

E-cigarette content analysis on YouTube in the pre- and post-pandemic periods: A comparative study and implications for tobacco control

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ABSTRACT

INTRODUCTION YouTube is widely used as a source of health information; however, the accuracy, reliability, and quality of user-generated content vary considerably. Although e-cigarette-related videos on YouTube may influence individuals' health-related decisions and their perceptions and attitudes toward e-cigarettes, differences in the characteristics of this content across time periods remain insufficiently understood. This study aimed to compare content stance, provision of useful information, reliability, and quality of e-cigarette- and vaping-related YouTube videos uploaded before and after the COVID-19 pandemic and identify video characteristics independently associated with useful information.

METHODS In this comparative cross-sectional content analysis, 400 videos were retrieved using the keywords 'e-cigarette' and 'vaping', were screened for eligibility, and 240 eligible videos were evaluated. Videos were classified by main topic, uploader category, and content stance and information provision. Reliability and overall quality were assessed using the Journal of the American Medical Association (JAMA) benchmark criteria and Global Quality Score (GQS). Multivariable logistic regression analysis identified factors independently associated with useful information.

RESULTS The proportion of videos providing useful information was lower in the post-pandemic period than in the pre-pandemic period ($p=0.001$). JAMA category distributions differed significantly between periods ($p=0.019$), with low JAMA category videos more frequent in the post-pandemic period. Videos uploaded by personal users ($p<0.001$) and those featuring personal experience, entertainment, or commercial content (Bonferroni-adjusted $p=0.002$) were more frequent post-pandemic. Pre-pandemic upload was independently associated with the provision of useful information (AOR=2.896; 95% CI: 1.061–7.904), whereas a pro-vaping stance was associated with lower odds (AOR=0.081; 95% CI: 0.018–0.377). Uploader category was not significantly associated with useful information ($p>0.05$).

CONCLUSIONS Useful information was less frequent post-pandemic, whereas personal experience, entertainment, or commercial content was more frequent. These findings may represent a challenge for tobacco control on digital platforms. Uploader identity and popularity alone are insufficient indicators of usefulness or reliability.

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INTRODUCTION

Electronic cigarettes (e-cigarettes) are devices that generate an inhalable aerosol by electrically heating a liquid¹. Since their introduction, these products have diversified from early ‘cig-a-like’ models into vape pens, mods, pod systems, and disposable devices that differ in design, power, liquid capacity, and nicotine delivery².

Modern e-cigarettes were developed in 2003 by the Chinese pharmacist Hon Lik and first commercialized in China in 2004, and subsequently entered European and United States markets³. E-cigarettes have been used as smoking-cessation aids and proposed as potentially less harmful alternatives to combustible cigarettes⁴. However, concerns have increased because of emerging evidence of adverse health effects and their uptake among non-smokers, particularly young people¹.

Despite a decline in global tobacco use, more than 100 million people worldwide currently use e-cigarettes⁵. Use is especially common in the World Health Organization (WHO) European Region, where the prevalence of use is estimated at 4.6% among adults and 14.3% among adolescents aged 13–15 years⁵. Increasing use among young people may undermine progress in tobacco control⁶. In response, the WHO has called for stronger regulation of e-cigarette promotion, accessibility, and product characteristics to protect children, adolescents, and non-smokers⁷.

Today, digital platforms have become important sources of health information. YouTube, owing to its large user base and video-based format, is frequently used to obtain health-related information^{8,9}. The platform allows healthcare professionals and institutions, commercial organizations, content creators, and personal users to reach large audiences. However, this open structure also facilitates the dissemination of misinformation and disinformation, which are recognized as major global health risks¹⁰. Moreover, popularity indicators such as views, likes, and comments do not necessarily reflect the scientific accuracy, reliability, or quality of the information presented¹¹.

This problem concerning the rapid spread of false and misleading health information became more visible during the COVID-19 pandemic. The pandemic

markedly affected how individuals accessed health information and their reliance on digital platforms^{12,13}. The increased uncertainty and need for information during the pandemic also intensified individuals’ behavior on seeking health information. Social media, an important platform for the dissemination of health information, became one of the leading sources through which users obtained health information during this period¹⁴. While social media facilitated the rapid dissemination of information related to the pandemic, it also enabled unverified or misleading information to reach wide audiences. As a result, the information crisis referred to as the ‘infodemic’ became more prominent¹³.

Given the widespread use of YouTube as a source of health information, studies directly comparing e-cigarette-related videos across clearly defined pre- and post-pandemic periods appear to be limited. Evaluating content stance, information adequacy, reliability, and quality together across these periods may provide a broader understanding of differences in e-cigarette-related content between distinct temporal contexts.

This study aimed to compare the content stance, information adequacy, reliability, and quality of e-cigarette- and vaping-related YouTube videos uploaded during the pre- and post-pandemic periods and to identify video characteristics independently associated with the provision of useful information.

METHODS

Study design and study periods

This study was a comparative cross-sectional, video-based content analysis, in which the videos on e-cigarette/vaping available on YouTube were compared between the pre-pandemic and post-pandemic periods. No human participants were included in the study, and the unit of analysis was YouTube videos.

In this study, to compare the quality of e-cigarette-related content on YouTube between the pre- and post-pandemic periods, videos were grouped into two timeframes. These timeframes were defined according to key milestones announced by the WHO. The pre-pandemic period (11 March 2019 – 11 March 2020) comprised the one-year period preceding the WHO’s declaration of COVID-19 as a global pandemic on

11 March 2020, whereas the post-pandemic period (5 May 2023 – 5 May 2024) comprised the one-year period following the end of COVID-19 as a Public Health Emergency of International Concern on 5 May 2023^{15,16}. The intervening period between these two reference points was excluded to allow comparison of two distinct one-year periods before and after the pandemic interval.

Sample selection

YouTube searches were conducted during a single data-retrieval session using the YouTube Data API v3. Searches were performed separately using the keywords ‘e-cigarette’ and ‘vaping’ for each predefined study period. Publication-date filters were applied to identify videos uploaded between 11 March 2019 and 11 March 2020 for the pre-pandemic period and between 5 May 2023 and 5 May 2024 for the post-pandemic period.

For each keyword–period combination, 100 videos were selected: the 50 most-viewed videos identified using the API’s viewCount ordering parameter and 50 additional videos selected using a Python-based random sampling procedure. Accordingly, 200 videos were selected for each study period, yielding an initial sample of 400 videos for eligibility assessment.

Duplicate records retrieved through different keyword searches were identified and excluded during the screening process. Videos were eligible when they were in English or had English subtitles, were directly related to e-cigarettes or vaping, and lasted at least one minute. Videos were excluded if they were not in English and did not include English subtitles, if the content was unrelated to e-cigarettes or vaping, or if the video duration was shorter than one minute. Duplicate videos and videos inaccessible, deleted, or unable to be opened due to technical reasons were also excluded.

The predefined inclusion and exclusion criteria were subsequently applied, and 240 eligible videos were included in the final analysis. The video selection process is presented in Figure 1.

Because YouTube search results are dynamic and may vary according to platform availability and API behavior, the same search may not yield an identical video pool at a later date. The combined use of highly viewed and randomly selected videos was intended

to broaden the sample beyond only the most popular content.

Data collection and video characteristics

For each video included in the study, the video title, upload date, and video duration were recorded. To assess the popularity and user interaction characteristics of the videos; the numbers of views, likes, comments, and channel subscribers displayed at the time of evaluation were recorded. Numerical metrics related to the videos were recorded within the same data collection process, since view and interaction values on YouTube can change over time.

Video content classification

The videos were classified according to three separate classification domains: the main topic, the profile of the content uploader, and the stance toward e-cigarette use. These classifications were performed independently of one another.

Main topic

The videos were assigned to one of the following three main topic categories based on their predominant content: personal experience, entertainment, or commercial content; regulation, campaign, or public service announcement; and health effects of e-cigarettes. When a video contained more than one topic, the topic that accounted for the largest proportion of the video’s duration and reflected its main message was considered the primary topic.

Uploader profile

The videos were classified into four groups based on uploader profile and primary area of activity of the uploading channel: personal channels; news channels, podcast channels, or media organizations; commercial content, brands, or advertising channels; health professionals (e.g. physicians), healthcare institutions (e.g. hospitals, universities), and health channels (providing health information without professional medical credentials).

Video stance

The stance of the videos was classified into two categories, pro-vaping and anti-vaping, based on the video’s dominant message.

Pro-vaping content

Videos that directly or indirectly encouraged e-cigarette use, emphasized its positive aspects, presented the product as attractive or preferable, or disregarded or downplayed the risks associated with its use were classified in this category. Sponsored product promotions, content encouraging viewers to purchase e-cigarette products, product reviews presenting e-cigarette use in an appealing manner, and videos emphasizing the social or recreational aspects of use were also classified as pro-vaping.

Anti-vaping content

Videos that did not support e-cigarette use or

recommended its cessation, and that emphasized health harms, the risk of nicotine dependence, societal effects, or the necessity of regulatory measures, were evaluated in this category.

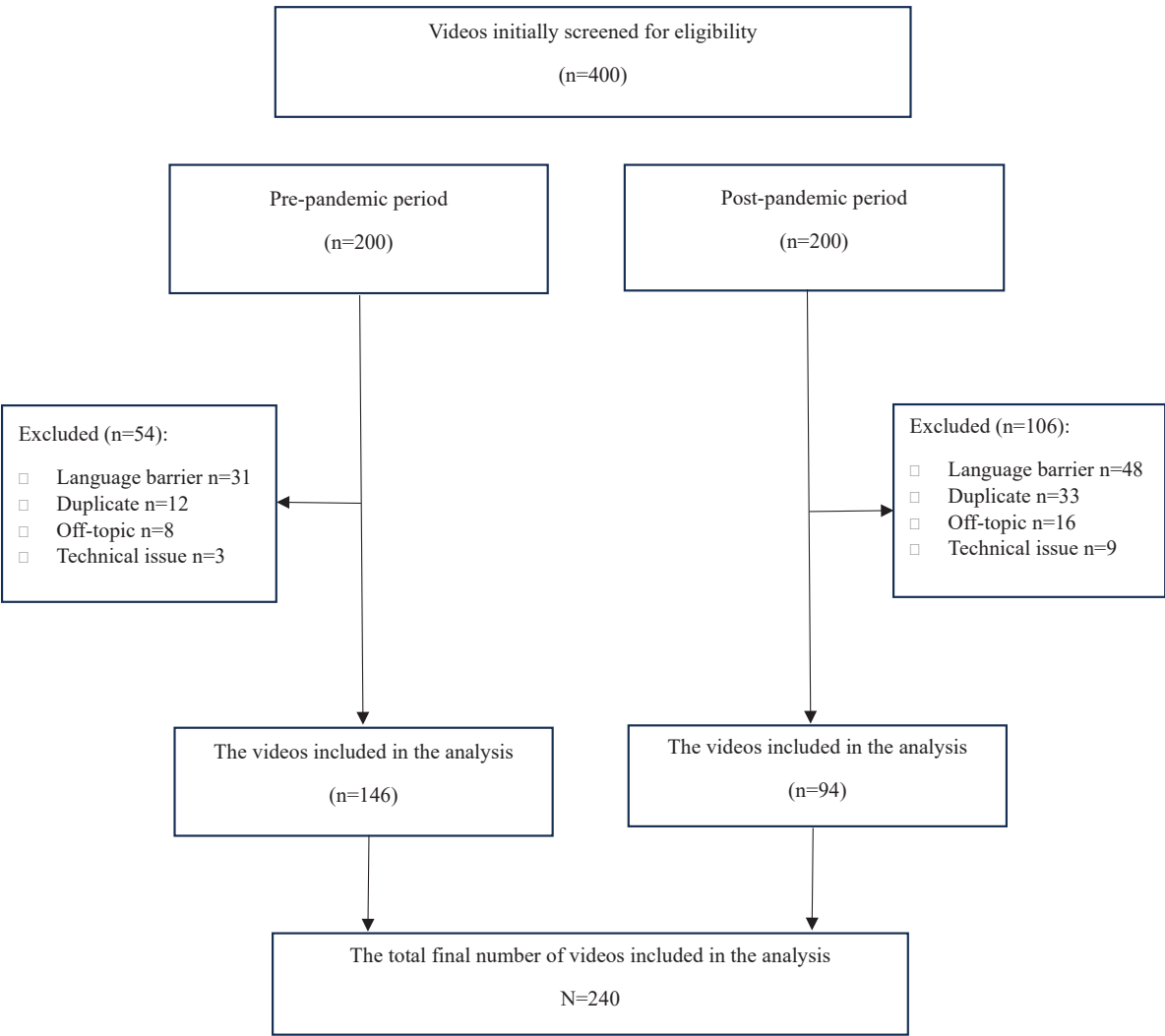
Evaluation on adequacy of information provided

The adequacy of information provided in the videos was evaluated in two categories: inadequate/misleading information provided, and useful information provided.

Inadequate/misleading information provided

Videos that did not provide verifiable information about e-cigarettes or vaping; contained only

Figure 1. Flowchart of video selection in a comparative cross-sectional content analysis of e-cigarette- and vaping-related YouTube videos from the pre-pandemic (11 March 2019 – 11 March 2020) and post-pandemic (5 May 2023 – 5 May 2024) sampling periods (N=400 screened; N=240 included)



personal experiences, entertainment, or product demonstrations; included scientifically inaccurate, misleading, unverified, or medically invalid claims; or presented substantially incomplete or decontextualized information, were classified in this category.

Useful information provided

Videos that contained relevant, understandable, and verifiable information about e-cigarettes or vaping; whose key messages were consistent with current medical guidelines, recommendations from official health organizations, or reliable academic evidence; and that did not contain significant information errors likely to mislead the user, were evaluated in this category.

Evaluation of video quality and reliability

The Journal of the American Medical Association (JAMA) benchmark criteria and the Global Quality Score (GQS) criteria were used to evaluate the quality and reliability of the videos¹⁷. Each of the four JAMA benchmark components was scored as 1 when the criterion was met and 0 when it was not met, yielding a total score ranging from 0 to 4. Scores of 0–1 were classified as low quality, a score of 2 as moderate quality, and scores of 3–4 as high quality. The four components were:

1. Authorship: clear and credible identification of the content author
2. Attribution: all information supported by valid references
3. Currency: information is up-to-date and consistent with recent medical advances
4. Disclosure: transparency regarding conflicts of interest or sponsorship

The GQS, videos were assigned a score ranging from 1 to 5 according to the extent to which they met the criteria described below. Scores of 1–2 were classified as low quality, a score of 3 as moderate quality, and scores of 4–5 as high quality¹⁸.

1. Poor quality: information missing, technique misleading; unlikely to be useful for patient education
2. Generally sparse quality: some information provided but majority lacking, technique poor, limited use for patients
3. Moderate quality: important information provided

but some lacking, technique mostly adequate; somewhat useful for patients

4. Good quality: majority of information provided but some information lacking, technique adequate; useful for patients because most important topics are covered
5. Excellent quality: full information provided; technique adequate; highly useful for patients

Reviewer assessment and adjudication

The videos included in the study were independently evaluated by two physicians who were specialists in family medicine. The reviewers separately coded the videos' content stance, adequacy of information provided, JAMA score, and GQS score according to predetermined evaluation criteria. No formal pre-coding training or calibration exercise was conducted.

Videos for which the two reviewers disagreed in at least one of the four evaluation domains – content stance, adequacy of information, JAMA category, or GQS category – were subsequently assessed by a third physician, who was blinded to the initial ratings, to resolve the discrepancies. The final classifications and scores established after third-reviewer adjudication were used in the main statistical analyses. All three physicians had clinical experience working in smoking-cessation clinics and providing tobacco-dependence counseling.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA). Categorical variables are presented as frequencies and percentages, whereas numerical variables were summarized using the median and interquartile range (IQR=Q3–Q1). The distributions of numerical variables were assessed using the Kolmogorov–Smirnov test. Because the numerical variables were not normally distributed, the Mann–Whitney U test was used to compare two independent groups.

Inter-rater agreement for content stance, adequacy of information provided, JAMA category, and GQS category was assessed using unweighted Cohen's kappa statistic, and κ values were interpreted according to the criteria proposed by Landis and Koch.

Associations between categorical variables were evaluated using Pearson's chi-squared test when the test assumptions were met. Fisher's exact test was used for 2×2 contingency tables with low expected cell counts, whereas the Fisher–Freeman–Halton exact test was used for larger contingency tables. When the overall comparison of a variable with more than two categories was statistically significant, category-specific proportions were compared using pairwise z tests with Bonferroni correction.

Multivariable binary logistic regression analysis was performed to identify factors independently associated with the useful information provided from the videos. The dependent variable was coded as 1 for useful information and 0 for misleading or inadequate information. Upload period, video stance, main topic, and uploader profile were selected *a priori* according to the study objectives and theoretical relevance and were entered simultaneously into the model.

The reference categories were the post-pandemic period for upload period, anti-vaping for video stance, health effects for main topic, and healthcare professionals, healthcare institutions, or health-information channels for uploader profile. The results are presented as adjusted odds ratios (AORs), 95% confidence intervals (CIs), and p-values. The explanatory power of the model was reported using the Nagelkerke pseudo- R^2 value. All statistical tests were two-sided, and $p < 0.05$ was considered statistically significant.

Ethical considerations

This study analyzed publicly accessible YouTube videos and did not involve human participants or intervention, access to private accounts, or the use of identifiable personal health data. Only publicly available video- and channel-level information was collected, and privacy, copyright, and research-integrity principles were observed throughout the study. As there was no interaction with users, access to private accounts, or collection of identifiable personal health data, formal ethics committee or institutional review board approval or exemption, was not sought.

RESULTS

Video selection and inter-rater agreement

A total of 400 videos were initially assessed for

eligibility, 240 videos were included in the final analysis. Inter-rater agreement was almost perfect for content stance ($\kappa = 0.825$, $p < 0.001$), substantial for the adequacy of information provided ($\kappa = 0.795$, $p < 0.001$), substantial for the JAMA benchmark criteria ($\kappa = 0.619$, $p < 0.001$), and substantial for the GQS assessments ($\kappa = 0.616$, $p < 0.001$). The two reviewers disagreed in at least one assessment domain for 109 of the 240 videos (45.4%).

General analysis of all videos

Regarding the main topic, 106 videos (44.2%) featured personal experience, entertainment, or commercial content, 100 (41.7%) focused on health effects, and 34 (14.2%) addressed regulation, campaigns, or public service announcements. Regarding uploader category, 81 videos (33.8%) were uploaded by personal users, 81 (33.8%) by news, podcast, or media organizations, 48 (20.0%) by health professionals, healthcare institutions, or health-information channels, and 30 (12.5%) by commercial content, brands, or advertising channels.

With respect to content stance, 145 videos (60.4%) were classified as anti-vaping, whereas 95 (39.6%) as pro-vaping. Regarding the adequacy of information provided, the videos were equally distributed between those providing adequate information and those providing inadequate or no information ($n = 120$; 50% for each group).

According to the JAMA benchmark criteria, 147 videos (61.3%) were classified as low, 67 (27.9%) moderate, and 26 (10.8%) high category. According to the GQS, 173 videos (72.1%) were classified as low, 40 (16.7%) moderate, and 27 (11.3%) high quality.

There were no statistically significant differences between pro-vaping and anti-vaping videos in terms of the number of views, likes, comments, or video duration ($p > 0.05$). However, the channels uploading anti-vaping videos had significantly more subscribers than those uploading pro-vaping videos ($p < 0.001$).

There were no statistically significant differences between videos providing useful information and those providing inadequate or no information with respect to the number of views, likes, comments, or video duration ($p > 0.05$). However, the channels uploading videos classified as providing useful information had significantly more subscribers

than those uploading videos classified as providing inadequate or no information ($p<0.001$).

The majority of pro-vaping videos (94.7%, $n=90$) were classified as providing inadequate or no information, whereas this proportion was 20.7% ($n=30$) among anti-vaping videos. The difference was statistically significant ($p<0.001$).

Analysis of the included videos by pre- and post-pandemic periods

Of the 240 videos analyzed, 146 (60.8%) were uploaded in the pre-pandemic period and 94 (39.2%) in the post-pandemic period. Video stance did not differ significantly between periods ($p>0.05$), with anti-vaping videos accounting for 63.7% ($n=93$) of pre-pandemic and 55.3% ($n=52$) of post-pandemic videos. There were also no differences between the periods in the numbers of views, likes, comments, and channel subscribers (all $p>0.05$), whereas video duration was longer in the post-pandemic period ($p=0.040$) (Table 1).

Useful information was less frequent in the post-pandemic period than in the pre-pandemic period (36.2%, $n=34$ vs 58.9%, $n=86$; $p=0.001$) (Table 1). The distribution of GQS categories did not differ significantly between periods ($p=0.184$), whereas the distribution of JAMA categories differed

significantly ($p=0.019$). The low JAMA category was more frequent in the post-pandemic period than in the pre-pandemic period (71.3% vs 54.8%), whereas the moderate category was less frequent (18.1% vs 34.2%); the high category was similarly represented in the two periods (10.6% vs 11.0%). Bonferroni-adjusted *post hoc* comparisons showed significant differences between periods in the low and moderate JAMA categories, but not in the high JAMA category.

A statistically significant difference was also observed in video uploader categories between periods ($p<0.001$). Personal-user uploads were more frequent in the post-pandemic period than in the pre-pandemic period (51.1% vs 22.6%; Bonferroni-adjusted $p<0.001$), whereas news/podcast uploads were less frequent (24.5% vs 39.7%; adjusted $p=0.015$); no significant between-period differences were observed in the remaining uploader categories. Main topic also differed between periods ($p=0.006$), primarily because of changes in personal experiences, entertainment, or commercial content, as well as those focusing on regulation, public campaigns, or public service announcements. Personal experience, entertainment, or commercial content was more frequent in the post-pandemic period than in the pre-pandemic period (56.4% vs 36.3%; adjusted $p=0.002$), whereas regulation, campaign, or public service

Table 1. Comparison of video characteristics between the pre-pandemic (11 March 2019 – 11 March 2020) and post-pandemic (5 May 2023 – 5 May 2024) periods in a comparative cross-sectional content analysis of e-cigarette- and vaping-related YouTube videos ($N=240$)

Variables	Pre-pandemic (N=146)	Post-pandemic (N=94)	p
Popularity and interaction metrics, median (IQR)			
Number of views	61941 (729062)	240000 (1302758)	0.245
Number of likes	805 (8407)	3127.5 (28481)	0.161
Number of comments	125.5 (813)	174.5 (1389)	0.304
Video duration (minutes)	4.11 (5.54)	7.81 (12.04)	0.040
Number of channel subscribers	253000 (1189100)	183500 (1143410)	0.572
Video stance, n (%)			
Pro-vaping	53 (36.3)	42 (44.7)	0.195
Anti-vaping	93 (63.7)	52 (55.3)	
Information adequacy, n (%)			
Useful information	86 (58.9)	34 (36.2)	0.001
Misleading/inadequate information	60 (41.1)	60 (63.8)	

Continuous variables: Mann–Whitney U test; categorical variables: Pearson's χ^2 or exact test, as appropriate. IQR: interquartile range; calculated as Q3–Q1. Percentages are presented as column percentages. Statistical significance was set at $p<0.05$.

announcement content was less frequent (8.5% vs 17.8%; adjusted $p=0.044$).

Comparison according to adequacy of information provided

Table 2 presents the comparison of adequacy of information provided with other study variables in videos published during the pre- and post-pandemic periods.

A statistically significant difference was observed between video content stance and the adequacy of information provided in both the pre- and post-pandemic periods ($p<0.001$). In both periods, the proportion of videos providing inadequate or no information was significantly higher among pro-vaping videos than among anti-vaping videos.

The distribution of JAMA categories differed significantly according to information adequacy in both the pre- and post-pandemic periods ($p<0.001$ for both). In the pre-pandemic period, Bonferroni-adjusted *post hoc* comparisons showed that the

proportion of videos classified in the low JAMA category was significantly higher among videos providing inadequate or no information (adjusted $p<0.001$). Videos providing useful information were significantly more likely to be classified in the moderate JAMA category (adjusted $p<0.001$) and the high JAMA category (adjusted $p=0.008$).

Similarly, in the post-pandemic period, the low JAMA category was significantly more frequent among videos providing inadequate or no information (adjusted $p<0.001$), whereas the moderate (adjusted $p=0.001$) and high JAMA categories (adjusted $p<0.001$) were significantly more frequent among videos providing useful information.

When the GQS distributions were analyzed, all videos providing inadequate or no information were classified in the low GQS category in both periods ($n=60$; 100% in each period). Among videos providing useful information, 39 (45.3%) were classified as low, 28 (32.6%) moderate, and 19 (22.1%) high GQS in the pre-pandemic period; the corresponding numbers

Table 2. Comparison of information adequacy with other study variables in a comparative cross-sectional content analysis of e-cigarette- and vaping-related YouTube videos, pre-pandemic (11 March 2019 – 11 March 2020) and post-pandemic (5 May 2023 – 5 May 2024) periods (N=240)

Variables	Pre-pandemic (N=146)			Post-pandemic (N=94)		
	Misleading/inadequate information (N=60)	Useful information (N=86)	p	Misleading/inadequate information (N=60)	Useful information (N=34)	p
Popularity and interaction metrics, median (IQR)						
Number of views	105882.5 (884227.75)	40191.50 (646919.75)	0.144	153771 (883244)	802090.50 (1881008.25)	0.016
Number of likes	1305.5 (11094)	265 (7941.50)	0.070	1432 (12963.5)	13437.50 (59121.25)	0.003
Number of comments	158.5 (574.5)	60 (853.50)	0.905	138.0 (648.75)	937.50 (3576.25)	0.010
Video duration (minutes)	5.04 (7.48)	3.86 (4.36)	0.341	7.89 (12.59)	7.81 (10.47)	0.937
Number of channel subscribers	50550 (390155)	467000 (1496725)	<0.001	69900 (459732.5)	859500 (3874750)	<0.001
Video stance, n (%)						
Pro-vaping	48 (80)	5 (5.8)	<0.001	42 (70.0)	0 (0)	<0.001
Anti-vaping	12 (20)	81 (94.2)		18 (30)	34 (100)	

Continuous variables: Mann–Whitney U test; categorical variables: Pearson's χ^2 or exact test, as appropriate. IQR: interquartile range. The interquartile range was calculated as Q3–Q1. Percentages are presented as column percentages. Statistical significance was set at $p<0.05$.

in the post-pandemic period were 14 (41.2%), 12 (35.3%), and 8 (23.5%), respectively.

Comparison according to video content stance

Table 3 presents the comparison of video content stance with other variables in videos published during the pre- and post-pandemic periods.

In the pre-pandemic period, the distributions of both the JAMA and GQS quality categories were significantly different between pro-vaping and anti-vaping videos ($p < 0.001$, for both). Bonferroni-adjusted *post hoc* comparisons showed that the low JAMA and low GQS categories were significantly more frequent among pro-vaping videos (adjusted $p < 0.001$ for both). In contrast, the moderate JAMA (adjusted $p < 0.001$), high JAMA (adjusted $p = 0.024$), moderate GQS (adjusted $p < 0.001$), and high GQS categories (adjusted $p = 0.001$) were significantly more frequent among anti-vaping videos.

In the post-pandemic period, the distributions of both the JAMA and GQS quality categories were

significantly different between pro-vaping and anti-vaping videos ($p < 0.001$). *Post hoc* comparisons showed that the low JAMA and low GQS categories were significantly more frequent among pro-vaping videos (adjusted $p < 0.001$ for both). In contrast, the moderate JAMA (adjusted $p = 0.047$), high JAMA (adjusted $p = 0.006$), moderate GQS (adjusted $p = 0.001$), and high GQS categories (adjusted $p = 0.023$) were significantly more frequent among anti-vaping videos.

Independent factors associated with the adequacy of the information provided

A multivariable binary logistic regression analysis was performed to identify the factors independently associated with whether a video provided useful information (useful vs inadequate or no information). The Nagelkerke pseudo- R^2 value was 0.759. Videos uploaded during the pre-pandemic period had approximately 2.9 times higher odds of providing useful information than those uploaded during the

Table 3. Comparison of video content stance with other study variables in a comparative cross-sectional content analysis of e-cigarette- and vaping-related YouTube videos, pre-pandemic (11 March 2019 – 11 March 2020) and post-pandemic (5 May 2023 – 5 May 2024) periods (N=240)

Variables	Pre-pandemic (N=146)			Post-pandemic (N=94)		
	Pro-vaping (N=53)	Anti-vaping (N=93)	p	Pro-vaping (N=42)	Anti-vaping (N=52)	p
Popularity and interaction metrics, median (IQR)						
Number of views	100355 (1054669.50)	42263 (664628.50)	0.122	22620 (634400)	738684 (1733289.75)	<0.001
Number of likes	1272 (15017)	268 (8041.50)	0.045	176.5 (9351.25)	11818 (45671)	<0.001
Number of comments	177 (673.50)	43 (816)	0.328	25 (380.25)	577 (2788)	0.001
Video duration (minutes)	5.42 (7.63)	3.40 (4.38)	0.135	7.71 (11.49)	7.81 (12.36)	0.915
Number of channel subscribers	49200 (446250)	452000 (1381950)	<0.001	18050 (135624.50)	533000 (3149500)	<0.001
JAMA, n (%)						
Low	47 (88.7)	33 (35.5)	<0.001	39 (92.9)	28 (53.8)	<0.001
Moderate	5 (9.4)	45 (48.4)		3 (7.1)	14 (26.9)	
High	1 (1.9)	15 (16.1)		0 (0)	10 (19.2)	
GQS, n (%)						
Low	52 (98.1)	47 (50.5)	<0.001	42 (100)	32 (61.5)	<0.001*
Moderate	1 (1.9)	27 (29)		0 (0)	12 (23.1)	
High	0 (0)	19 (20.4)		0 (0)	8 (15.4)	

Continuous variables: Mann–Whitney U test. Categorical variables: Pearson's χ^2 or exact test, as appropriate. IQR: interquartile range; calculated as Q3–Q1. Percentages are presented as column percentages. JAMA: Journal of the American Medical Association benchmark criteria. GQS: Global Quality Score. For variables with more than two categories that showed a statistically significant overall association, category-specific Bonferroni-adjusted *post hoc* comparisons were performed. The results are presented in the text. *Fisher–Freeman–Halton exact test was used. Statistical significance was set at $p < 0.05$.

Table 4. Multivariable binary logistic regression analysis of factors associated with the provision of useful information among e-cigarette- and vaping-related YouTube videos included from the pre-pandemic (11 March 2019 – 11 March 2020) and post-pandemic (5 May 2023 – 5 May 2024) sampling periods in a comparative cross-sectional content analysis (N=240)

Variables	AOR	95% CI	p
Upload period (pre-pandemic/post-pandemic)	2.896	1.061–7.904	0.038
Video stance (pro-vaping/anti-vaping)	0.081	0.018–0.377	0.001
Main topic (personal experience, entertainment, or commercial content/health effects)	0.037	0.010–0.134	<0.001
Main topic (regulation, public campaigns, or public service announcements/health effects)	0.257	0.083–0.796	0.018
Uploader profile (personal users vs healthcare professionals/organizations)	0.299	0.062–1.451	0.314
Uploader profile (news/podcasts vs healthcare professionals/healthcare organizations)	0.473	0.120–1.855	0.283
Uploader profile (commercial organizations vs healthcare professionals/healthcare organizations)	0.724	0.086–6.091	0.767

AOR: adjusted odds ratio. The dependent variable was coded as 1 for videos providing useful information and 0 for videos providing inadequate or no information. The reference categories were the post-pandemic period for upload period, anti-vaping for video content stance, health effects for primary video topic, and healthcare professionals/healthcare organizations for uploader category. All variables were entered into the model simultaneously. Nagelkerke pseudo-R²=0.759. Statistical significance was set at p<0.05.

post-pandemic period (AOR=2.896; 95% CI: 1.061–7.904; p=0.038). Compared with anti-vaping videos, pro-vaping videos had 91.9% lower odds of providing useful information (AOR=0.081; 95% CI: 0.018–0.377; p=0.001). Compared with videos focusing on health effects, videos addressing regulation, campaigns, or public service announcements had 74.3% lower odds of providing useful information (AOR=0.257; 95% CI: 0.083–0.796; p=0.018). Videos focusing on personal experience, entertainment, or commercial content had 96.3% lower odds of providing useful information than videos focusing on health effects (AOR=0.037; 95% CI: 0.010–0.134; p<0.001). No independent association was observed between uploader category and the adequacy of the information provided (all p>0.05) (Table 4).

DISCUSSION

In this study, the content stance, adequacy of information provided, quality, and reliability levels of e-cigarette/vaping-related videos on YouTube were compared between the pre- and post-pandemic periods. It was shown that half of the videos analyzed contained content that provided useful information, and that the majority had an anti-vaping stance. While no significant difference was found between the periods in the distribution of video content stances, videos uploaded by personal users and

videos classified in the low JAMA category were more frequent in the post-pandemic period, whereas videos providing useful information were less frequent than in the pre-pandemic period. In multivariable analysis, upload period was independently associated with the adequacy of information provided; videos uploaded in the pre-pandemic period were more likely to provide useful information than those uploaded in the post-pandemic period. Similarly, the proportion of videos classified as low quality according to the JAMA criteria was higher in the post-pandemic period. Physical distancing measures, quarantine practices, and restrictions on social activities implemented during the pandemic have been associated with a decline in face-to-face social interactions and a greater shift of interpersonal communication and information-seeking behaviors toward digital platforms. During this period, individuals increasingly turned to social media platforms not only to maintain social relationships, but also to access up-to-date information, including health-related information, share experiences, and resolve uncertainties^{19,20}. While expanding the reach of digital health communication, these broader changes may have created a context for greater participation by personal users, alongside healthcare professionals and official institutions, in the production of health-related content. In our study, the higher proportion

of videos uploaded by personal users in the post-pandemic period, as well as the higher proportion of personal experience, entertainment, or commercial content, may be considered alongside these changes.

The higher proportion of misleading or inadequate information in the post-pandemic sample represents an important finding of the present study. The continued availability of e-cigarette products through channels such as online sales, in-store pickup, and home delivery during the pandemic may also have contributed to the expansion of the digital content ecosystem. It has been reported that among adolescents and young adults, the sourcing of e-cigarettes shifted toward alternative retail outlets and online channels, and that some vape shops continued their operations through delivery options during restrictions²¹. Furthermore, evidence that e-cigarette retailers incorporated pandemic-related themes into their online marketing suggests that social media users may have been exposed not only to health-related information, but also to product promotions, user experiences, and content encouraging e-cigarette use²². Indeed, a study evaluating smoking cessation-related YouTube videos across the pre-pandemic, pandemic, and post-pandemic periods found that video quality temporarily improved during the pandemic. The authors attributed this improvement to contributions from healthcare professionals; however, it was not sustained in the post-pandemic period²³. The lower quality indicators observed in our post-pandemic sample may be considered alongside the greater representation of individual- and user-driven content. In addition, the finding by Xie et al.²⁴ that anti-vaping videos and focusing on its health risks became more prominent in YouTube search results between 2018 and 2019, may represent a period-specific characteristic that may be relevant when interpreting the higher information adequacy observed in the pre-pandemic period of our study. Therefore, the lower information adequacy observed in the post-pandemic sample may reflect broader temporal differences in content creator profiles, the digital e-cigarette environment, platform dynamics, and user interests, rather than effects attributable specifically to the pandemic. Indeed, previous studies have also reported that YouTube content related to e-cigarettes has, for many years, been shaped

predominantly by videos focusing on product use and promotion, and that these videos largely presented information about health risks in an incomplete or unbalanced manner²⁴⁻²⁶.

However, a video having an anti-vaping stance alone does not guarantee that it provides scientifically reliable and comprehensive information. Although the information adequacy of anti-vaping videos in our study was markedly higher than that of pro-vaping videos, some videos in this group were still classified in the low-quality categories according to the JAMA criteria or GQS. Fear-based messaging, the generalization of individual case examples, or definitive health claims presented without citing scientific references may limit content quality, even when the content adopts an anti-vaping stance. Therefore, when evaluating e-cigarette videos, consideration should be given not only to whether they are pro- or anti-vaping, but also to whether the information is evidence-based, risks are presented in a balanced manner, references are cited, and conflicts of interest are transparently disclosed.

Despite the observed between-period differences in content characteristics and information adequacy, the number of views, likes, comments, and channel subscribers did not differ significantly between periods. This suggests that the observed between-period differences in the characteristics and informational value of e-cigarette-related content were not accompanied by corresponding differences in popularity or user engagement. Although no significant association between popularity and information adequacy was observed in the overall sample, videos providing useful information had a significantly higher view count specifically within the post-pandemic period, suggesting that the relationship between popularity and information adequacy may vary according to period-specific platform dynamics rather than being uniform across time. On the other hand, several studies have shown that content creators may influence video quality, with videos uploaded by physicians and healthcare organizations generally reported to be more reliable^{27,28}.

In the multivariable analysis, the main topic of the video was independently associated with the provision of useful information. Videos focusing on health effects were more likely to provide useful information

than those addressing regulation, campaigns, or public service announcements and those featuring personal experiences, entertainment, or commercial content. In contrast, uploader category was not independently associated with information adequacy in our study. These findings suggest that the informational value of e-cigarette-related videos may depend not only on the identity of the uploader but also on the topic addressed and the communicative purpose of the content. Previous studies examining other health-related topics on YouTube have generally reported greater reliability for videos uploaded by physicians and healthcare organizations²⁷⁻²⁹. This discrepancy may partly reflect differences in the health topics examined and the criteria used to evaluate video quality and usefulness, as well as the evaluation of uploader category after accounting for other video characteristics in the present multivariable analysis. Therefore, even content uploaded by a source generally regarded as reliable may have limited educational value when it lacks sufficient scientific references, balanced risk communication, or comprehensive information.

From the perspective of primary care practice, these findings highlight the importance of addressing the information patients obtain from online sources about e-cigarettes and incorporating digital health literacy into counseling. Health professionals and health organizations may contribute to more reliable digital health communication by producing accessible, evidence-based content with greater visibility on video-sharing platforms. A recent review has suggested that collaboration between health professionals or organizations and highly engaged individual content creators may represent a potential approach to reducing online misinformation³⁰.

These findings also have implications for tobacco control in digital environments. Within the sampled videos, the lower proportion of content providing useful information in the post-pandemic period, together with the higher proportions of videos classified in the low JAMA category, videos featuring personal experience, entertainment, or commercial content, and videos uploaded by personal users, may represent a challenge for tobacco control efforts that rely on video-sharing platforms to reach the public. Because uploader category was not independently

associated with the provision of useful information in the multivariable model, uploader identity alone should not be regarded as a sufficient indicator of content quality. However, this finding does not imply that uploader type is unimportant; rather, it suggests that tobacco control messages should also be evaluated according to content characteristics such as topic, stance, scientific evidence base, citation of sources, and transparency.

Limitations

This study has several limitations. YouTube is a dynamic platform, and data were collected during a single retrieval session; therefore, the study represents a snapshot of the platform and may not capture changes in search results, video availability, engagement metrics, or platform algorithms over time. The sampling strategy, in which half of the videos were selected from the most-viewed videos, may have introduced selection bias toward popularity despite the random selection of the remaining videos. The use of only the search terms ‘e-cigarette’ and ‘vaping’ may have excluded relevant videos using alternative terminology, while restricting the analysis to English-language or English-subtitled YouTube videos, limits generalizability to other languages and platforms. In addition, the pre- and post-pandemic sampling windows were separated by an approximately three-year interval. Thus, the observed between-period differences cannot be attributed specifically to the pandemic and may also reflect broader secular changes in YouTube content; the absence of an intermediate sampling period prevents these effects from being disentangled.

Although inter-rater agreement was assessed and disagreements were resolved by a third reviewer, video classification involved subjective judgment, and some risk of misclassification bias remains. The reviewers were also not blinded to uploading dates or study periods, which may have influenced assessments in subjective domains. Finally, the small number of observations in some categories may have contributed to wide confidence intervals and possible quasi-complete separation in the multivariable model. Because a penalized regression sensitivity analysis was not performed, these estimates should be interpreted with caution.

CONCLUSIONS

This study showed that a substantial proportion of e-cigarette- and vaping-related content on YouTube did not provide useful and reliable health information and that most videos were classified in the low JAMA and GQS categories. In the post-pandemic period, videos providing useful information were less frequent, whereas videos classified in the low JAMA category and those uploaded by personal users were more frequent than in the pre-pandemic period. Upload during the pre-pandemic period, an anti-vaping stance, and a focus on health effects were independently associated with the provision of useful information, whereas no statistically significant association was detected for uploader category in the multivariable model. In addition, the absence of significant associations between the numbers of views, likes, or comments and the provision of useful information in the overall sample suggests that popularity metrics alone may not reliably reflect information quality. Further studies incorporating repeated observations over time and including other social media platforms may help determine whether the differences and associations observed in the present study are consistent across different time periods and digital platforms.

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CONFLICTS OF INTEREST

The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none was reported.

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As there was no interaction with users, access to private accounts, or collection of identifiable personal health data, formal ethics committee or institutional review board approval or exemption was not sought.

DATA AVAILABILITY

The data supporting this research are available from the authors on reasonable request.

AUTHORS' CONTRIBUTIONS

SÖS: investigation, formal analysis, writing of original draft. SBA: investigation, writing of original draft. YGA: investigation, formal analysis. GZÖ: supervision. All authors: conceptualization, methodology, writing, reviewing and editing of the manuscript. All authors read and approved the final version of the manuscript.

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