



## Hesitancy towards COVID-19 vaccines on social media in Canada

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### ABSTRACT

To effectively end the pandemic, the acceptance of effective vaccines against COVID-19 is critical. Comments posted in online platforms act as a barometer for understanding public concerns regarding vaccination and can be used to inform communication strategies for the 'moveable middle'. The aim of this exploratory study was to identify online dialogue regarding the nature of vaccine hesitancy related to COVID-19 vaccine(s). We analyzed user comment threads in response to news reports regarding COVID-19 vaccines on the Canadian Broadcasting Corporation national news website (with as many as 9.4 million unique visitors per day). User comments ( $n = 1145$ ) were extracted from 19 articles between March 2020 and June 15th, 2020. Comments were then coded inductively for content to establish a coding framework that was subsequently applied to the dataset. Our data provide empirical support for misrepresentation as a form of misinformation and further demonstrate the utility of social media content as data for social research that informs public health communication materials. The data point to the need for, and value of, rapid communication interventions to foster vaccine acceptance. False information will continue to create challenges for delivering COVID-19 vaccines. Communication strategies to get ahead of the pace of misinformation are critical, particularly in light of boosters and the possibility of COVID-19 vaccination on an annual basis.

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## 1. Introduction

Effective vaccines against COVID-19 are key to ending the pandemic. However, to be successful, vaccination campaigns against COVID-19 need to be well accepted by the population. There are growing concerns by public health officials regarding the role of social media as contributing to the growth of anti-vaccination content and consequently, vaccine denial [1]. The present study, conducted in 2020, was designed to identify common concerns expressed by individuals regarding COVID-19 vaccination on social media. The landscape has changed considerably since the design of this work and to date (March 2022), ~80% of the Canadian population is fully vaccinated, with nearly 90% of 12+ being fully vaccinated [2]. Despite the success of vaccination campaigns, there remains hesitancy among the population, as some Canadians continue to deny vaccination, or accept vaccines only because of mandates. The present study highlights some of the challenges we will continue to face in the promotion of COVID-19 vaccines and misin-

formation that will need to be countered. Further, the data speak to the role that social media may play in fostering vaccine acceptance, which will be critical as we move forward in the use of boosters, annual vaccination and child vaccination.

## 2. Background

Vaccine hesitant individuals have been described as having specific attitudes and beliefs that are not extremely for or against vaccinations but rather, fall on a spectrum of acceptance [3,4]. When investigating hesitancy, the focus of public health efforts is typically the 'movable middle' – that is, not individuals who directly oppose vaccination and are unlikely to change their beliefs and behaviours but rather, the individuals who may accept vaccination through various communication strategies [5]. The knowledge, attitudes and beliefs of the movable middle are influenced through a variety of sources of information, such as social media, medical doctors, educational campaigns, or complementary and alternative medicine practices [6]. Because these influences can move individuals towards greater hesitancy – the vaccine refusal end of the spectrum – it is critical that public health identify the information that may be raising concern in these populations

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and develop communication materials to counter information that works in opposition to public health initiatives.

To date literature suggests that concerns regarding COVID-19 vaccination include mistrust in government, fears relating to rapid vaccine development, fears relating to unknown side effects, and feelings that the vaccine(s) are not necessary [7–10]. Social media use has been found to be associated with COVID-19 vaccine hesitancy, and specifically exposure to anti-vaccine messaging [1,11,12]. The literature also identifies conspiracy theories, which stem from general mistrust in the healthcare system and government more broadly, as a reason for vaccine hesitancy which typically spread through social media [7,11]. This widespread misinformation seen throughout various social media websites has been identified as contributing to the ‘infodemic’ which might impede the success of COVID-19 vaccination campaigns [13]. Most authors call for increased health literacy among the general public, as well as heightened efforts from public health to police and disprove misinformation on social media platforms [14].

Social media provides a space for members of the general public to create and share information at a rapid pace [15]. However, the capability to quickly share information with little consequence can perpetuate misinformation [1]. Indeed, social media has become known as an effective method for spreading anti-vaccination or vaccine hesitant views [16]. While very polarized online discussions often live in ‘echo chambers’ – forums where users typically engage with others who share the same extreme views [1] – anti- or vaccine-hesitant sentiment is also pervasive in mainstream open online communities. Online platforms such as Facebook and Twitter, and news source websites allowing user comments, provide platforms for the spread of mis- and dis-information [16] – the former referring to information that is false or misleading and the latter defined as false information that is purposely spread to deceive people [17]. Indeed data has shown that exposure to disinformation can have a detrimental impact on vaccine acceptance [18] and social media provides a platform for information dissemination.

The aim of this research was to identify the nature of hesitancy towards COVID-19 vaccines in an online platform in Canada. By identifying concerns expressed by individuals in these online forums, we contribute to the public health communities’ understanding of the ongoing challenges to be faced in the promotion of COVID-19 vaccines and misinformation that may need to be countered for the ~11% of the population aged 12+ who remain unvaccinated [2]. Our data also address concerns that might negatively impact future acceptance of booster doses, annual COVID-19 vaccination and more broadly, other routinely recommended vaccines. Indeed, tailored communication strategies that address disinformation around vaccines are more needed than ever to ensure vaccine acceptance.

### 3. Methods

A systematic search of news reports available on the CBC national news website was conducted. CBC was chosen because the articles and comment threads are freely available (no subscription required) and published digitally (accessible to many). The CBC is also Canada’s largest national public broadcaster, with as many as 9.4 million unique visitors per day [19]. For inclusion in this project, articles had to contain ‘COVID-19 vaccine’ or ‘coronavirus vaccine’ in the title and allow users to provide written comments. News articles were included if they were a text-based news report, published between March 1st 2020 to June 15th, 2020 and reported on COVID-19 vaccines. This time period was selected because user comment engagement increased in mid-March 2020 (from 4 articles combined in Jan/Feb to 12 articles in March)

and continued to stay elevated until the end of the collection period.

Following the identification of relevant news articles, comments were manually scraped using cut and paste functions and screened for relevance to the research aim, as previous research has suggested that news article content is not always predictive of user dialogue [20]. Data that were not relevant were removed prior to commencing coding. CBC Terms of Use indicate that individuals must register an account with accurate information to post but this information is not available outside of the CBCs internal system. As such we were unable to conduct analyses of demographic and user characteristics.

Given our awareness of bots and trolls in online vaccine debates [21] BR made efforts to detect the presence of suspicious activity; for example, by noting multiple posts of the same content by a single user. We were unable to identify whether this is indeed bot participation. However, instances of suspicious activity observed by the authors were rare and in cases they were observed, comments were excluded from analysis.

Comments were entered into an excel file alongside the article title and date posted. Comments that were original posts were kept separate to threaded comments (responses to original posts) by using a separate column in the excel document. The document was imported into the NVivo software for coding and analysis.

Two independent reviewers (BR and SBM) coded 100 user comments inductively for content to establish a coding framework. BR then applied the framework created by the inductive codification to the entire dataset and refined it in consultation with SBM until consensus was reached. BR then coded the data for a second time using the framework which was iteratively refined through the emergence of inductive codes during the analysis and formal reviews of data with author SBM. The framework was guided by our collective knowledge of the wider literature on vaccine hesitancy and experience with the analysis of data in online communities.

### 4. Ethics

The data collected were publicly available user comments, on publicly available news reports, which are themselves posted on a publicly available website with uncontrolled access. With this information in hand, we consulted with Research Ethics at the University of Waterloo, it was determined that ethics approval was not required.

### 5. Results

Of the 41 articles identified, less than half of the articles ( $n = 19$ ) were open to user comments. As other researchers have identified [20], we were unable to determine why certain titles were open to user comments while others were not. Out of the 19 articles that allowed for comments, seven articles contained less than 10 comments and were not included in the present analysis. The remaining 12 articles ranged from 30 to 3025 comments. If articles contained greater than 750 comments ( $n = 2$ ), we extracted the first 750 as a sample of content due to the limitations of human coding as opposed to the use of machine learning, a conscious decision in the research design. As noted, following extraction, comments were screened for their relevance to the research objective and omitted if found to be outside of our scope (i.e., unrelated to COVID-19 vaccination). Table 1 provides article information. In total we yielded a sample of 1145 comments which was considered sufficient by the data analysts for the purpose of meeting our primary aim of identifying online dialogue related to COVID-19 vaccines.

**Table 1**  
Article information and number of comments at the time of data collection.

Article	Date Published	Link to source	Number of comments at the time of data collection
Trudeau to join global COVID-19 vaccine fundraiser amid calls for fair access	June 3rd, 2020	<a href="https://www.cbc.ca/news/politics/trudeau-joins-global-vaccine-fundraiser-1.5597328">https://www.cbc.ca/news/politics/trudeau-joins-global-vaccine-fundraiser-1.5597328</a>	29
Trudeau urges shared COVID-19 vaccine at global summit in a week amid UN run	June 4th, 2020	<a href="https://www.cbc.ca/news/politics/trudeau-pandemic-summit-1.5597979">https://www.cbc.ca/news/politics/trudeau-pandemic-summit-1.5597979</a>	541
Potential COVID-19 vaccine shows promising early results	May 22nd, 2020	<a href="https://www.cbc.ca/news/health/covid-19-vaccine-test-canadians-1.5581494">https://www.cbc.ca/news/health/covid-19-vaccine-test-canadians-1.5581494</a>	332
Potential COVID-19 vaccine clears 'major milestone': Sask. Researchers	May 25th, 2020	<a href="https://www.cbc.ca/news/canada/saskatoon/potential-covid-19-vaccine-clears-major-milestone-1.5583741">https://www.cbc.ca/news/canada/saskatoon/potential-covid-19-vaccine-clears-major-milestone-1.5583741</a>	30
U.S. narrows down candidates in major push for COVID-19 vaccine	May 15th, 2020	<a href="https://www.cbc.ca/news/world/us-azar-vaccine-global-supply-1.5571264">https://www.cbc.ca/news/world/us-azar-vaccine-global-supply-1.5571264</a>	1757
'A race against the disease': Canadian researchers part of global effort to develop COVID-19 vaccine	April 27th, 2020	<a href="https://www.cbc.ca/news/health/covid-19-vaccine-development-research-1.5535041">https://www.cbc.ca/news/health/covid-19-vaccine-development-research-1.5535041</a>	212
Could a vaccine wipe out COVID-19 or will protection be short-term? That's the 'million dollar question'	May 10th, 2020	<a href="https://www.cbc.ca/news/canada/toronto/could-a-vaccine-wipe-out-covid-19-or-will-protection-be-short-term-that-s-the-million-dollar-question-1.5558764">https://www.cbc.ca/news/canada/toronto/could-a-vaccine-wipe-out-covid-19-or-will-protection-be-short-term-that-s-the-million-dollar-question-1.5558764</a>	407
Long before COVID-19 vaccine is available, B. C. begins planning for rollout	April 21st, 2020	<a href="https://www.cbc.ca/news/canada/british-columbia/long-before-covid-19-vaccine-is-available-b-c-begins-planning-for-rollout-1.5540503">https://www.cbc.ca/news/canada/british-columbia/long-before-covid-19-vaccine-is-available-b-c-begins-planning-for-rollout-1.5540503</a>	36
Trudeau urges world leaders to pull together as U.S. steers clear of COVID-19 vaccine pledging conference	May 4th, 2020	<a href="https://www.cbc.ca/news/politics/global-vaccine-pledge-trudeau-1.5554278">https://www.cbc.ca/news/politics/global-vaccine-pledge-trudeau-1.5554278</a>	3025
About 20% of people in a recent survey said they wouldn't take COVID-19 vaccine	April 22nd, 2020	<a href="https://www.cbc.ca/news/canada/saskatchewan/covid-survey-first-round-results-1.5541053">https://www.cbc.ca/news/canada/saskatchewan/covid-survey-first-round-results-1.5541053</a>	57
COVID-19 vaccine test begins as volunteer patient administered 1st shot	March 16th, 2020	<a href="https://www.cbc.ca/news/health/coronavirus-vaccine-1.5499244">https://www.cbc.ca/news/health/coronavirus-vaccine-1.5499244</a>	228
China OK's human trials of potential COVID-19 vaccine	March 17th, 2020	<a href="https://www.cbc.ca/news/health/china-covid-19-vaccination-1.5500202">https://www.cbc.ca/news/health/china-covid-19-vaccination-1.5500202</a>	280

Primary concerns related to COVID-19 vaccines were mainly focused on safety and efficacy as well as government decisions regarding vaccine procurement. Notable too was the extent of misinformation and misrepresentation in user comments.

### 5.1. Concerns of vaccine safety and effectiveness

Commenters indicated their uncertainty with regards to vaccine acceptance due to safety concerns, personal beliefs about vaccination more broadly, or in reference to the country of origin of a COVID vaccine. Several individuals indicated they would outright refuse a vaccine if it came from China.

*"As soon as the Americans have a vaccine I'm heading south even if I have to pay for it myself. I will NOT take the NRC/Chinese vaccine tested in China even if its free."* ("U.S. narrows down candidates in major push for COVID-19 vaccine", May 15th, 2020).

*"Honestly, I'd be more inclined to ask my family doctor for a serological test looking for Covid antibodies, before I'd putting ANYTHING in my body that was made, produced, crafted or designed in China."* ("Potential COVID-19 vaccine shows promising early results", May 22nd, 2020).

For some, concerns related to a vaccine out of China were related to concerns about vaccine testing; individuals were concerned that a Chinese vaccine would not go through proper safety trials. Although, there were many cases where no rationale was provided for why a Chinese vaccine would not be accepted. Comments of this nature were not always posted in response to articles relating to vaccine development in China, suggesting that article content was not a prompt for these concerns.

As noted in the below example, concerns about vaccine safety were fueled by broader concerns of political ideology:

*"That's why I don't want the Chinese Communist version. There is no way to hold the Chinese communists to account. No one will even*

*know if there's a problem. If the Americans get something wrong it will be discovered and I can always join a class action suit."* ("U.S. narrows down candidates in major push for COVID-19 vaccine", May 15th, 2020).

Vaccine refusal was most notable in discussions regarding the vaccine being rushed or unsafe, though it is unclear what information individual users are relying on to evaluate 'safety'.

*"We must not accept a vaccine developed in under a year. This is insanity to believe we need mass (even some calling for 'mandatory'/ forced) vaccination for this."* ("Potential COVID-19 vaccine shows promising early results", May 22nd, 2020).

*"Who the heck would want a rushed RNA-altering vaccine that obviously will not have gone through proper safety trials? And if they try to force it in Canada, there WILL be lawsuits."* ("U.S. narrows down candidates in major push for COVID-19 vaccine", May 15th, 2020).

Refusal was also associated with concerns about vaccine side effects and the severity of reactions, in contrast to perceptions of severity associated with contracting the virus.

*"The most common side effects – described as "mild" and "moderate" – were pain at the injection site, fever, fatigue and headache." Sounds like covid 19 infection for the majority of cases. Maybe we should just spare the expense on the middleman and open back up."* ("Potential COVID-19 vaccine shows promising early results", May 22nd, 2020).

*"ok let's stick a dead virus in my body so that I can possibly have the same effects as the actual flu that we've spent billions on trying to distance everyone from. I'll get mine from the herd, that millions probably already have had anyway, while more money is spent helping all those who now have respiratory problems because they wear their masks to long....."* ("Potential COVID-19 vaccine shows promising early results", May 22nd, 2020).

*“Healthy people don’t need to be immunized for bat coronavirus, cultured on animal cells.” (“Could a vaccine wipe out COVID-19 or will protection be short-term? That’s the ‘million dollar question”, May 10th, 2020).*

*“This is insane. Wake up everyone please don’t fall for this propaganda about life returning to normal unless there’s a vaccine. Artificial immunizations are not as effective as your own body naturally fighting off the virus. If you are healthy please to not buy into this fear peddling by the authorities puppet experts.” (“Potential COVID-19 vaccine shows promising early results”, May 22nd, 2020).*

The above quotes illustrate a preference for listening to one’s body or waiting for protection through herd immunity. Quotes also referred to refusal in relation to forced vaccination. Commenters were also concerned about the time (or lack of time) taken to develop a vaccine (possibly also suggesting concerns about safety or efficacy) and questioned calls for mass vaccination, particularly if mandated.

### 5.2. Criticisms of government

Data also speak broadly about concerns over government spending on a vaccine. These individuals were concerned about the costs incurred by government, funded by taxpayer dollars:

*“and how much will this cost or cost our healthcare system we pay for in part through taxes?...” (“Potential COVID-19 vaccine shows promising early results”, May 22nd, 2020)*

*“And who’s going to mass produce the vaccine for free? Nobody, that’s who. Pharmaceutical companies spend a lot on equipment and training to produce vaccines and other drugs. They have a right to make their money back.. By the way, many vaccines are covered by provincial drug plans, and COVID-19 will likely be one of them since it affects so many people...”. (“Potential COVID-19 vaccine clears ‘major milestone’: Sask. Researchers”, May 25th, 2020).*

Indeed, concern over government spending was central in participant responses. In reference to an article stating that “Prime Minister Justin Trudeau says a COVID-19 vaccine must be shared by the world in order to eradicate the disease” users specifically questioned the Prime Minister’s spending on a vaccine: *“And how many hundreds of millions is he going to borrow and donate for this one?”*. Related, users shared concerns about whether this investment would pay off:

*“So of all the billions Canada flung out the door at various national lab companies to find a vaccine, this privately funded lab looks to be the most promising one? Can we claw back any of that money?”*

Individuals suggested that alternative remedies would be more cost-effective than a vaccine,

*“Here’s an immune system supplement stack that will get you through this: Vitamin C, Vitamin D, Zinc, Niacin. Cheap. Exercise. what promising is the billions its going to cost us for an ineffective vaccine. the former suggestions are a better choice.” (“Potential COVID-19 vaccine shows promising early results”, May 22nd, 2020).*

Users also questioned the Canadian government’s financial interests being served over the wellbeing of the population. In response to article content “We’ll likely be producing the vaccine on Canadian soil so it gives us security of supply” a commenter responded *“Really. We come up with a vaccine no doubt Donnie’s [Donald Trump] boys with suitcases full of cash will appear at the manufacturing plant. Sorry ROC but we cannot locate your vaccines.”* Lastly, individuals suggested that the development of a successful vaccine meant immense profits for that individual/company.

Across the data, comments illustrate the financial interest accompanying vaccine development: *“Who ever makes it first hits the jackpot”*.

Skepticism about the integrity of pharmaceutical companies and/or of government in some cases was also noted.

*“If even a single federal dollar went to support this, the patents should be held by a crown corporation in the public trust. There is no way this should be handed over to a pharma so it can be sold back to us at \$100 a shot. And if necessary, build a manufacturing plant in Canada. Maybe we’d actually start to see some diversification instead of watching tax dollars circle the drain.” (“Potential COVID-19 vaccine clears ‘major milestone’: Sask. Researchers”, May 25th, 2020).*

### 5.3. Sources of information used to support posts

To provide support for their statements, many commenters drew on government sources in the form of quotes, statistics, and general information, particularly government research or progress with the virus. Commenters using government sources of information often did so in support of vaccination. The commenter below, for example, unpacked the article content, summarizing key points in support of COVID-19 vaccination in Canada.

*“This intricately masterful! “Dr. Joanne Langley of the Canadian Center for Vaccinology in Halifax said CanSino’s partnership with the National Research Council of Canada puts a spotlight on home-grown scientific expertise, and should guarantee a Canadian supply if the potential vaccine proves viable.” “We’ll likely be producing the vaccine on Canadian soil so it gives us security of supply,” she said.1. Cooperation between China (CanSino) and Halifax (National Research Council of Canada).2. HOMEGROWN = Canada’s = A Canadian supply.3. There’s work still to be done, but I am enjoying the China/Canadian cooperation.4. No American involvement, seems USA may have to purchase from us.” (“Potential COVID-19 vaccine shows promising early results”, May 22nd, 2020).*

Commenters also referenced information received from health sources outside of government, particularly in relation to the current state of the virus and vaccine development. Sources included Canadian newspapers, the World Health Organization and the Centre for Disease Control (CDC). They drew on sources to both state their opinion, but also to counter the arguments put forward by other posters. For example, in response to an original post linking vaccines with narcolepsy, a commenter posted:

*“A major study in 2014 by the CDC found no relationship between the h1n1 vaccine and narcolepsy, in contradiction to early Finnish findings. No study found ‘brain damage’ as you put it. Stop sensationalising and fact check your information from reputable sources.” (“Potential COVID-19 vaccine shows promising early results”, May 22nd, 2020).*

Notably but not surprisingly, sources we identify as credible information – i.e., consistent with public health messaging – were most often found in commenters who supported a potential vaccine.

### 5.4. Concern and misinterpretation

Dialogue also spoke largely to a lack of understanding of vaccines and particularly RNA vaccines.

*“This is very concerning. How do they know it’s safe when they are pushing it out the door in record time? There has never been a safe viral RNA vaccine. SARS vaccine was scrapped because it was*

unsafe. Too many questions unanswered and I'm not seeing great investigative journalism reporting on this." ("Potential COVID-19 vaccine shows promising early results", May 22nd, 2020).

In this case, the statement that the SARS vaccine was 'scrapped because it was unsafe' is incorrect; rather, until COVID-19, a vaccine for SARS-COV was not yet developed [22]. In other cases, comments included misinformation, though with a tone that suggests their intention is not to dissuade individuals from getting a vaccine. Rather, they are drawing on misinformation they may have heard when sharing their own hesitations. For example:

"Good. . . .it joins 100+ other potential COVID vaccines that are in some trial stage. The downside is that once a vaccine is found it could take 5+ years to manufacture enough to vaccinate 20% of world's population." ("Potential COVID-19 vaccine shows promising early results", May 22nd, 2020).

"there are six stages of vaccine development: exploratory, pre-clinical, clinical development, regulatory review and approval, manufacturing and quality control. The clinic phase has three stages all by itself. My worry is they fast track the vaccine without proper vetting, like they did with the Abbott test. The latter apparently missed almost 50% of infections it tested for. If the vaccine is similar, it could be catastrophic. And that's just the efficacy, what about complications or adverse side effects? Rushing to get out the vaccine could not only not protect people, but it could put their life in even more jeopardy." ("U.S. narrows down candidates in major push for COVID-19 vaccine", May 15th, 2020).

We also identified misinformation through data misrepresentation, particularly in comments from individuals making claims unsupported by public health. The code misrepresentation, rather than misinformation, was most often used in relation to comments that made false or misleading statements about accurate information or in misreporting information. Specifically, commenters made posts that were technically correct, but were observed as having an agenda by analysts in the way they were framed.

"“access to an eventual vaccine for the deadly coronavirus [article content]”. There has never been a successful vaccine for any type of coronavirus. The SARS vaccine made it to human trials and those results were very poor making the test subjects more susceptible to the virus. The trials ended as SARS went away. For some reason Bill Gates thinks there will be a vaccine for the entire population. Whatever. Expose Bill Gates day is June 13th." ("Trudeau urges shared COVID-19 vaccine at global summit in a week amid UN run", June 4th, 2020).

In this comment, the individual is technically correct, in that there has never been a human coronavirus vaccine brought to the market. However, this was not due to "test subjects more susceptible to the virus" but rather, there was no longer the monetary investment from development companies [23,24]. Many commenters seemed to misunderstand the information they were sharing, leading to statements that could perpetuate additional misunderstandings that are detrimental to public health efforts. Some other examples of misrepresentation:

"Take look at the top photo from this: <https://www.cbc.ca/news/health/coronavirus-vaccine-1.5499244> If the volunteer is not sick, and the vaccine does not contain the virus (as per text), why the pharmacist injecting the vaccine wears mask and goggles? What is he afraid of?" ("China OK's human trials of potential COVID-19 vaccine", March 17th, 2020).

"I like how all the "experts" keep saying there will not be a vaccine for a year to 18 months. They have been doing that for nearly 4 months now. Perhaps it is time they revise their message to saying there won't be a vaccine for 8 to 14 months? Or have we made

zero progress in developing a vaccine?" ("Could a vaccine wipe out COVID-19 or will protection be short-term? That's the 'million dollar question'", May 10th, 2020).

These individuals may not understand that numbers reported by the public health experts are usually estimates, as there is no way to know exactly if or when a successful vaccination will be developed. In addition, safety protocols are used when conducting clinical trials, which could explain why a researcher may wear a mask and gloves. However, this commenter is insinuating the protective gear may be indicative of a vaccine being unsafe.

## 6. Discussion

Our analyses complement existing literature, providing insight into public concerns and the role that social media may play in the diffusion of misinformation to both users and observers [25]. While at the time of data collection it was suggested that vaccine opponents were already getting prepared to fight against COVID-19 vaccination [18], we found that users were less vocal in the sense of typical anti-vaxx sentiment. This may suggest that the majority of commenters were reading and engaging out of interest rather than with an agenda to garner support for or against vaccination.

The data suggest dissatisfaction with the Canadian government's decision-making regarding spending, concerns for the origin of vaccines and mandatory vaccination. User concerns also related to the procurement of COVID-19 vaccines, with comments suggesting acceptance might be informed by the provision of more information regarding vaccine safety and efficacy. This latter finding is consistent with previous studies suggesting that new vaccines generate more vaccine hesitancy and that safety concerns are one of the main reasons for being reluctant to vaccinate [26–28]. The user dialogue – suggesting a need for more information rather than holding a position on vaccination – is likely related to the time of data collection whereby there was so much uncertainty regarding the then pending vaccines. Commenters could only speculate about effectiveness and safety. Conversations in such forums have likely evolved beyond procurement to align with the current knowledge base regarding authorized vaccines. Nonetheless, the analysis points to the need for and value of rapid communication interventions to foster vaccine acceptance.

Novel in our findings are empirical data supporting misrepresentation as distinct from misinformation, where misinformation is a statement that is false or misleading, and misrepresentation a statement that is false or misleading because information from varying sources is presented incorrectly. We noted this in the case where users seemed to misunderstand the information they were sharing – for example, regarding RNA vaccines or the interpretation of public health data. It has been suggested that because of the complexity of science, laypeople find scientific studies difficult to understand. As such, the communication of science is often simplified. However, oversimplifying may inadvertently lead to misunderstanding on the part of the public [29]. Indeed, there has been criticism regarding public health messaging, and the role this plays in a lack of public understanding throughout the pandemic [30]. Alternatively, misrepresentation may be a new tactic whereby individuals misconstrue accurate information to meet their personal agenda regarding vaccination. However, it is not clear from the data if this information is intentionally misrepresented. Regardless, the misrepresentation of information – intentionally or otherwise – has the potential to raise real concerns, particularly in individuals representing the movable middle.

Our data also speak to the usefulness of social media content as data for social research and to inform public health communication

materials. Context is extremely important when reviewing these data, as many of the responses can only be understood once the original comment is also analyzed. Generally, there were very few threads to suggest engagement in discussion; rather, original comments typically had either one or no replies. In cases where there was more than one reply, replies were mostly disconnected. This finding is inconsistent with previous research investigating vaccination discussions in online forums reporting engagement between opposing sides of the vaccine debate [20,31]. As noted, this may be due to the lack of information relating to a potential COVID-19 vaccine at the time of posting. There were little to no grounds for informed statements from acceptors, leading to a forum of shared opinions and uncertainties rather than debates. Any dialogue that did occur tended toward correcting misinformation and requesting sources from individuals from the opposition rather than outright discussions. The ability to document these interactions, or lack thereof, is a strength of human (as opposed to machine) analysis. While the use of artificial intelligence is becoming more commonplace in the analysis of online data [1–32], manual collection and human analysis permit analyses of dialogue, allowing us to contextualize comments.

## 7. Limitations and mitigations

Data collected from online communities only captures perspective of individuals engaging in discussions. We are unable to identify how the information presented changes, if at all, the attitudes and beliefs of both active participants and passive ‘observers’ [32]. As such, the aim here is not to determine how this information affects vaccine intention but rather, to identify the information circulating on one of many sources that come to form vaccine attitudes. In addition, data were collected from only CBC News articles. Thus, data reflect the opinions of consumers of CBC News only. Our analysis would be more nuanced if we were able to identify user characteristics and speak more specifically to the findings as they reflect specific segments of the population.

Although not a limitation, we are mindful that ‘social media’ are not uniform and different platforms will draw different users, as well as different types of use – that is, a user may behave one way on Twitter and another when commenting on CBC. As such, replication of the present study on other platforms that allow for user comments and interactions will likely yield different findings. We also removed data that were suspicious or indicative of bots or trolls so that we might reflect user comments only. These might in future be treated as data, particularly if incidents are frequent, given that they do constitute content that are intended to shape knowledge and attitudes and thus are a critical piece of the puzzle in terms of understanding how social media participates in shaping vaccine intention.

## 8. Conclusion

At this point in time, in March 2022, vaccinations have been made widely available in Canada, yet false information continues to circulate about the vaccines. As such, there are many challenges when delivering COVID-19 vaccines that are reflected in our data. We demonstrate how communication strategies need to combat misrepresentation, as it appears it does not use the same mechanism as misinformation. Ultimately, it is important that any messaging put forth by the government or public health is clear for the population to combat misunderstanding and misrepresentation. Now that just under 80% of Canada’s population is fully vaccinated [2], these data might be useful in developing communication strategies to target late adopters or refusers and build resilience against vaccine misinformation in general. For

example, communication strategies may draw on data from this paper to develop debunking messages to combat misinformation. Further, data could inform strategies in the promotion of boosters, annual vaccination, as well as vaccination for children.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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