,114 (74.1)	419 (52.8)	274 (30.3)	169 (25.4)	741 (43.8)	658 (54.4)	592 (57.0)	561 (52.3)	700 (57.0)
At least 1	*N*(%)	216 (29.2)	256 (24.2)	3,850 (62.7)	21,644 (61.0)	176 (24.3)	381 (25.4)	367 (46.2)	621 (68.6)	477 (71.6)	910 (53.8)	542 (44.8)	443 (42.6)	461 (43.0)	499 (40.6)
Employment status															
Employed	*N*(%)	623 (84.1)	840 (79.3)	5,433 (88.5)	32,304 (91.0)	636 (87.9)	1,237 (82.3)	644 (81.1)	704 (77.8)	345 (51.8)	989 (58.5)	939 (77.6)	853 (82.1)	728 (67.9)	921 (74.9)
Unemployed	*N*(%)	118 (15.9)	220 (20.8)	299 (4.9)	1,670 (4.7)	71 (9.8)	248 (16.5)	134 (16.9)	193 (21.3)	311 (46.7)	667 (39.4)	255 (21.1)	180 (17.3)	319 (29.7)	283 (23.0)

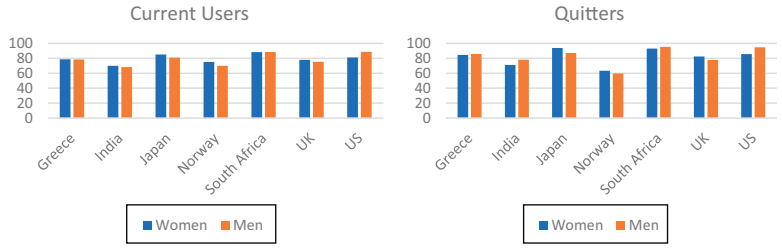
Notes: SD = Standard deviation; SE = Socioeconomic; GR = Greece; IN = India; JP = Japan; NO = Norway; SA = South Africa; UK = United Kingdom; US = United States

Table 2 User groups for current and former users

	GR				IN				JP				NO				SA				UK				US			
	Women		Men		Women		Men		Women		Men		Women		Men		Women		Men		Women		Men		Women		Men	
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Current users																												
Exclusive combustible	565	89.3	810	89.6					239	41.3	483	40.8	331	49.1	288	39.8	457	78.7	1,457	94.2	447	45.2	358	40.1	473	51.1	337	30.7
Cigarettes					613	14.1	11,385	36.6																				
Bidis					185	4.2	4,026	12.9																				
Exclusive non-combustible	34	5.4	55	6.1	0	0.0	0	0.0	72	12.5	117	9.9	8	1.2	6	0.8	1	0.2	3	0.2	80	8.1	66	7.4	93	10.0	60	5.5
Exclusive smokeless	1	0.2	5	0.6	2,551	58.5	7,920	25.4	0	0.0	0	0.0	74	11.0	76	10.5	47	8.1	1	0.1	0	0.0	0	0.0	1	0.1	44	4.0
Daily dual/poly	16	2.5	18	2.0	482	11.0	5,598	18.0	144	24.9	423	35.8	119	17.7	133	18.4	22	3.8	34	2.2	325	32.8	363	40.7	256	27.6	508	46.4
Non-daily single/dual/poly	11	1.7	12	1.3	472	10.8	1,807	5.8	85	14.7	117	9.9	114	16.9	192	26.5	50	8.6	47	3.0	121	12.2	96	10.8	97	10.5	137	12.5
Non-user	6	0.9	4	0.4	59	1.4	394	1.3	38	6.6	43	3.6	28	4.2	29	4.0	4	0.7	5	0.3	17	1.7	9	1.0	6	0.6	10	0.9
Total	633	100.0	904	100	4,362	100.0	31,130	100.0	578	100	1,183	100	674	100	724	100	581	100	1,547	100	990	100	892	100	926	100	1,096	100
Quitters																												
Exclusive combustible	87	80.6	129	82.7					85	58.2	224	70.0	46	38.3	58	32.0	54	63.5	114	78.6	96	43.6	47	32.0	63	42.9	40	30.1
Cigarettes					166	9.3	1,557	35.7																				
Bidis					61	3.4	555	12.7																				
Exclusive non-combustible	2	1.9	3	1.9	0	0.0	0	0.0	4	2.7	6	1.9	1	0.8	0	0.0	0	0.0	0	0.0	5	2.3	2	1.4	9	6.1	3	2.3
Exclusive smokeless	0	0.0	1	0.6	1,205	67.7	956	21.9	0	0.0	0	0.0	1	0.8	0	0.0	4	4.7	0	0.0	0	0.0	0	0.0	0	0.0	5	3.8
Daily dual/poly	5	4.6	4	2.6	97	5.4	472	10.8	12	8.2	50	15.6	22	18.3	16	8.8	4	4.7	2	1.4	64	29.1	67	45.6	39	26.5	44	33.1
Non-daily single/dual/poly	11	10.2	14	9.0	195	11.0	547	12.5	36	24.7	32	10.0	37	30.8	98	54.1	22	25.9	22	15.2	45	20.5	30	20.4	31	21.1	35	26.3
Non-user	3	2.8	5	3.2	56	3.1	272	6.2	9	6.2	8	2.5	13	10.8	9	5.0	1	1.2	7	4.8	10	4.5	1	0.7	5	3.4	6	4.5
Total	108	100.0	156	100	1,780	100.0	4,359	100.0	146	100	320	100	120	100	181	100	85	100	145	100	220	100	147	100	147	100	133	100

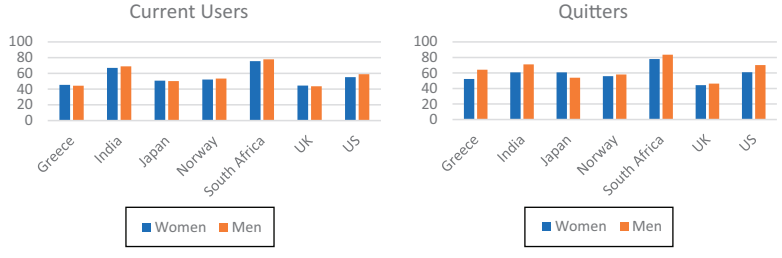
Notes: GR = Greece; IN = India; JP = Japan; NO = Norway; SA = South Africa; UK = United Kingdom; US = United States

Figure 1 Nicotine is harmful (% yes)



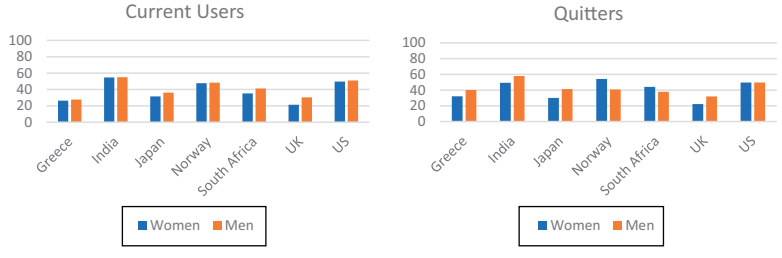
Notes: Samples sizes: GR, *n* = 633 (women), *n* = 904 (men); IN, *n* = 4,362 (women), *n* = 31,130 (men); JP, *n* = 578 (women), *n* = 1,183 (men); NO, *n* = 674 (women), *n* = 724 (men); SA, *n* = 581 (women), *n* = 1,547 (men); UK, *n* = 990 (women), *n* = 892 (men); US, *n* = 926 (women), *n* = 1,096 (men)

Figure 2 Nicotine is the primary cause of tobacco-related cancer (% yes)



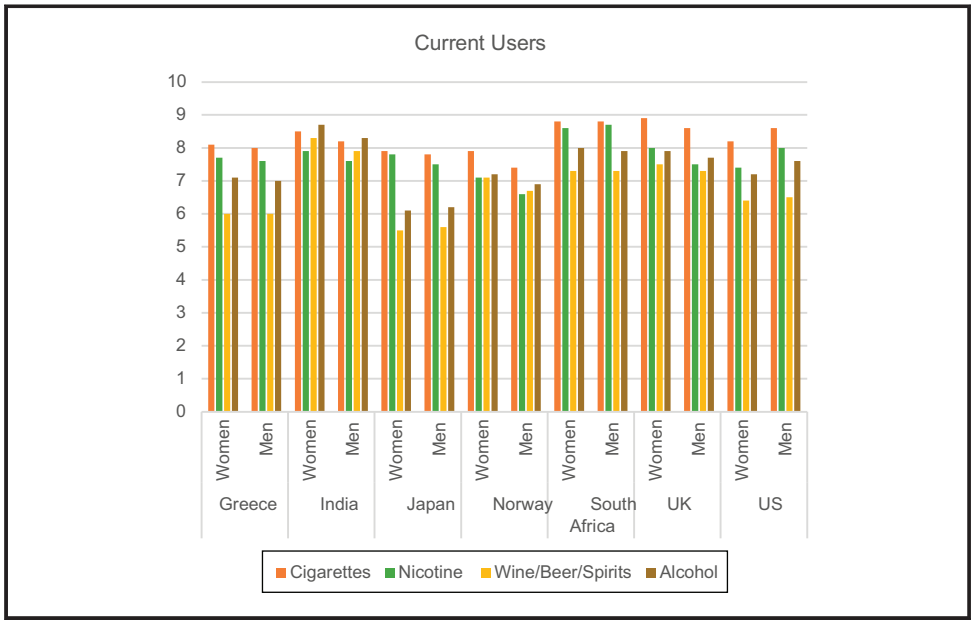
Notes: Samples sizes: GR, *n* = 633 (women), *n* = 904 (men); IN, *n* = 4,362 (women), *n* = 31,130 (men); JP, *n* = 578 (women), *n* = 1,183 (men); NO, *n* = 674 (women), *n* = 724 (men); SA, *n* = 581 (women), *n* = 1,547 (men); UK, *n* = 990 (women), *n* = 892 (men); US, *n* = 926 (women), *n* = 1,096 (men)

Figure 3 NRTs and nicotine in e-cigarettes cause cancer (% yes)



Notes: NRT: nicotine replacement therapy; UK: United Kingdom; US: United States. Samples sizes: GR, *n* = 633 (women), *n* = 904 (men); IN, *n* = 4,362 (women), *n* = 31,130 (men); JP, *n* = 578 (women), *n* = 1,183 (men); NO, *n* = 674 (women), *n* = 724 (men); SA, *n* = 581 (women), *n* = 1,547 (men); UK, *n* = 990 (women), *n* = 892 (men); US, *n* = 926 (women), *n* = 1,096 (men) GR = Greece; IN = India; JP = Japan; NO = Norway; SA = South Africa; UK = United Kingdom; US = United States

Figure 4 Comparative risk perception of a product and its substance on a scale of 1–10 in current users



was some debate about the efficacy of ecigarettes in serving as a cessation tool, there was no coverage pointing to the therapeutic uses of nicotine.

Discussion

Media coverage on nicotine leading up to our poll was predominantly negative. Most survey participants believed that nicotine is harmful and assumed that both cigarettes and nicotine are similar in terms of the level of harmfulness.

When examining the media dialogue leading up to the poll, we found that selective coverage was used, sometimes in addition to spreading misleading stories and omitting stories that potentially contradicted a desired message. The conveyed messages seemed to both confirm and strengthen widespread negative beliefs about nicotine. Therapeutic effects and potential beneficial applications of nicotine were completely ignored by the media leading up to the poll despite ongoing research in this field.

Nicotine was considered harmful across all subgroups surveyed in our poll and a large part of current and former users believed it is the primary cause of tobacco-related cancer. These findings are in line with previous studies. A British report from 2015 stated that 78% of smokers believed that nicotine is harmful to health (Royal Society for Public Health, 2015), very similar to the 81.4% and 79.3% we found among smoking women and men, respectively, in the UK (Appendix Table A2). Not much has changed in recent years in terms of nicotine perception despite the ongoing discussion in the media. A more recent study from the UK reported that only 9.8% of female and 12.3% of male current and former smokers thought that none or just a small amount of health harms of tobacco cigarettes comes from nicotine (Wilson *et al.*, 2019). In the same study 59.1% of women and 62.1% of men said that nicotine in cigarettes is not what causes most of the cancer. Again, these numbers come close to what we observed in our UK sample with 44.6% of women and 43.7% of men incorrectly saying that nicotine is the primary cause of tobacco-related cancer (Figure 2). In a US study, half the population incorrectly agreed that nicotine is the substance that causes most of the smoking-related cancers while a quarter was unsure (O'Brien *et al.*, 2017); in our US sample, it was 58.9% for women and 55.2% for men

(Figure 2). Studies on nicotine perceptions from the other five countries are lacking. We found that in most countries a large part of the population who believed that nicotine is harmful did not believe that it was the primary cause of tobacco-related cancer indicating that the perceived harmfulness may be related to other diseases. Even if participants believed it was the primary cause of tobacco-related cancer they often disagreed when asked if the nicotine in e-cigarettes or NRTs cause cancer. This underlines the confusion regarding nicotine and suggests that nicotine is assessed differently depending on the product it is linked to. Comparability with studies that evaluated specific products instead of nicotine itself is limited, although these are becoming more common.

We observed that the majority of current and previous product users estimated the harmfulness of nicotine and cigarettes alike. This has led to the misled conclusion that nicotine is responsible for the detrimental effects related to combustible tobacco consumption, even though science has found only very limited and often inconclusive evidence to date that nicotine is any more harmful than other legally consumed stimulants. The belief that nicotine is the primary culprit of smoking-related harm to health seems to be deeply engrained in many people's minds as the substance and the product are often not separated in commonplace conversations. This may continue to skew perception and further the idea that nicotine and the specific tobacco product are equal. Contradictory statements by leading researchers supported by renowned funding agencies and misreporting by the media may further public confusion as people have stated they use the media as a source of health information (Gartner *et al.*, 2020). The media could play a decisive role in raising awareness that nicotine is delivered through various products that represent a continuum of risk. Tobacco cessation through THR product use requires a more pragmatic and balanced approach in communications. It remains uncertain how much of the confusion surrounding nicotine can be blamed on inaccurate media messages but this phenomenon has been observed with other topics as well (Wilson *et al.*, 2009; Maggio *et al.*, 2019; Moghimi and Wiktorowicz, 2019). Journalists may be pressed for time to produce a catchy headline or ill-qualified to interpret statistical outcomes and assess expert opinions. Research has shown that stories written by specialist health journalists working for a single media outlet are of higher quality than other categories of journalists (Wilson *et al.*, 2010). Standardized evidence scales for lay audiences have been among the solutions proposed but these may prove challenging to enforce (Braithwaite, 2011). Accurate, timely and complete reporting by the media is necessary to avoid further public misunderstanding and mistrust (Gartner *et al.*, 2020).

Strengths and limitations

The survey was conducted simultaneously in all countries minimizing the influence from the fast-paced media dialogue that may have changed the populations' beliefs. The following limitations are to be noted: Using online surveys in some countries and face-to-face interviews in others may have introduced a selection bias among the population, especially in terms of SES and education. Response rates were not recorded for the face-to-face interviews. The questions we asked about nicotine were newly formulated and had not been validated in previous studies. We could not discuss the effects for GR, NO and JP as the media dialogue assessment was limited to english language publications in (partly) english-speaking countries. Given the timing of these analyzes, there is further need to evaluate how recent media events may have altered public perception.

Conclusions

In alignment with the recommendations found in articles 12 and 14 of the FCTC, the media should take responsibility for an unbiased and truthful communication of the latest state of knowledge regarding health risks of both tobacco and THR products and tobacco

cessation treatment strategies should be based on the best available evidence of effectiveness. It is important to clarify differences between nicotine and various products as perceived relative harm may influence future product switching (Persoskie *et al.*, 2019), which, in turn, could impact cessation rates and public health.

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Author affiliations

Sarah Rajkumar, Nada Adibah, Michael Jonathan Paskow and Brian Eric Erkkila are all based at the Department of Health, Science and Technology, Foundation for a Smoke-Free World, New York, New York, USA.

Appendix. *Methods* addendum

Table A1 Income brackets for SES classification according to Nielsen

	UK (£)	*US ($)*	*NO (NOK)*	*JP(¥)*	*GR (€)*	*SA (R)*	*IN (₹)*
			Annual household income			*Monthly household income*	
Low	Below 19,999	Below 34,999	Below 399,999	Below 4,999,999	Below 1,000	Below 6,000	Below 9,999
Middle	20,000–49,999	35,000–74,999	400,000–819,999	5,000,000–11,999,999	1,001–2,000	6,001–16,000	10,000–29,999
High	Greater than 50,000	Greater than 75,000	Greater than 820,000	Greater than 12,000,000	Greater than 2,001	Greater than 16,001	Greater than 30,000

Notes: SES = socio-economic status; GR = Greece; IN = India; JP = Japan; NO = Norway; SA = South Africa; UK = United Kingdom; US = United States

Table A2 Perceptions of nicotine in current users by user group

		GR				IN				JP				NO				SA				UK				US			
		Women		*Men*		*Women*		*Men*		*Women*		*Men*		*Women*		*Men*		*Women*		*Men*		*Women*		*Men*		*Women*		*Men*	
		N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*
Nicotine is harmful	Exclusive combustible	456	80.7	644	79.5					193	80.8	376	77.8	234	70.7	209	72.6	401	87.7	1,290	88.5	364	81.4	284	79.3	284	84.3	432	91.3
	Cigarettes					408	66.6	7,386	64.9																				
	Bidis					113	61.1	3,088	76.7																				
	Exclusive non-combustible	25	73.5	42	76.4	0		1		66	91.7	92	78.6	6	75.0	2	33.3	1	100.0	3	100.0	54	67.5	40	60.6	39	65.0	78	83.9
	Exclusive smokeless	1	100.0	5	100.0	1,837	72.0	5,548	70.1	0		0		55	74.3	53	69.7	42	89.4	1	100.0	0		0		37	84.1	1	100.0
	Daily dual/poly users	6	37.5	6	33.3	342	71.0	4,017	71.8	117	81.3	357	84.4	98	82.4	100	75.2	18	81.8	28	82.4	244	75.1	271	74.7	401	78.9	219	85.5
	Non-daily single/dual/poly	7	63.6	8	66.7	300	63.6	1,023	56.6	81	95.3	99	84.6	92	80.7	131	68.2	47	94.0	43	91.5	93	76.9	69	71.9	117	85.4	86	88.7
Nicotine is the primary cause of cancer	Exclusive combustible	267	47.3	366	45.2					112	46.9	212	43.9	200	60.4	177	61.5	348	76.1	1,141	78.3	200	44.7	139	38.8	200	59.3	294	62.2
	Cigarettes					432	70.5	7,519	66.0																				
	Bidis					116	62.7	3,046	75.7																				
	Exclusive non-combustible	11	32.4	22	40.0	0		1		25	34.7	48	41.0	1	12.5	2	33.3	1	100.0	1	33.3	17	21.3	14	21.2	19	31.7	33	35.5
	Exclusive smokeless	1	100.0	3	60.0	1,749	68.6	5,527	69.8	0		0		20	27.0	19	25.0	36	76.6	1	100.0	0		0		17	38.6	0	0.0
	Daily dual/poly users	3	18.8	4	22.2	328	68.0	4,011	71.7	76	52.8	242	57.2	49	41.2	72	54.1	13	59.1	24	70.6	160	49.2	192	52.9	291	57.3	151	59.0
	Non-daily single/dual/poly	5	45.5	5	41.7	244	51.7	1,134	62.8	56	65.9	70	59.8	68	59.6	109	56.8	36	72.0	35	74.5	57	47.1	40	41.7	72	52.6	64	66.0
NRTs cause cancer	Exclusive combustible	155	27.4	221	27.3					63	26.4	144	29.8	192	58.0	171	59.4	169	37.0	609	41.8	98	21.9	119	33.2	186	55.2	260	55.0
	Cigarettes					339	55.3	5,997	52.7																				
	Bidis					93	50.3	2,165	53.8																				
	Exclusive non-combustible	4	11.8	15	27.3	0		1		16	22.2	36	30.8	0	0.0	2	33.3	0	0.0	0	0.0	2	2.5	5	7.6	13	21.7	28	30.1
	Exclusive smokeless	1	100.0	3	60.0	1,469	57.6	4,538	57.3	0		0		14	18.9	10	13.2	13	27.7	0	0.0	0		0		17	38.6	0	0.0
	Daily dual/poly users	4	25.0	4	22.2	206	42.7	3,255	58.1	52	36.1	183	43.3	50	42.0	67	50.4	5	22.7	10	29.4	74	22.8	122	33.6	253	49.8	128	50.0
	Non-daily single/dual/poly	3	27.3	3	25.0	218	46.2	987	54.6	41	48.2	51	43.6	57	50.0	94	49.0	15	30.0	16	34.0	32	26.4	24	25.0	68	49.6	50	51.5

Notes: NRT = nicotine replacement therapy; GR = Greece; IN = India; JP = Japan; NO = Norway; SA = South Africa; UK = United Kingdom; US = United States

Table A3 Perceptions of nicotine in previous users by user group

		GR				IN				JP				NO				SA				UK				US			
		Women		*Men*		*Women*		*Men*		*Women*		*Men*		*Women*		*Men*		*Women*		*Men*		*Women*		*Men*		*Women*		*Men*	
		N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*
Nicotine is harmful	Exclusive combustible	78	89.7	115	89.1					80	94.1	198	88.4	26	56.5	34	58.6	49	90.7	110	96.5	79	82.3	35	74.5	36	90.0	62	98.4
	Cigarettes					128	77.1	1,324	85.0																				
	Bidis					41	67.2	412	74.2																				
	Exclusive non-combustible	0	0.0	1	33.3	0		0		3	75.0	4	66.7	0	0.0	0		0		0		3	60.0	2	100.0	2	66.7	7	77.8
	Exclusive smokeless	0		1	100.0	845	70.1	744	77.8	0		0		1	100.0	0		3	75.0	0		0		0		4	80.0	0	
	Daily dual/poly users	4	80.0	2	50.0	73	75.3	396	83.9	10	83.3	42	84.0	18	81.8	9	56.3	4	100.0	2	100.0	50	78.1	54	80.6	39	88.6	36	92.3
	Non-daily single/dual/poly	9	81.8	12	85.7	141	72.3	379	69.3	35	97.2	30	93.8	24	64.9	62	63.3	22	100.0	22	100.0	40	88.9	22	73.3	27	77.1	29	93.5
Nicotine is the primary cause of cancer	Exclusive combustible	47	54.0	86	66.7					49	57.6	117	52.2	28	60.9	35	60.3	41	75.9	96	84.2	35	36.5	13	27.7	21	52.5	50	79.4
	Cigarettes					122	73.5	1,226	78.7																				
	Bidis					30	49.2	364	65.6																				
	Exclusive non-combustible	0	0.0	0	0.0	0		0		2	50.0	2	33.3	0	0.0	0		0		0		3	60.0	0	0.0	0	0.0	5	55.6
	Exclusive smokeless	0		1	100.0	730	60.6	710	74.3	0		0		0	0.0	0		3	75.0	0		0		0		4	80.0	0	
	Daily dual/poly users	3	60.0	2	50.0	56	57.7	385	81.6	8	66.7	27	54.0	14	63.6	7	43.8	3	75.0	2	100.0	34	53.1	37	55.2	31	70.5	20	51.3
	Non-daily single/dual/poly	4	36.4	9	64.3	114	58.5	335	61.2	25	69.4	22	68.8	20	54.1	59	60.2	18	81.8	21	95.5	20	44.4	17	56.7	24	68.6	24	77.4
NRTs cause cancer	Exclusive combustible	30	34.5	51	39.5					25	29.4	87	38.8	29	63.0	30	51.7	20	37.0	41	36.0	14	14.6	3	6.4	17	42.5	32	50.8
	Cigarettes					114	68.7	1,047	67.2																				
	Bidis					23	37.7	231	41.6																				
	Exclusive non-combustible	0	0.0	0	0.0	0		0		1	25.0	3	50.0	0	0.0	0		0		0		1	20.0	0	0.0	0	0.0	4	44.4
	Exclusive smokeless	0		1	100.0	583	48.4	592	61.9	0		0		1	100.0	0		4	100.0	2		0		0		3	60.0	0	
	Daily dual/poly users	2	40.0	1	25.0	29	29.9	288	61.0	2	16.7	23	46.0	14	63.6	10	62.5	2	50.0	8	400.0	14	21.9	32	47.8	23	52.3	21	53.8
	Non-daily single/dual/poly	3	27.3	8	57.1	101	51.8	307	56.1	12	33.3	16	50.0	16	43.2	31	31.6	11	50.0	0	0.0	15	33.3	12	40.0	21	60.0	13	41.9

Notes: NRT = nicotine replacement therapy; GR = Greece; IN = India; JP = Japan; NO = Norway; SA = South Africa; UK = United Kingdom; US = United States

Table A4 Nielsen conducted pilot interviews to test the survey

Country	*Method*	*Number of pilot interviews*	*Language*
IN	Face-to-face interview	30	Hindi, Bengali, Tamil, Marathi (7–8 interviews per language)
SA	Face-to-face interview	6	English
GR	Face-to-face interview	6	Greek
NO	Online interview	6	Norwegian
JP	Online interview	7	Japanese
UK	Online interview	8	English
US	Online interview	6	English

Notes: GR = Greece; IN = India; JP = Japan; NO = Norway; SA = South Africa; UK = United Kingdom; US = United States

Table A5 Intersectional analysis of nicotine perceptions

	GR		*IN*		*JP*		*NO*		*SA*		*UK*		*US*	
	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*	N	*(%)*
Of those who said nicotine is harmful, part who also said that nicotine is the primary cause of cancer	679	56.4	22,254	91.5	870	60	663	65.4	1,602	85.1	802	55.7	1,120	65.3
Of those who said nicotine is harmful, part who also said that NRTs cause cancer	394	32.7	17,692	72.8	588	40.6	595	58.7	800	42.5	448	31.1	966	56.3
Of those who said nicotine is the primary cause of cancer, part who also said that NRTs cause cancer	332	48.2	18,399	75.5	496	55.9	521	70.5	777	47.3	349	42	815	70.6

Notes: GR = Greece; IN = India; JP = Japan; NO = Norway; SA = South Africa; UK = United Kingdom; US = United States

Corresponding author

Brian Eric Erkkila can be contacted at: Brian.Erkkila@smokefreeworld.org