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Trend Analysis of Public Enthusiasm for COVID-19 Vaccines on Social Media

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Abstract

Social media users benefit from advances in information and communication technology. Each user can access and obtain information by using a mobile phone or other communication device connected to the internet. The implementation of the COVID-19 Vaccination is one of the hottest topics discussed on the Twitter social media platform. Therefore, the purpose of this study is to analyze the trend of public interest in the COVID-19 vaccine on Twitter. This study utilizes Twitter data crawled by the *Drone Emprit Academic* application using the term "Pfizer Vaccine Enthusiasm and Moderna Vaccines". This study examines 170,641 Twitter mentions related to COVID-19 vaccine messages. Based on the findings of this study, the public's response to COVID-19 immunization was 42,963 mentions from August 23, 2021, to April 23, 2022. Based on the findings of this study, Asia, Europe, and the United States factored for the vast bulk of tweets about the COVID-19 vaccination. There were 25,288 (59 percent) mentions of positive emotions, followed by 16,484 (38 percent) comments and 1,191 (3 percent) topics of neutral emotions. This study's findings enable the government to understand the complexities of the widely discussed topic of COVID-19 immunization, which it can utilize to promote policies and enhance service quality.

Keywords: public enthusiasm, emotion, COVID-19 vaccines, social media

1. Introduction

1.1 Background of the Research

A significant public health catastrophe was brought on by the 2019 coronavirus (COVID-19) pandemic, which spread quickly around the world and resulted in the deaths of thousands of individuals (Aghababaeian et al., 2020). Scientists believed that vaccination was an important kind of defense when the situation first became out of control. The creation and use of a COVID-19 vaccination have been advanced by international initiatives. In order to design effective educational efforts and campaigns to promote vaccine usage, it is crucial for governments, public health professionals, and politicians to comprehend public attitudes and views regarding vaccination (Hu et al., 2021). Scientists are working hard to develop a vaccination to combat COVID-19 in the current COVID-19 period (Mir & Maurya, 2020).

The COVID-19 pandemic is a global public health crisis. Social media has become the main means for the general public to get information and express their thoughts and views (Han et al., 2020). The Internet not only serves as a vital platform for the public to access information and express opinions, but also poses the risk of social public opinion. Predicting the evolution of public opinion on the network in advance allows government agencies to be prepared for public opinion crises and make informed decisions (Liu et al., 2021).

Concern over the COVID-19 pandemic has been expressed in a significant way across a variety of social media platforms throughout the world. Comments on user views, attitudes, tendencies, and behaviors related to the COVID-19 Pandemic, as well as a collection of texts with a high level of sentiment-based evolution of public opinion (Zhang et al., 2021). (Han et al., 2021) say that social media platforms are becoming more important as a way to share information and control public opinion.

With the rapid expansion of the Internet and big data, social media has a direct impact on the speed and channel of

public opinion (Li & Xu, 2020). The social media platform Twitter, for example, has proven to be a significant news distribution and public dialogue engine. In the near future, they will offer a lot of semi-structured data and direct access to conversational data (Müller et al., 2020).

1.2 Importance of the Problem

Given the ever-present and changing challenges of internet misinformation, we are confident that research has discovered new and viable techniques for improving news literacy as part of a larger effort to combat the spread of disinformation. Traditional sources of information, including national television, national newspapers, and local newspapers, increase the likelihood of getting vaccinated. People are more likely to get vaccinated if they get their information from traditional media instead of social media, or if they get information from both traditional and social media (Piltch-Loeb et al., 2021).

Outreach measures, such as extending public health messages tailored to local communities and providing access to vaccinations, can help increase vaccination coverage in some places (Barry et al., 2021).) Informative social media campaigns will not only provide those who rely excessively on social media with excellent content to share, but they will also encourage those people to stop using social media and instead visit websites that are reliable and authoritative (Chadwick et al., 2021).

Analysis of social media data helps the government to monitor public attitudes and opinions about vaccines, and the government can address the concerns of vaccine skeptics and increase public confidence in vaccination in a given region or community (Hu et al., 2021). Twitter can be used to gain interesting insights into the general public's perception of the COVID-19 epidemic. Several people were detected posting tweets seeking information about COVID-19 (Noor et al., 2021).

Opinion within a group generally has a considerable influence on the evolution of public opinion in the exchange of public opinion. Furthermore, environmental compensation from the government can only alleviate the problem temporarily (Liu et al., 2021). Public panic increases in the early stages of a disaster as the number of interactions between individuals increases and awareness of risk deepens. In addition, different levels of disaster have different consequences on panic risk. Positive and negative information will lead to greater differences in the number of public risk fears (Chen et al., 2021). Governments can use public opinion topic charts to quickly detect user problems. At the same time, it is very important for regulating online writers, predicting evolutionary trends, and stopping the spread of bad news on social media (Xing & Li, 2021).

Understanding vaccination attitudes and opinions on Twitter can assist public health officials in promoting good messages and dispelling negative ones to improve vaccine implementation (Yousefinaghani et al., 2021). Liu et al. (2020) say that data from social media about how much people know about the COVID-19 vaccine can be used to change educational programs and other activities in order to get more people to accept the COVID-19 vaccine.

Evaluation of pandemic response policies should include public opinion in order to identify policy shortcomings. How public opinion has changed over time in regards to vaccination policy can be better understood with the use of social media (Suratnoaji et al., 2020). Even though trust in information sources is linked to how people feel about vaccinations, the confidence gap does not explain why people of different races have different views on vaccinations (Woko et al., 2020). In addition, daily public opinion and new cases are related. Public opinion grows as the infection spreads. As the outbreak is contained, public sentiment plummets (Du et al., 2021). Daily public opinion and new cases are positively correlated. COVID-19's rapid spread is changing public opinion. While the infection is under control, public opinion polls are declining (Tri Sakti et al., 2021).

2. Method

2.1 Types of Research

This article uses secondary data in relation to social media approaches, particularly Twitter. The Drone Emprit Academic (DEA) application is used by authors who display data and social media analysis on some interesting social issues using artificial intelligence (AI). In addition, AI-based tools are playing an increasingly important role in the media, from smart tools that help researchers analyze data automatically through the tools they use (Helberger et al., 2020). The author also searches reputable articles through the Scopus database for article references with the keywords "public opinion and vaccine", "sentiment and COVID-19 vaccine", and "sentiment and COVID-19" with a time limit of 2020–2022 used for literature searches.

For this research, we used the DEA app's scan of the Twitter service (Fahmi, 2018). "Enthusiasm for COVID-19 Vaccines" is the keyword used for data presentation. The DEA collected conversations from August 23, 2021, to April 23, 2022. The researchers chose the time limit because there were a lot more conversations on Twitter, along with suggestions to get vaccinated for mobilization purpose. To retrieve this data via an API call: *{"id":1188,"name":"Pfizer*

Vaccines and Moderna Vaccines Enthusiasm","start_date":"2021-8-23","end_date":"2022-4-23 ","data":{"neg":16484,"pos":25288,"net":1191}}.

2.2 Data Analysis

Through analyzing all processed tweets, this study looked at people's opinions towards the COVID-19 vaccine (including mentions, retweets, and replies). The DEA engine analyzes Twitter's word frequency and mood by checking whether the primary emotion is positive, negative, or neutral. The DEA sensing algorithm is created using machine learning methods, and the results are interpreted using a probabilistic classifier. Currently, telecommunication service providers generate a lot of data records. A clear understanding of their customers is the key to the success of any institution. Network analytics is often used to find influencers and shared communities on social media in order to study how customers act and how they relate to each other.

3. Results and Discussion

Social media has developed into a new way for people to express their political aspirations. Social media is considered as the most effective and practical means to communicate ideas and opinions in order to criticize a government policy. This is closely related to the ease with which mobile devices access social networking sites. Initially, social media was only used for social networking, but it was also used as a medium for democracy. Users make decisions about how to use technology to meet their daily needs.

Health systems and healthcare professionals will face additional challenges as they attempt to implement the mass immunizations necessary to mitigate the virus's impacts. It is important for health professionals to draw attention to the challenges presented by the distribution and administration of the COVID-19 vaccine, which increase as more doses become available (Kohl, 2021).

3.1 Trends of Total Mentions COVID-19 Vaccine on Twitter

During the study period, 42,963 mentions were collected on Twitter. Figure 1 shows that the most mentions were made on August 31, 2021, with 1,566 posts, and on September 2, 2021, with 2,177 posts, mentioning public enthusiasm for the COVID-19 Vaccine.

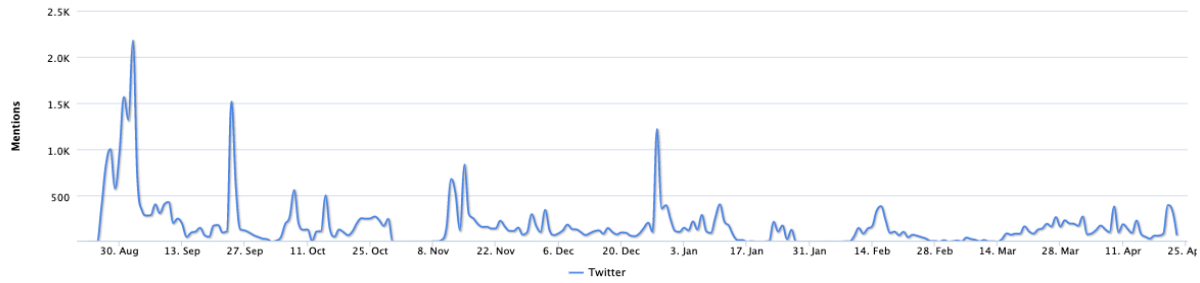

Figure 1. Trends of total mentions public enthusiasm for COVID-19 vaccines in Twitter

Figure 1 shows the trend of mentions of public enthusiasm for vaccines that seem to be most often carried out between August and September 2021. Various comments made not only support the implementation of public enthusiasm against the vaccine, but there are also those who refuse.

The mention that supports the reason that the COVID-19 vaccine is safe and has been proven as a solution to break the chain of the spread of the COVID-19 virus. This step is expected to increase the decrease in the spread of COVID-19 in the community. The COVID-19 vaccination is intended to minimize the morbidity and mortality caused by the COVID-19 virus. Although this vaccination cannot completely prevent infection with the Corona virus, it can reduce the likelihood of severe symptoms and problems caused by COVID-19. For example, the community supports mandatory vaccination because it is a helpful and effective measure to increase vaccine coverage (Gentile et al., 2021). Health education and accurate information dissemination are unquestionably pillars for changing the situation and dispelling widespread and unfounded fear of vaccination (Facciola et al., 2019).

As for those who refuse the COVID-19 vaccination, the main reason is that there are still concerns about the safety of the CIVID-19 vaccine. This is similar to the findings of Kim et al., 2020 that more exposure to comments in threads showing unfavorable opinions about vaccines results in unfavorable attitudes towards vaccines by changing perceptions about the distribution of public opinion about vaccinations. The indirect effect of comments on attitudes about vaccination was stronger among individuals with lower perceived vaccine effectiveness than the direct effect of public comments (Kim et al., 2020).

In a highly concentrated media environment, there is a news gap in terms of themes and frames (Zunino, 2022).

Figure 2. Location distribution based on COVID-19 vaccine comments on Twitter

Based on Figure 2 found that posting of COVID-19 vaccines on Twitter was mostly done in Asia, with 7,624 (98.48 percent) posts, followed by Europe with 97 (1.25 percent) posts, and America with 21 (0. 27 percent). Geographic location, topic selection, cultural sensitivity, and frequency of posting all have an impact on the public's reaction to posts and the subsequent views they inspire (Barachi et al., 2021).

External factors that affect how information spreads through online social networks are taken into account, and the influence of external behavior patterns is tracked by the media's role in shaping public opinion and the way network structures change over time (X. Liu & He, 2020). The government is able to implement an effective and quick early warning system in response to public opinion if computers automatically evaluate and classify the semantics of online public opinion (Xiang et al., 2020).

Vaccination should be prioritized as an important component of preventive health care (Azzari et al., 2020). The vast majority of people are prepared to get vaccinated against COVID-19 if they are certain of its safety and it is advised. Specialists and groups in the field of public health should distribute information geared toward young people that deals directly with the problem of vaccination (Brandt et al., 2021).

3.2 Public Sentiment around the COVID-19 Vaccine on Twitter

The sentiment trend is based on mentions on Twitter as shown in Fig. 2 and Fig. 3 shows positive sentiment dominates with 25,288 (59 percent) mentions, followed by negative sentiment with 16,484 (38 percent) mentions and neutral sentiment with 1,191 (3 percent) mentions.

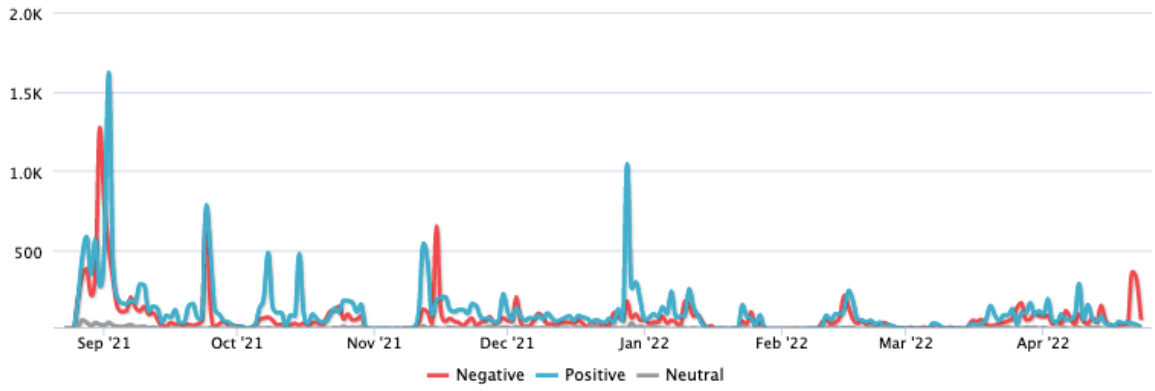

Figure 3. Sentiment's trends of COVID-19 vaccine in Twitter

The trend of sentiment based on mentions on Twitter, as shown in Figure 3. and Figure 4., shows that positive sentiments dominate with comments that support the implementation of the vaccine, such as the comment stating that "*after the Moderna vaccine, I am really sleepy, after I wake up from sleep, I feel refreshed*." Similarly, there is a mention that "*safe and useful, pfizer recommends children 5-11 years old be given the booster vaccine".* There was also a comment stating that "the latest Moderna COVID-19 vaccine is effective against the Omicron variant." Additionally, "*The Pfizer vaccine has perfectly fine."* In the same way, the community had questions about how the vaccine would be used. For example, someone asked for information about Moderna vaccines in Bekasi or Jakarta.

In Figure 3. and Figure 4., there are mentions of negative sentiments, such as comments stating "Europe stopped the

#Moderna Vaccine because of the risk of heart attack/myocarditis." But strangely, it was changed to save you from the virus (Omnicron) variant. There was also a comment explaining that "*the efficacy of the COVID-19 vaccine will decline after a few months, that's why PICK gave a boosting dose"*. The administration of a boosting dose that is different from the original dose is practiced in many countries. In Chile, Pfizer's boost dose to Sinovac recipients is up to 95 percent effective. Also, there was a comment stating that "*I ran out of booster shots yesterday and had to get a new one on the second day; there was no effect other than hand pain, and the original AZ vaccine felt like it was going to die."* There was also a comment that "*if there are still non-halal vaccines after the Supreme Court's decision, we will sue and report criminally"*. https://t.co/Mj3WZJK86B.

The mention of neutral sentiment is shown in Figure 3 and Figure 4. Like the comment that said, *"What a point! An FDA review of Pfizer's vaccination trial documents revealed 9 pages (approximately 158,000) of adverse events! -- Moderna filed a patent for a partial gene sequence for COVID-19 three years before COVID-19. https://t.co/nG9rLETipq*." Likewise with netizens who said that *"My immune system is very good, how from the first vaccine to modern boosters, I feel very happy."* There is also a comment stating that *"If the distance from dose 1 to dose 2 is more than 6 months, it is considered a drop out, I have to repeat dose 1 again because I previously received the Moderna Vaccine after 1 re-vaccination. https://t.co/5a9bWmECZe."*

Based on the mention of positive, negative, and neutral sentiments above, it can be seen from the various mentions of netizens that comments that support the implementation of the COVID-19 vaccine are beneficial for controlling COVID-19. Those who give negative sentiment towards the implementation of the COVID-19 vaccine are those who still have doubts about the government's recommendations regarding vaccination. People's doubts are also reinforced by the slanted news about vaccines; there are deaths; or they will be exposed to the virus again. Further, it can be said that these people do not understand the usefulness of the vaccine itself. It's the government's job to encourage and campaign for vaccinations because this way we can break the chain of spreading COVID-19. Meanwhile, Twitter users who said a gap of more than 6 months between doses 1 and 2 was regarded broken were commented on by those who expressed neutral reactions. Pre-administration of the Moderna Vaccine necessitates a booster shot after the initial dosage.

This shows that there is a direct correlation between negative and neutral sentiments of netizens on social networking platforms. Also, netizens like to use subjective language to talk about their thoughts and feelings, and it's hard to change their minds on social media platforms (Bi et al., 2021).

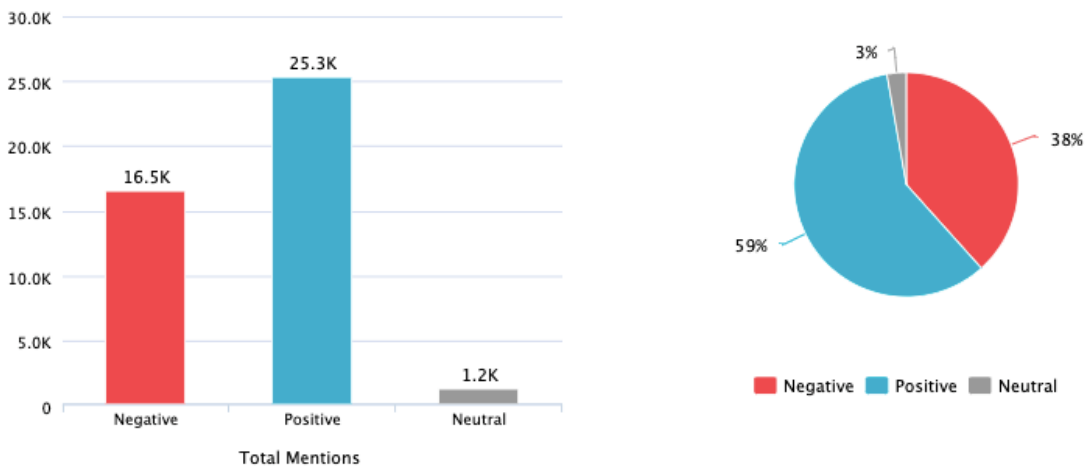

Figure 4. Total public sentiment around COVID-19 vaccines on Twitter

Based on Figure 3 and Figure 4, there is a trend based on time which shows that public sentiment is more positive than negative and neutral. The total public opinion, attitudes, and feelings exchanged about a significant public health emergency via the Internet, which maps the level of impact and disaster scenarios of a public health event in real space, is known as online public opinion (Y. Zhang et al., 2020).

The majority of people know about the anti-vaccine movement and have negative sentiments about it, but the movement still has an impact on society. Furthermore, the relationship between education level and overall attitude towards vaccination is usually more unfavorable among people with higher education (Pisaniak et al., 2021). Society in general is skeptical about vaccines. It is not enough to be aware of the anti-vaccination movement. As a result, training must be prepared, legal evaluations must be carried out, and health literacy must be improved to combat anti-vaccination effectively and efficiently (Şimşek & Artantaş, 2021).

Governments must ensure that their citizens have access to reliable evidence-based information about the COVID-19 vaccine to make informed vaccination decisions (Alliheibi et al., 2021). An inclusive communication plan should be designed to address stakeholder questions through a process that the community and health care professionals must undertake and implement. The socio-cultural dimension of vaccination acceptance should be incorporated into the communication approach. Coordination of public safety planning until vaccination is widely accessible, but social segregation must remain. Because the number of cases and death rates change, policymakers must adapt to new situations (Oleribe et al., 2021).

Given the significant prevalence of COVID-19 vaccine skepticism, evidence-based communication, mass media techniques, and legislative measures should be implemented to convert vaccination to mass vaccination with a focus on specific groups (Khubchandani et al., 2021). Transparent negative communication may threaten vaccination adoption in the short term, but it may also increase trust in health authorities in the long term. Also, confusing and interesting communication options don't make people more likely to get vaccinated. Instead, they make people less likely to trust and more likely to believe in conspiracy theories (Petersen et al., 2021).

Based on Twitter's emotional network examination of user behavior based on text (Reply, Mention, and Retweet) as well as numerical scores such as number of tweets, total posts based on emotions Regarding the COVID-19 Vaccine on Twitter: To assess the effect of values, we combine them with user attitudes and emotions on a particular theme. Previous studies focused on the text of tweets, but the new research looks at both tweets and replies to find out what users are talking about.

3.3 Public Emotion around the COVID-19 Vaccine on Twitter

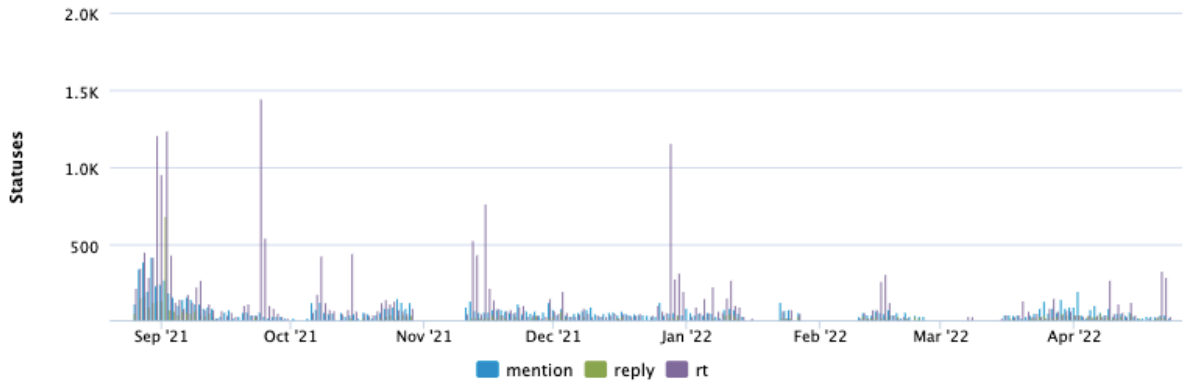

Figure 5. Trends reply, mention, and retweet surrounding the COVID-19 vaccine in Twitter

Followed by mentions with a status of 13,253 (30.85 percent) and replies with a status of 5,573 (12.97 percent). Contraindications to vaccination and perceptions of the vaccination qualification process were found to be the most important elements influencing general public opinion in the area of vaccination safety (Braczkowska et al., 2018).

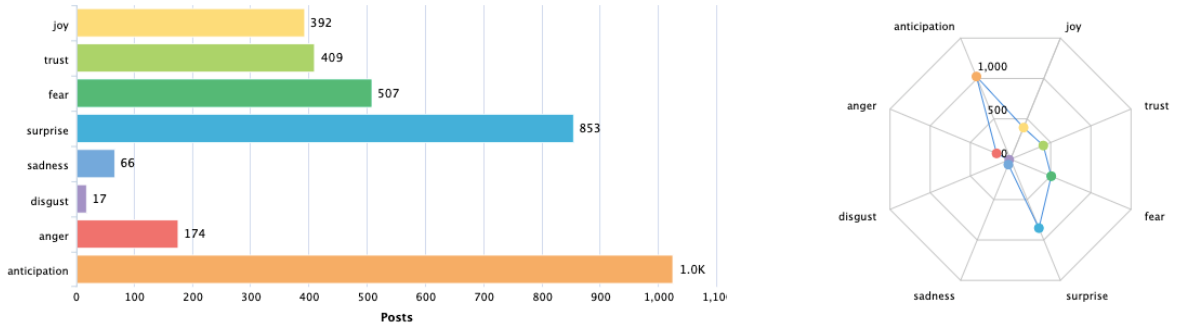

Figure 6. Total of posts by emotion surrounding the COVID-19 vaccine in Twitter

Figure 6 and Figure 7 describe the main feelings during the study period, namely anticipation, hopelessness, and anger. The most prominent emotion is expectation, which indicates the public's preparation and desire for the future. (Wang et al., 2021) found that there were significant patterns in the size and mood of topics for different themes. These patterns happened at the same time as several major pandemic events and policy changes, which shows how much they affect social media (Wang et al., 2021).

Greater social media conversation around COVID-19 is associated with increased psychological distress, with about two-thirds of this impact occurring indirectly through increased perceptions of the dangers of COVID-19. Crisis response frameworks of blame, praise, and corrective action are all closely linked to narratives of power and contestation, heroism, and nationalism (Zhang et al., 2020).

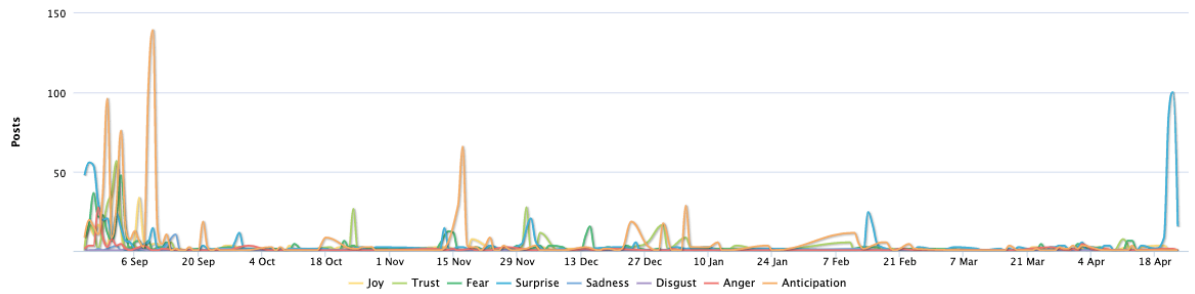

Figure 7. Trends of posts by emotion surrounding the COVID-19 vaccine in Twitter

Massive dissemination of information through the media can be an effective method to educate the public about the benefits of anti-COVID-19 vaccination, both for self-defense and for the greater good (Medina et al., 2021). Anxiety, fear, threats, humiliation, distrust, hatred, and controlled aggressiveness are all related to emotional coherence (Isupova et al., 2021). Vaccination trust by shifting the focus from a lack of public understanding to honesty in research collaborations and recommending steps to reduce distrust of potentially complementary alternative vaccines (Wheelock & Ives, 2022). To stop people from having doubts about vaccinations, public health messages could take Twitter traffic patterns and the possible impact of more targeted social media campaigns into account (Fazel et al., 2021).

3.4 Word Cloud Trends around COVID-19 Vaccines on Twitter

Similarly, this analysis finds word cloud trends on Twitter that show public enthusiasm for COVID-19 vaccines. The results of this word cloud describe review data in the form of the value of phrases that often appear on Twitter and provide comments. The larger the font size in the word cloud, the more often the subject being reviewed is discussed by Twitter users. The word cloud findings are as shown in the following image.

Figure 8. Word cloud around COVID-19 vaccines on Twitter

Making a public opinion monitoring system on a cloud platform that is used to obtain timely and accurate public opinion information from various media platforms and to provide timely information on changes in public opinion. It will be more conducive to the control and monitoring of users of public opinion information (Wei et al., 2021). Even though the government has done a lot to educate the public and stop the spread of disease, more needs to be done to aid those at the bottom of the economic scale (Abdelhafiz et al., 2020).

4. Conclusion

The COVID-19 pandemic has been a major public health disaster, and when it first spread, experts considered vaccination an important means of defense. Therefore, understanding public attitudes and views on vaccination is very important for governments, public health experts, and policymakers to create successful educational activities and campaigns to increase vaccine use. The evolution of hot events can be best studied by predicting the trajectory of the network's public opinion in advance, thus providing important assistance to government agencies to overcome the crisis of public opinion, since social media has a direct influence on the speed and channel of public opinion.

Twitter is a news anchor and public dialogue engine. In public opinion interchange, group opinions affect public opinion evolution. Different crises affect panic risk differently. It gradually becomes involved in the growth and transformation of social phenomena, problems, and events, developing into politics and public administration. In public opinion interchange, group opinions affect public opinion evolution. A consensus-building strategy based on public opinion management is described to manage public opinion from all important people's perspectives and ensure seamless event implementation. Lack of information causes vaccine anxiety and distrust.

The COVID-19 challenge allows society time to construct more resilient communities that will survive and prosper beyond the current crisis and be better prepared for future challenges. Despite significant financial resources, coordinated community engagement is vital for boosting COVID-19 vaccine confidence.

Community participation, fair advertising, and cultural sensitivity can help people follow public health norms. Implementing a complete grassroots approach provides communities a voice and allows them to promote COVID-19 immunization through community-initiated and -driven programs. Society supports mandatory vaccination as a strategy to increase vaccine coverage. Health education and information distribution are key to improving the situation and removing unfounded vaccine worries. People avoid COVID-19 vaccination due of safety concerns that increased exposure to negative comments about vaccines leads to adverse attitudes about vaccinations via modifying assumptions about public opinion.

The indirect effect of public comment on vaccination attitudes was stronger among those with lower vaccine efficacy, while the direct effect was weaker. Geographic location, topic selection, cultural sensitivity, and posting frequency influence public reaction and views. External aspects of online social network information transmission are studied, and the influence of external behavior patterns is tracked through media public opinion and network structure dynamics. The government can only build a comprehensive, effective, and timely early warning mechanism by automatically assessing and classifying online public opinion using computer technology.

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