RESEARCH ARTICLE

Negative sentiment towards COVID-19 vaccines: A comparative study of USA and UK social media posts before vaccination rollout [version 1; peer review: 2 approved with reservations]

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Abstract

Introduction: The global spread of the COVID-19 pandemic was rapid and devastating to humanity. The public health response to the pandemic was rapid too. Completion of COVID-19 vaccine development was achieved in under a year. The USA and the UK were the first countries to rollout COVID-19 vaccines to contain the pandemic. Successful rollout of the vaccines hinges on many factors, among which is public trust.

Aim: To investigate the sentiments towards COVID-19 vaccines in the USA and UK prior to vaccination rollout.

Methods: Neuro-linguistic programming with human validation was used to analyse a sample of 243,883 COVID-19 vaccine related social media posts from the USA and the UK in the period 28 July to 28 August 2020. The sentiment analysis measured polarity (positive, neutral, negative), and the themes present in negative comments.

Results: In the sample of 243,883 social media posts, both the USA and the UK had a net sentiment profile of approximately 28% positive, 8% negative and 63% neutral sentiment. On further analysis, there were distinct differences between the two country's social media sentiment towards COVID-19 vaccines. The differences were seen in the themes behind the negative sentiment. In the USA, the negative sentiments were mainly due to health and safety concerns, the fear of making a vaccine mandatory, and the role that pharmaceutical companies would play with the release of vaccines. In the UK the main driver of negative sentiment was the fear of making the vaccine mandatory (almost double the size of the sentiment in the USA).

Conclusions: Negative sentiments towards COVID-19 vaccines were

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prevalent in the third quarter of 2020 in the USA and the UK. Reasons behind the negative sentiments can be used by authorities in the two countries to design evidence-based interventions to address the refusal of vaccination against COVID-19.

Keywords

COVID-19 pandemic; new vaccines; social media; sentiment analysis; USA and UK.

This article is included in the **Emerging Diseases and Outbreaks** gateway.

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This article is included in the **Coronavirus** collection.

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Introduction

On a global scale, Coronavirus disease 2019 (COVID-19) resulted in an unprecedented public health challenge, including disruption of social-economic and cultural systems¹. The disease was declared a pandemic by the World Health Organisation (WHO) in March 2020². Public health interventions to contain the pandemic are guided by existing and emerging evidence on the epidemiology of the disease. To mitigate the impacts of the COVID-19 pandemic, tremendous and record-breaking efforts culminated in the development and subsequent rollout of novel vaccines^{3,4}. In the first quarter of 2021, several vaccines were approved for emergency use by health regulatory authorities across the world. Against this background, a global survey on public acceptance of COVID-19 vaccines showed a wide-ranging acceptance rates of below 55% to a high of about 90%⁵.

Successful rollout of COVID-19 vaccines to the communities will hinge on many key factors, among which is public trust and benefits of the vaccines⁶. Negative public sentiments and uncertainty towards COVID-19 vaccines can hinder high uptake during the rollout, resulting in less vaccination impact than expected. Therefore, characterising sentiments towards COVID-19 vaccines is an ongoing public health priority. Social media provides inexpensive access to large and global data that can be used for characterising vaccine sentiments, with the potential to identify priority areas for interventions to improve high uptake of vaccines.

Social media platforms are increasingly becoming frequent sources of vaccination misinformation⁷. Sentiment analysis of social media posts is an approach used for collecting and analysing posted information to gain detailed insights of people's decision making process with regards to vaccination^{8,9}. Research in the field of measuring vaccine sentiments from social media is advancing rapidly. Its applications are wide - from a gaining deeper understanding of sentiments towards specific vaccines, such as HPV, to understanding sentiments towards vaccination of vulnerable populations, such as pregnant women^{10,11}. At a global scale, COVID-19 pandemic and the development of vaccines against the disease have generated unprecedented misinformation on social media^{12,13}. We therefore conducted a social media sentiment analysis towards COVID-19 vaccines in the USA and the UK prior to the full-scale vaccination rollout. Both the USA and UK were among the first countries to rollout COVID-19 vaccines at scale and have the most pandemic-related deaths proportionally to their COVID-19 cases or population⁴. Leading pharma from both countries are front runners in the development and testing of new COVID-19 vaccines¹⁴.

In the planning phase of rolling out COVID-19 vaccines, Operation Warp Speed of the USA government committed significant resources to make available hundreds of millions of COVID-19 vaccine doses to the members of the public¹⁵. The USA has been a front runner in rolling out COVID-19 vaccines. However, experiences from the past, including recent pandemics, show that availability of vaccines does not necessarily translate to high vaccine uptake^{16,17}. To address the potential

low uptake, a *Working Group on Readying Populations for COVID-19 Vaccine* was formed¹⁸. The purpose of the group was "to develop and disseminate recommendations emanating from design thinking process and evidence from social, behavioural, and communication sciences, that would support realistic planning for a US COVID-19 vaccination campaign"¹⁸.

In December 2020, the UK Government authorised emergency use of a new COVID-19 vaccine¹⁹. The UK has past experience wherein misinformation on the safety of measles, mumps and rubella vaccination (The MMR vaccine) which resulted in a dramatic fall in uptake and subsequent outbreaks of measles²⁰. Knowledge on the extent and nature of public trust on COVID-19 vaccines is useful for UK authorities. This understanding can be used to develop and implement strategies that will ensure high COVID-19 vaccine uptake.

Against this background, we were interested in mining and analysing social media sentiments towards COVID-19 vaccines in the USA and the UK prior vaccination rollout. Social network analysis has been successfully used to understand COVID-19 pandemic sentiments in the USA²¹. In 2020, the USA and UK ranked first and fifth respectively with respect to leading countries based on number of Twitter users²². Although there are prior studies that have been conducted to characterise sentiment towards COVID-19 vaccines²¹, our study methodology has some unique aspects, including the broad scope of analysing unsolicited social media sentiment as opposed to survey methodologies that often involve subjective sampling.

Methods

From 28 July – 28 August 2020 (one month) of social media data were examined and allowed for unsolicited and noncoercive responses that captured the lived experiences of consumers commenting on the concept of a COVID-19 vaccine. The analysis was completed before a confirmed announcement of a vaccine was made by Pfizer in November 2020²³. Conversations about the COVID-19 vaccines were accessed via an application programming interface (API) called **gnip**: that enabled social media data to be gathered from Twitter. GNIP (an API aggregation company) was used to collect the social media data for the period and normalise the data²⁴.

These posts were analysed for themes and sentiment with a computerised natural language processing (NLP) program provided by research company **BrandsEye**. This type of NLP is like that available on platforms like **Amazon Lex**, **IBM Watson Assistant** and **DialogFlow**. With the use of BrandsEye's custom interface, a sub-sample of posts were sent for human topic analysis and sentiment validation^{25,26}. This methodology of sub-sample validation improves the accuracy of net-sentiment measurement and topic analysis as NLP is still not accurate enough for precise interpretation of slang, sarcasm and emoji's²⁵. Mentions were analysed by the human raters (a large, distributed workforce who BrandsEye curate and pay to verify and mark-up raw social media data) and a set of themes were generated. Posts were then tagged according to these classified themes.

Results

In total, 243,883 COVID-19 vaccine related posts were collected from both the USA and the UK for the sample period. A

sub-sample of 8,392 posts were sent for human topic analysis and sentiment validation. **Figure 1a and 1b** provide examples of the kind of posts that were collected for analysis.

a

No mandatory COVID-19 vaccine! If you mandate this vaccine, you will force me to break the law, because I'm not getting one.

27th Aug 07:00

RT @Public_Citizen: Taxpayers paid for 100% of Moderna's COVID-19 vaccine development. We paid \$1,300,000,000. Now Big Pharma wants us to buy back a potential vaccine developed *with our tax dollars* They want to make billions off this pandemic. This is the #PeoplesVaccine. It should be free.

28th Aug 23:49

b

RT @CllrBSilvester: All this hype about tests and masks is just to scare people so they will accept the #COVID vaccine when it comes. This is the biggest scam in world history.

30th Jul 11:28

Watch this and then tell me, would you take a Covid19 vaccine? I am in general pro vaccine, but I am reminded of Thalidomide. Rushing a vaccine is just not smart. twitter.com/LegendaryEnergy/status/1287509508206391296

Quote tweeting An0maly:

Even CBS pressures Bill Gates on the topic that almost everyone had side effects. He doesn't seem to care. t.co/2SiBmowJo3

28th Jul 15:29

Dr. Fauci is warning that distributing a COVID-19 vaccine under special emergency use guidelines before it has been proved safe and effective in large trials is a bad idea that could have a chilling effect on the testing of other vaccines. reuters.com/article/us-health-coronavirus-vaccine-approval-e/exclusive-fauci-says-rushing-out-a-vaccine-could-jeopardize-testing-of-others-idUSKBN25K2M0

25th Aug 13:00

Let me repeat! Trump bought millions of doses of Russia's Covid vaccine! If a vaccine is available it will not be from our country! We have been told from all vaccine researchers that a vaccine will not be ready until next year! Any vaccine put out will be Russia's! Dangerous!

28th Aug 13:06

Reminder that the manufacturer knows the vaccine is being rushed, accepts there will be side effects and has been granted immunity from prosecution by the Gov...not sinister at all 😊...@MattHancock @BorisJohnson @MrMasonMills #COVID #vaccine google.com/amp/s/amp.insurancejournal.com/news/international/2020/08/03/577696.htm

5th Aug 21:47

We need another 25k signatures. Currently around 75k Please sign and share this petition to stop restrictions on those who refuse the proposed Covid vaccine. petition.parliament.uk/petitions/323442

15th Aug 08:49

Figure 1. A sub-sample of 8 392 posts were sent for human topic analysis and sentiment validation. An example of raw data (tweets) by users from USA and UK are shown. **Figure 1a:** Sample of Tweets from the USA (Mentions anonymised to protect author privacy). **Figure 1b:** Sample of Tweets from the UK (Mentions anonymised to protect author privacy).

Sentiment analysis

The sentiment margin of error was calculated by comparing how many percentage points this calculation's result will differ from the real population value. For example, a 95% confidence interval with a 4% margin of error means that the statistic will be within 4 percentage points of the real population value 95% of the time. In the case of the data that verified for sentiment, the margin of error ranged from $\pm 1.6\%$ (overall sample) to $\pm 2.3\%$ (UK sample). The combined process of the machine learning algorithm and manual validation has created a confidence level of 95% and an overall 1.6% margin of error, showing a strong reliability of the data (Table 1).

Overall conversation sentiment

In total, over 64% of the sampled posts had neutral sentiment relating to vaccines, whereas over 28% was expressed negative sentiment and less than 9% expressed positive sentiment (Figure 2). When isolating the two sampled countries' specific sentiment profile, the sentiment was very similar in both the USA and UK.

In the USA, the majority of sentiment was neutral (63.2%) with negative being 28.7% and positive being 8.1%. In the UK, the majority was also neutral (63.8%) with negative being 27.5% and positive being 8.7% (Figure 3).

Theme analysis

While the overall sentiment showed consistency between the two countries, the theme analysis did show that the distribution of drivers of negative sentiment were different in each country. In total, nine core themes were identified and quantified from the negative sentiment. These themes were coded as Conspiracy, No danger, Hoax, Health and safety, Mandatory, Pharmaceutical, Politics, Scientific process, and Vaccine efficacy. The

Figure 2. Overall sentiment to a COVID-19 vaccine (USA and UK combined). The sentiment analysis measured by polarity (positive, neutral, negative). The polarity for the 2 countries is combined. Authors were most hesitant about a mandatory COVID-19 vaccine. Authors shared petitions to appeal restrictions that may be imposed on those who refuse the vaccine. Health and safety was the second most prevalent theme cited, as authors worried about adverse reactions and side effects. Authors hypothesised that the scientific process followed to produce the vaccine would be flawed due to institutions rushing to find an answer to the pandemic. Hesitancy mentions on average generated 4.8 engagements; 3.3 times higher than that seen in advocacy mentions. Authors mentioning developments in vaccine trials accounted for nearly a fifth of all advocacy conversation. These mentions also featured calls to action aimed at finding human volunteers in order to accelerate the research. Vaccine advocates expressed concern about the equitable distribution of the COVID-19 vaccine. This highlights a trend of institutional distrust that underlies vaccine-related conversation from both advocates and sceptics alike. Advocacy mentions generated an average of 1.4 engagements per mention.

themes were coded and defined based on the different sentiment profile in both the USA and the UK (Table 2).

In the USA, the main drivers of negative sentiment for the sample period were health and safety concerns, the fear of making a vaccine mandatory and the role that pharmaceutical companies will play in the release of vaccines. In the UK, the main driver of negative sentiment was the fear of making the vaccine mandatory (almost double the size of the sentiment in the USA). The role of health and safety was second and slightly higher than in the USA (even though it was first in the USA, the USA sentiment was slightly more distributed among the six themes. Third was scientific process, which aligned closely in number to the USA, but was only fourth most prevalent theme there (Table 2).

Table 1. Total sample of micro-blogs collected and analysed (28 July – 28 August 2020). Shows the total volume of twitter mentions BrandsEye identified about a COVID-19 vaccine from 28 July – 28 August 2020. BrandsEye's Crowd of human contributors evaluated the sentiment contained in 8,392 mentions. Mentions were assigned sentiment scores of positive, negative or neutral. 1505 mentions were categorised into nine hesitancy themes. The resultant margin of error for COVID-19 vaccine sentiment is below 2.5% for both USA and UK, calculated at a 95% confidence interval.

	Overall	USA	UK
Total COVID-19 vaccine conversation	243 883	219 671	24 212
Sentiment verification and theme analysis	8 392	4 887	3 505
Mentions tagged with classification	1 505	839	666
Sentiment margin of error	$\pm 1.6\%$	$\pm 2.1\%$	$\pm 2.3\%$

Figure 3. Sentiment in the USA and UK (28 July – 28 August 2020). The sentiment analysis measured by polarity (advocacy, neutral and hesitancy). The polarity is shown for each country. The USA saw a lower ratio of advocacy mentions and a higher ratio of hesitancy mentions compared to the combined aggregate. Conversely, the UK saw a higher ratio of advocacy mentions and a lower ratio of hesitancy mentions.

Table 2. Coded themes related to overall negative sentiment. Themes on negative sentiments towards COVID-19 vaccine were identified, coded and a definition justifying the assigned code was provided. The % negative sentiments was then computed separately for tweets from the USA and UK. Mandatory vaccination was the dominant theme code in the UK while in both countries, health and safety concerns were dominant negative sentiments.

Theme code	Definition	USA (% negative conversation)	UK (% negative conversation)
Conspiracy	Author believes that the COVID-19 vaccine is part of a conspiracy (not just money making). Eg., mark of the beast, tracking chips etc.	3.7%	3.4%
No danger	Author accepts COVID-19 is real but does not think it is very dangerous or harmful.	0.8%	0.5%
Hoax	Author states that COVID-19 is a hoax, conspiracy or simply not real. Includes "plandemic" mentions.	0.8%	4.2%
Health and safety	Author references health safety issues, side effects of a COVID-19 vaccine or concerns about ingredients of the vaccine.	15.1%	16.4%
Mandatory	Author is against making the vaccine mandatory or believes it should be optional.	13.3%	26.1%
Pharmaceutical	Author doesn't trust the pharmaceutical industry. Eg., thinks they are tricking people, trying to make money etc.	10.8%	5.8%
Politics	Author believes the vaccine is political in nature or mistrusts the government about the vaccine.	7.2%	4.2%
Scientific process	Author thinks that the development of the vaccine is being rushed, has been poorly tested or is otherwise scientifically flawed.	10.5%	10.8%
Vaccine efficacy	Author is doubtful or sceptical about how effective a vaccine will be.	6.6%	4.9%

Discussion

The impacts of the COVID-19 pandemic coupled with rapid vaccine development and rollout has demanded a rapid understanding of the public sentiment concerning the vaccines and how this may affect vaccination uptake. In this study, we

tapped into huge volumes of opinionated social media data for analysis to gain insights on a topical issue about people's potential to accept new COVID-19 vaccines in the USA and UK. Through sentiment mining and analysis, this study shows in both countries, negative public sentiments towards COVID-19

vaccines were nearly fourfold higher than positive sentiments before rollout. Interestingly, neutral public sentiments towards future COVID-19 vaccines dominated over negative and positive sentiments. Our findings agree with those reported by Loomba *S et al.*, who used a randomized controlled trial in the USA and UK to quantify how exposure to online misinformation resulted to a large proportion not intending to get vaccinated against COVID-19²⁷. Thematic analyses in both countries showed complexity and differential distribution of the reasons for the negative sentiments. Negative vaccine sentiments can translate to attitude, and then vaccine hesitancy. Our results indicate that, at the time the study was conducted, more than a quarter of the population in the USA and UK would not accept vaccination against COVID-19.

Safety of rapidly developed COVID-19 vaccines was listed as the first and second main reasons of negative sentiment towards vaccination in the USA and UK respectively. This was not a surprising finding because, in general, vaccine safety ranks among the top reasons for lack of public vaccination confidence in most settings²⁸. A poll conducted in the USA in June 2020 showed only about 50% of Americans were committed to receiving a COVID-19 vaccine, with acceptance commitment among some communities being as low as 40%²⁹. One possible explanation for our findings is that the vaccines against COVID-19 were developed at a record speed and in the context of an infodemic, both these factors can exacerbate heightened negative safety sentiments^{30,31}. As the vaccination rollout continues globally, and with millions of doses administered in the first quarter of 2021, preliminary safety reports from the USA show COVID-19 vaccination results to mild adverse events and in rare cases, allergic reactions³². The reports are in line with the expected safety profile. We propose widespread communication of up-to-date and accurate information on the observed effectiveness and safety profile of COVID-19 vaccines. Communication is at the core of any process to empower and change mindsets and perceptions. Understanding the audience and using language and methods that are accessible, reliable, and credible is critical to building public trust in COVID-19 vaccines and vaccination in general.

Before health regulatory approval for rollout to the public, vaccines are usually tested through a rigorous, well-established, and regulated processes³³. Traditionally, vaccine development processes are often detached from political, media, and public attention. This did not happen with COVID-19 vaccine development due to the enormous attention the pandemic rightfully attracted. Therefore, it is not surprising that in our study, politics was a key theme identified as a driver of negative sentiment in both countries, albeit at moderate frequencies. Given that governments are major stakeholders for vaccinations, it is critical for leaders of government to not politicise the science of vaccine development as our results show this can be a driver of negative sentiments. Senior government leaders in the USA and the UK were among the first to publicly get vaccinated with new COVID-19 vaccines during the rollout. This is important in advancing positive sentiment of vaccines to the public.

More must be done rapidly and openly to communicate accurate and up-to-date information on COVID-19 vaccines to improve public trust and positive sentiments.

Mandatory vaccination was listed as the first and second main reason of negative sentiment towards vaccination in the UK and USA respectively. With some degree of success, mandatory vaccination is legislated in some countries to address the resurgence of vaccine preventable diseases^{34,35}. In the UK, discussions around mandatory vaccination featured in the mainstream media with senior health officials not completely ruling out such an option in mid-2020. Such discussions may have driven the high frequencies of negative sentiment observed in our study. Ethics on mandatory vaccination is a topic that generates a lot of controversies with individuals refusing to be vaccinated considered to cause harms to others^{36,37}. Our findings suggest that careful considerations must be made by authorities prior developing legislation on mandatory COVID-19 vaccination as this can result in a backlash. Neither of these two countries have instituted a mandatory COVID-19 vaccination during the rollout. Other forms of legislation, such as incentivisation to be vaccinated can be considered in some settings³⁶.

In the USA, lack of trust in the pharmaceutical industry was the third main reason cited for negative sentiment on COVID-19 vaccination. The same reason was ranked fourth in the UK. In general, mistrust by the public towards pharmaceutical industry is a key element driving vaccine hesitancy³⁸. Further compounding the issue of the pharmaceutical industry in the context of COVID-19 vaccines is the relationship between governments and pharmaceutical companies, which may involve non-disclosure agreements³⁹. Both the USA and the UK governments are key stakeholders in COVID-19 vaccine development through advanced market commitments as well as through regulatory processes³⁹. The relationships between governments and the pharmaceutical industry remains under public scrutiny during the COVID-19 pandemic, hence the observed high rates of negative sentiments towards pharmaceutical industry was somewhat expected. Our results suggest that open and transparent communication from the pharmaceutical industry as well as the Governments has the potential to improve positive sentiment towards COVID-19 vaccines.

Scientific process was the third most frequently reported reason for negative sentiment in the UK and the same reason was ranked fourth in the USA. COVID-19 vaccines were developed at a rapid pace³. Mistrust in vaccine information is a key element of vaccine hesitancy³⁸. Due to the rapid COVID-19 vaccine development process, public mistrust in the scientific process may have been driven by a lack of optimal communication as well as by misinformation. It is critical for researchers working in the field to continue communicating widely, openly and transparently on the reasons behind the remarkable success of COVID-19 vaccine development and how it was possible to achieve the success while maintaining expected standards of scientific rigour⁴⁰.

There were other less frequent reasons for negative sentiments in both countries. The reasons were associated with vaccine efficacy, conspiracy, no danger and hoax. Taken together, our results show that reasons behind negative vaccine sentiments are many, complex, and can vary in scale across different countries.

There are limitations to this study. First, sentiments identified could be temporal and may have changed by the time COVID-19 vaccines are rolled out. There is a possibility of a shift in sentiment as more information such as safety, is made available to the public. This, however, provides further opportunity to extend this research to a longer time frame. A repeat mining and analysis of similar data will be needed to identify any changes in the sentiments. Second, it is hard to determine how representative the selected data was to make inference to the general population.

In conclusion, widespread access and use of safe, effective, and trusted vaccines will be crucial in the control of the COVID-19 pandemic. Our findings show that negative sentiments towards COVID-19 vaccines were prevalent in the third quarter of 2020 in the USA and the UK. Social media, such as twitter, has been an influential platform for information, disinformation and misinformation during the COVID-19 pandemic⁴¹. The findings of our study offer a snapshot of possible reasons that will make people to refuse COVID-19 vaccination.

Tailor-made education and communication strategies addressing the identified and prevalent negative sentiments may result in higher uptake of future COVID-19 vaccines in the USA and UK.

Data availability

Underlying data

The raw data needed to replicate these analyses has not been made public by the data providers, meaning we are forbidden from sharing it in this paper. However, the reader can apply for access to the data through a direct application to BrandsEye for the purchase of this data. BrandsEye can be contacted on contact@brandseye.com. BrandsEye is a commercial research company that has had its data published in journals such as MethodsX (Elsevier) and the International Journal of Bank Marketing (Emerald). More details on how to apply to access these data can be found at <https://www.brandseye.com>.

Authors contributions

JL collected the data; JL and BMK conceived the study. KM reviewed the manuscript; BMK interpreted the data and wrote the first draft of the manuscript. All authors reviewed and approved the final manuscript for submission.

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Daniel Thomas

Public Health Wales Communicable Disease Surveillance Centre, Wales, UK

This is a very interesting analysis of social media posts in two countries during Summer 2020 to assess public acceptability of COVID vaccination in advance of the rollout.

In terms of style it is well written and clear. The language is a bit dramatic at times, *e.g.* 'devastating to humanity', 'record-breaking' efforts' etc. and this could be toned down. The term 'pharma' should be specified in full. The titles of figures are very long, *e.g.* Figure 2, and the detailed explanation should go into the manuscript text.

I have three main points on content:

1. There appears to be contradictory findings presented in the abstract (28% positive; 8% negative) compared to the results section (negative sentiment four fold higher than positive sentiment).
2. The results would have been more useful if some stratification by age, gender, socioeconomic status was presented. I presume this was not possible. If so, it should be recognized as a limitation and included in the discussion section. Also, it would have been useful to see some discussion about differential social media use in the UK and US by type of platform. In the UK for example younger people are more likely to use Instagram rather than Twitter or Facebook. Is that the case in the US?
3. Lastly, it would be helpful if the authors could expand on their discussion about the suitability of this approach for behavioral insight surveillance, to complement more traditional disease surveillance methods.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Not applicable

Are all the source data underlying the results available to ensure full reproducibility?

Partly

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Epidemiology, public health

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 26 July 2021

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Rakhi Tripathi

Centre for Digital Innovation, Fore School of Management New Delhi, New Delhi, Delhi, India

This article is well-written. It discusses the sentiments of citizens of the US and UK regarding COVID vaccination. The sentiments are extracted from social media and analyzed. The results are explained well especially the Table 2 where the themes related to negative sentiments are explained.

Few suggestions would strengthen the paper:

- How did the authors segment the data? How was the data cleaned; Any issues with sarcasm, multilingual posts, or posts consisting of slang? A paragraph on it would be useful.
- It is unclear that the reach of each post is considered or not. For example, if an influencer tweets a negative sentiment and it engages millions then that post has a bigger impact as compared to the post with limited reach. It is important to discuss this factor.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Not applicable

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Social media analytics, Social listening, Digital technologies

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

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