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Brief Report

Engagement Analysis of Canadian Public Health and News Media Facebook Posts and Sentiment Analysis of Corresponding Comments during COVID-19

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Abstract: During the COVID-19 pandemic, key stakeholders have used social media to rapidly disseminate essential information to the public to help them make informed health-related decisions. Our research examined how the public responded to official actors' Facebook posts during COVID-19 and examined the comment sentiment and post engagement rates. CBC News and CTV News received a greater proportion of negative comments and a lower average post engagement rate compared with Healthy Canadians. Additionally, the proportion of negative and positive comments varied over time for all sources; however, over 30% of the comments for all three actors were consistently negative. Key stakeholders should monitor the public's response to their social media posts and adapt their messages to increase the effectiveness of their crisis communication efforts to encourage the adoption of protective measures.

Keywords: COVID-19; crisis communication; sentiment analysis; engagement analysis

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1. Introduction

The COVID-19 pandemic is an unprecedented crisis within a globalized and highly connected society. Communication regarding the risks and recommended behaviors associated with COVID-19 is complex, due to the uncertain nature of the disease, the rapidly evolving conditions, and the corresponding infodemic [1]. In Canada, after the number of COVID-19 infections levelled off in the summer months, they started to steadily rise again in September 2020, with an all-time high number of new daily infections (n = 7894) reported at the end of November 2020 [2]. During a time in which the spread of the virus rapidly increases, public adherence to risk-protective measures is critical to reduce the burden of disease [3–5]. Confusion and lack of clarity about changing decisions and recommendations may contribute to a lack of adherence [3], making it essential for effective risk communication strategies to influence risk perception and the adoption of recommendations.

Recent research has reiterated the importance of transparent, targeted and tailored information and communication channels, and the repetition and clarity of messages to increase understanding and adherence to COVID-19 recommendations [3,6,7]. Crisis communication guidelines state that key stakeholders must provide an accurate and timely crisis communication response at the onset, and for the duration of an emergency, sharing information to encourage the public to make informed decisions to protect their health [8,9]. Crisis communication can shape public beliefs and risk perception, and influence people to partake in risk-protective measures by promptly communicating accurate and consistent information [9–12].

Multiple communication channels are essential for effective crisis communication, and audience needs must be taken into consideration [13]. Social media is one such channel

that provides rapid and extended reach to various audiences [13,14]. Crisis communication through social media can be used to increase awareness and improve preparedness during public health emergencies [15,16], and to encourage the adoption of risk-protective behaviors [17–19]. Evaluation of crisis communication on social media channels through analytics such as engagement metrics and sentiment analysis can help key stakeholders monitor the effectiveness of their communications, and the reach of their efforts [20,21]. Facebook, the most used social media network in Canada, noted a significant increase in use during the COVID-19 pandemic [22]. Facebook is widely used by crisis actors in Canada, including public health officials, the government, politicians, and news media, and allows the public to participate in the crisis communication response [14].

The reactions of the public are essential to monitor and assess, as they give insight into the effectiveness of crisis communication [23–25]. It is possible to assess the public's response to crisis messages with a social media rhetorical arena, where multiple public actors are crisis communicators [23]. Monitoring crisis rhetorical arenas, such as Facebook pages, can indicate message acceptance and the uptake of recommendations by crisis publics [23]. Engagement metrics and sentiment analysis are tools actors can use to monitor the public's reactions to crisis messages [20,24].

Sentiment analysis is used to determine the emotional tone behind a series of words and emoticons [26], and identify how people are more likely to share and talk about the topics they experience emotions over [24]. The literature varies on how sentiment influences engagement. Some studies have found positive sentiment increases likes and comments [27], and others have found both positive and negative sentiments promote engagement [24]. During the COVID-19 pandemic thus far, sentiment analysis has been used to measure the public's response to public health messaging [28,29]. There have been mixed results, as some studies found a positive public response to these messages [28,30], whereas others noted a greater negative public response [29,31,32]. Importantly, negative comments left by other Facebook users have been shown to have persuasive effects on the views of other users [33].

Additionally, users can interact with Facebook posts by reacting to posts (including likes), commenting on posts, and sharing the post within their own social network. Engagement metrics signal active interaction with the content; shares can organically increase content views, comments indicate conversation, and reactions can indicate someone's opinion to the content [34]. Reactions and shares provide indirect social information to the public about the social media messages. Although indirect social information has not been found to influence people's judgements of the message and source, as comments have been [35,36], they have been found to impact personal attitudes [35]. People use reactions, comments, shares, etc., to evaluate information they see on social media. Exemplars or single interactions on social media can be perceived as the opinion shared by others [37]. Importantly to crisis communication, this exemplification can influence the public's perception of risks, and the effectiveness of the official response [38].

Our research describes the public's engagement and emotional response to crisis communication on Facebook by Canadian public health and news media. The objectives of this research were to:

1. Classify the engagement rate of Facebook posts over time;
2. Assess the proportion of negative sentiment on comments over time;
3. Assess how trends in the proportion of trinary sentiment (positive, neutral, or negative emotional response) of comments may affect the total number of comments per post.

This research builds upon prior research examining the quality and content of Facebook posts for guiding principles for effective crisis communication, and how this influenced the public's sentiment to the messages. The results of this research will allow crisis actors, including those of public health, to better understand the public's reaction to COVID-19 messaging in the first wave in Canada, which will help inform current and future messaging, and the evaluation of public response.

2. Materials and Methods

2.1. Data Collection

This research did not require an ethics approval, as it was a retrospective infodemiology study of publicly posted information on social media.

The advanced search function on Facebook was used to manually collect posts from Healthy Canadians, CTV News, and CBC News pages, and the corresponding comments. Healthy Canadians is the sole federal public health Facebook page and CBC and CTV News are the most subscribed to national news sources among Canadians [39]. CBC is a taxpayer funded and government run corporation that provides a variety of news channels across Canada in English, French, and eight Indigenous languages [40]. CTV News runs both national and local programming in English and is owned by Bell Media [41]. Two searches were run on each page with common COVID-19 terms/concepts at the time: COVID and coronavirus and masks and social distance. All posts made between December 2019 and June 2020 were collected from the three pages that included the key terms/concepts. Posts written in English and those relevant to the national or provincial scope were included. Comments were included if they included text and were in English. Posts shared by one of the three Facebook pages, but authored by another source, were excluded.

Researchers manually copied post text, the date of post, number of reactions, number of shares, and number of comments into an Excel [42] spreadsheet on a shared drive. An identification number was created for each post. Screenshots of each post were also captured and stored in a shared drive. Comments were also copied into an Excel spreadsheet and the corresponding post ID was used to connect the comments to the original Facebook post.

2.2. Data Analysis

Similar to Calderon et al. [43], our research team used SentiStrength (Java, version, ersion 2.3.7110.19972), a sentiment analysis software that runs an algorithm to estimate the sentiment of short and informal pieces of text [44]. SentiStrength assigns words a sentiment strength value which is positive (+1 not positive to +5 extremely positive) or negative (-1 not negative to -5 extremely negative) [45]. The most positive and most negative values in the text are then compared, and an overall trinary classification of positive, neutral, or negative is provided [45]. SentiStrength provides a machine learning approach to sentiment analysis that is more accurate than other machine-learning approaches, due to the ability to decode non-standard spelling, and booster the strength of words [44].

Pre-assigned sentiment scores for some words were modified, as they could differ for highly specific topics, such as the COVID-19 pandemic [46]. After testing the changes for increased accuracy, the modified words changed to neutral sentiment included: cancer, death, dying, emergency, ill, infect, isolate, risk, and sick. We also altered the acronym and idiom lists to reflect those that frequently appeared in the comments, such as "bs" and "shut up". Finally, the program's spelling correction list, booster word list, negating word list, emoticon list, and standard settings were used.

2.3. Statistical Analysis

The post engagement rate was calculated by adding the number of comments, reactions, and shares for each post, dividing by the total followers, and multiplying by 100 to get a percent [47]. Next, to examine the change in comment sentiment overtime, we obtained the monthly proportions of negative, neutral, and positive comments by dividing the monthly totals of the negative, neutral, and positive comments by the total number of comments analyzed for sentiment per month.

Lastly, linear regression analyses were conducted to model any potential relationship between the total number of comments, and the sentiment score of the posts for Healthy Canadians and the news media (CBC and CTV News). Posts with no comments (n = 6) were excluded, as were posts with fewer than 10 comments, as they were deemed unlikely to add information to the regression analysis. Once the sentiment scores were calculated,

the univariate linear regression analyses were conducted in R Version 4.0.3 (R Core Team, Vienna, Austria).

3. Results

A total of 438 posts and 26,774 anonymized comments related to COVID-19 were manually collected. Healthy Canadians posts accounted for 26% of the total posts and CBC and CTV accounted for 36% and 39%, respectively (Table 1). As reported in our related research, negative sentiment of comments on included posts was found to be highest for all sources [48]. The pattern of sentiment across sources was found to be statistically significant with comments on posts made by Healthy Canadians evenly distributed across positive, neutral, and negative sentiment, whereas posts made by the news media evoked approximately 50% more negative comments than positive [48].

Table 1. Total number of posts and engagement across sources.

Source	Followers * (n)	Number of Posts (n)	Comments (n)	Reactions (n)	Shares (n)	Average Post Engagement Rate (%)
Healthy Canadians	352,822	112	2211	65,111	42,229	0.3016
CBC News	2,688,920	157	11,554	113,043	123,082	0.0707
CTV News	977,636	169	13,009	99,152	147997	0.1787

* Total Followers in August 2020.

On average, the news media posted more and had the largest number of comments per post (Table 1). Healthy Canadian posts received 8% of the total comments and CBC and CTV accounted for 42% and 49% respectively. Despite this, Healthy Canadians had an average post engagement of 0.3%, which is above the average engagement rate of 0.27% across sectors on Facebook [49]. News media average post engagement fell below the benchmark.

3.1. Change in Post Engagement Rate over Time

Post engagement rate across sources varied (Figure 1), with the highest post engagement rate (6.1%) found for a post made by Healthy Canadians in March 2020. The highest post engagement rate found for a post made by CTV News was 3.3% in April 2020 and 2.5% for CBC News in March 2020.

3.2. Change in Comment Sentiment over Time

Our research team explored the change in negative comments between 1 March and 14 June 2020 for Healthy Canadians and the news media (Figure 2). This period was selected as March was the month during which the novel coronavirus outbreak was declared a pandemic and June 14th 2020 was the time at which the data collection began.

Both sources experienced a similar proportion of negative comments between March and June, with slight fluctuations. During this time, the proportion of negative comments for Healthy Canadians ranged from 29.73% to 37.43%, and for the news media they ranged from 34.39% to 37.63%. Of note is that during May, the news media received a larger proportion of negative comments (34.39%) in response to their posts compared with Healthy Canadians (29.73%). Overall, the news media typically received a greater proportion of negative comments, specifically between April and June.

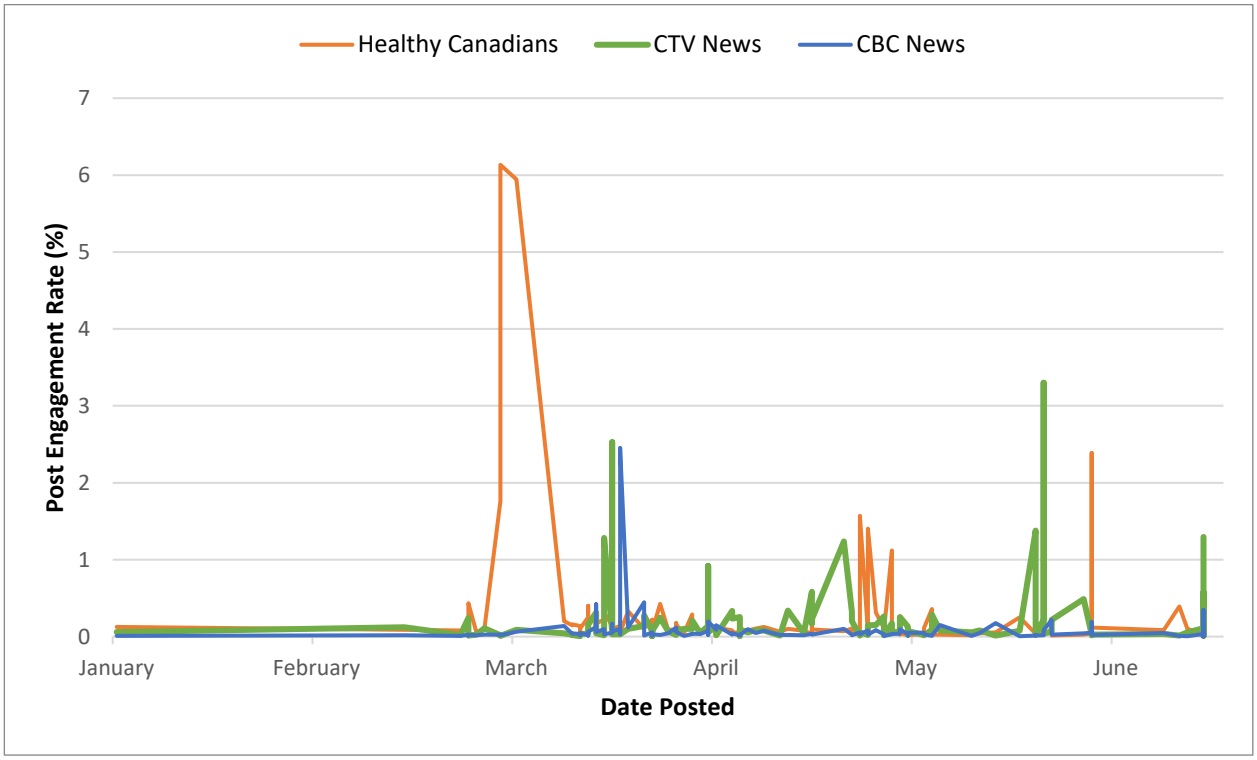

Figure 1. Engagement Rate of Facebook Posts by Source Between January 2020 and June 2020.

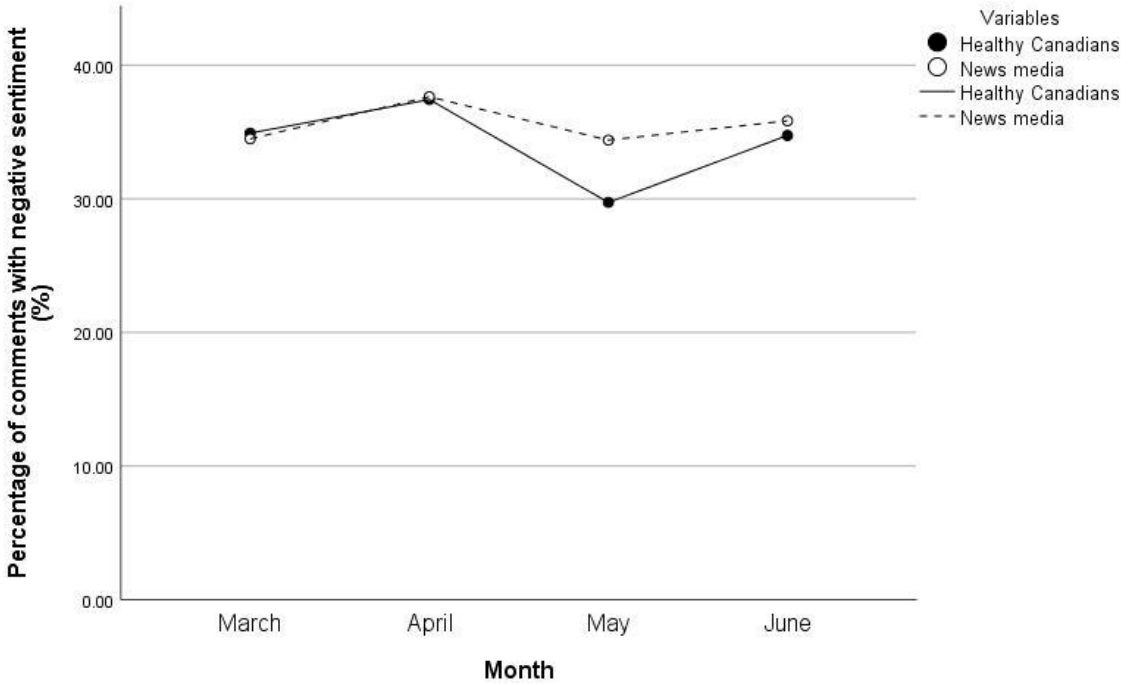

Figure 2. Change in negative comments for public health and news media over time.

3.3. Relationship between Sentiment Scores and Total Number of Comments Per Post

For both Healthy Canadians and the news media, regardless of the number of comments on a post, there was no linear relationship between the calculated sentiment score and total number of comments for each post (Healthy Canadians, B = -4.2×10^{-6}, $p = 0.958$; news media, B = 3.06×10^{-5}, $p = 0.267$), as shown in Table 2.

Table 2. Results from the univariate regression analyses for the total number of user comments per Facebook post about COVID-19 predicting the sentiment score for Healthy Canadians and the news media.

Healthy Canadians				
	B	B (95% CI)	SE(B)	*p* Value
(Intercept)	1.97	(1.91, 2.03)	0.03	<0.001
Number of comments	-4.2×10^{-6}	$(-1.7 \times 10^{-4}, 1.6 \times 10^{-4})$	8.04×10^{-5}	0.958
News media				
	B	B 95% (95% CI)	SE(B)	*p* Value
(Intercept)	1.85	(1.82, 1.87)	0.014	<0.001
Number of comments	3.06×10^{-5}	$(-2.35 \times 10^{-5}, 8.47 \times 10^{-5})$	2.75×10^{5}	0.267

Note. B represents regression weights. CI represents confidence interval. SE(B) represents the standard error.

4. Discussion

Overall, the news media received a greater proportion of negative comments and lower post engagement compared with Healthy Canadians, although negative sentiment was highest for all sources. Although Healthy Canadians posts accounted for approximately 1/4 of the posts, they received only 8% of the total comments. There was no linear relationship between the calculated sentiment score and total number of comments for each post (Healthy Canadians, B = -4.2×10^{6}, $p = 0.958$; news media, B = 3.06×10^{5}, $p = 0.267$), as shown in Table 2.

4.1. Monitor and Increase Social Media Engagement

Our research found that Healthy Canadians had a slightly higher than average post engagement rate, whereas news media was below this average. The engagement rate takes into account the number of interactions and followers to understand how many people are connecting with the information. A past study found increased likes on a Facebook post resulted in more positive attitudes towards the flu vaccination [35]. Reactions, including likes, can increase how much attention the public pays to the post [35], making it important to understand and incorporate aspects of messaging that increase likes within key actor's followers. A study on the platform Sina Weibo in China during COVID-19 found that social media functions, such as mentions and hashtags, as well as responding to comments, can positively influence sentiment [24]. Additionally, shares organically spread posts throughout follower networks [34] and, similar to reactions, actors should assess what makes their posts go viral and aim to include those features. The use of guiding principles for effective crisis communication should be used to increase message acceptance and uptake [48]. Additionally, hashtags, media features such as images and videos, mentions, and replies to comments have been shown to increase engagement [24,25].

4.2. Monitor the Sentiment of Comments on Social Media to Correct for Exemplars

The large proportion of negative comments observed for all sources was concerning when related to the exemplification theory. The public may interpret the high number of negative comments to represent the opinions held by the majority, negatively impacting their judgements of both the information and the source [37]. This difference in the proportion of negative versus positive comments may be explained, in part, by the public's trust in the source itself. Previous research found that although the media is often the first source of information for many during a public health emergency [50], studies with representative samples of the general public in countries in North America, Oceania, and Europe find them untrustworthy [51–54]. Therefore, due to distrust of the source, the public may be more likely to respond negatively to messages shared by the media. Nonetheless, the public may also judge the trustworthiness of a source's crisis communication by analyzing its content for timeliness and honesty [55]. Although research has also shown that the public places greater trust in public health during infectious disease outbreaks and

pandemics [50,52,55–58], the public may still perceive their messaging to be of poor quality due to lack of timeliness, clarity, consistency, and transparency [3,6], leading to a more negative response. Furthermore, a recent study examining COVID-12 vaccine hesitancy found that distrust in government and public health is related to hesitancy [59]. The study found that messaging that is targeted and tailored to the specific concerns of this group can increase message acceptance and influence hesitancy [59].

No relationship was observed between the aggregate sentiment and total number of comments for each post. Public health and the news media should monitor the comments on their social media posts, assessing their sentiment to gauge how people are reacting to the content due to the possible impact they have on others' perceptions of the information and source. Social media monitoring is used by public health to detect disease outbreaks, analyze disease trends, and conduct social listening where opinions and reactions to official communications are monitored [60]. Social media management platforms, such as Hootsuite [61] or Sprout Social [62], allow communicators to automatically monitor engagement, mentions, and comments, and respond within the management tool [15]. There is no one way to monitor and analyze data for public health social media monitoring. Public health agencies should clearly define the purpose for monitoring and how the data will be used [60] and use automated monitoring and management to analyze public perceptions and needs during various stages of a pandemic [24].

Additionally, the use of guiding principles for effective crisis communication to maintain trust can increase positive sentiment and should be consistently applied [48].

4.3. Pay Close Attention to Sentiment When Key Crisis Events Occur

A change in comment sentiment was observed across time for Healthy Canadians and the news media. Between March and June, both sources experienced fluctuations in the proportion of negative comments. This may have been impacted by the key outbreak events and public health measures that took place during this time. The uncertainty that may have arisen from the unfamiliarity of events and measures, along with inconsistent messaging concerning earlier recommendations, may have evoked fear and anxiety amongst the public [63], contributing to the large proportion of negative comments. A study on Facebook posts in Macao found that focusing on different types of messaging during the various stages of a pandemic is important for maintaining engagement [25]. In the acute phase, messages that focus on efficacy and rumor control result in higher positive engagement, whereas during the chronic phases, support and resources result in higher positive engagement [25].

5. Limitations

Facebook's algorithm also impacts the reach of posts based on ranking signals based on "users' past behaviors" [64]. Moreover, individuals who comment on the social media posts may tend to exaggerate their responses, as crises impact how people understand and process information [63,65].

Additionally, the largest proportions of Facebook users in Canada in 2020 are between 25 and 34 (25.9%) and 35 and 44 years of age (19.2%) [66]. Consequently, the results should be generalized cautiously, and other social media platforms should be explored.

SentiStrength is unable to detect sarcasm and irony, commonly seen among the comments, causing an increase in positive ratings [44].

6. Conclusions

News media received a greater proportion of comments with negative sentiment and had a lower overall average post engagement compared with public health. Public health had an above average engagement post rate, meaning their posts were liked, commented on, and shared more than news media. Although the comments' overall sentiment did not impact the total number of comments per post, the influence that negative comments can have on the opinions and behaviors of others is of importance. Public health and the news

media should monitor the public's comments and engagement via social media, directly address negative comments, and employ best practices for effective crisis communication to ensure that the public accepts crisis messages and ultimately adopts recommended risk-protective measures. Future research of a similar nature should aim to include a larger sample size, and include other social media platforms. In addition, future research should include participants, to better understand perceptions regarding official actor crisis communications, and what increases positive engagement.

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