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Early Outlook of Public Perception on Covid-19 Booster Shots

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ABSTRACT (REQUIRED)

The Covid-19 pandemic, which began in late 2019, is still ongoing. Several vaccines are available in the United States, and booster doses for all adults have been approved. However, a significant proportion of people are still not willing to get vaccinated against Covid-19. The goal of the study was to detect the emotions and topics of discussion on Twitter around the COVID-19 booster shots. The emotion and common topics were discovered using sentiment analysis and topic modeling approaches. The results suggest that the public has a negative perception of booster shots in general. Positive themes include gratitude to science for vaccines and encouraging people to get vaccinated. The negative themes concern those who are dissatisfied with the government's handling of the pandemic, as well as blame the unvaccinated for the spread of the virus.

Keywords (Required)

Covid-19 vaccine, booster shots, sentiment analysis, topic modeling.

INTRODUCTION

The Coronavirus pandemic, commonly known as the Covid -19 pandemic, is an ongoing pandemic caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The first case of Covid-19 was detected in China in late December 2019 (Huang et al., 2020) and it was declared a pandemic on March 11th 2020 by the World Health Organization (WHO) (Cucinotta & Vanelli, 2020). The Food and Drug Administration (FDA) has currently approved three vaccines in the United States to fight against the pandemic. The two of the approved vaccines – Pfizer/BioNTech and Moderna require two doses of the vaccine whereas the third approved vaccine Johnson & Johnson requires only one dose. Vaccines are extremely beneficial in reducing major illnesses caused by Covid-19, but booster shots are also being advocated for the protection against new mutations in the virus due to the waning effect of first and second doses. Vaccine hesitation is a delay or rejection of vaccinations irrespective of the availability of the vaccine. Vaccine hesitancy is posing a danger to end the Covid-19 outbreak. It is considered to be responsible for lowering vaccination coverage and increasing the likelihood of a vaccine-avoidable pandemic (Dubé et al., 2013). Vaccine hesitancy is reported in previous studies related to the first doses of the Covid-19 pandemic (Daly et al., 2021; Hamel et al., 2021), and this trend might continue for the Covid-19 booster shots. Hence, this study aims to investigate the current public opinion after the availability of booster doses. In specific, it aims to determine the sentiments and emotions as well as analyze dominating themes related to Covid-19 booster doses. We utilize Twitter posts and employ Machine Learning (ML) techniques to learn the sentiments and topics. The findings could aid public health officials in developing effective policies to increase vaccination adoption.

PRIOR WORK

Various studies have performed investigations around the public perception of the Covid-19 vaccine research area using different methods such as web-based surveys and exploratory studies. Yadete et al. (2021) conducted a cross-sectional study to assess hesitancy and its associated factors for Covid-19 booster shots. The results suggest that 38% of the participants were hesitant about the booster shot. Also, the hesitant group had a low vaccine confidence index and vaccine literacy mean scores. Similarly, in another study (Pal et al., 2021), the authors examined the attitude towards booster shots among healthcare workers. They reported only 14.3% of respondents of the vaccine-hesitant group intended to take a yearly Covid-19 booster dose. The hesitant group also showed mistrust in regulatory authorities, government, and pharmaceutical companies. These studies have gathered data manually and the number of respondents is relatively low when compared to opinions obtained from the Twitter platform. Hence, this study leverages a high volume of opinions that are of free speech form and ML techniques to perform automated analysis. The goal of the study is to learn the current attitude toward Covid-19 vaccines specifically booster shots and examine if there is a shift in attitude comparing the previous doses of the vaccine.

METHODOLOGY

Data Collection

In this study, we extracted pertinent data from the Twitter platform utilizing the Twitter API. We utilized TwitterR (Gentry, 2015) package developed in the R programming language. The tweets were gathered three weeks before the FDA approved the booster doses for certain high-risk individuals i.e., September 22nd, 2021 (Commissioner, 2021a). In essence, our search query focused on tweets about booster shots written in English and posted between September 1st and February 15th, excluding retweets, and limiting the location to the United States. Tweets were collected using hashtags such as #BoosterShots, #booster, #boosterdose, #BoosterJab, #OmicronVariant, and #OmicronVirus. We also added hashtags about the omicron variant because it was discovered around the same period (December 1st 2021) (CDCMMWR, 2021). The total number of tweets in our final dataset is 23,244.

Data Analysis

Initially, data preprocessing is performed. This involved tokenization, removal of stop words, punctuation marks, and URLs. Lemmatization has also been performed to eliminate inflectional ends from words, retaining only the dictionary form. We obtained a corpus of tweets for text mining after preprocessing the data. Next, we performed sentiment analysis, emotion analysis, and topic modeling. In sentiment analysis, posts are classified as positive, negative, or neutral. SentiStrength (Thelwall, 2017) was used since it is one of the best tools available (Ahmed Abbasi & Dhar, 2014). SentiStrength classifies tweets using a lexical approach. SentiStrength reverses the sentiment of words followed by a negating word (e.g., I don't like you) while neutralizing negative terms (e.g., I don't hate you). Emotion analysis is also performed to categorize the tweets into eight emotions. We utilized the National Research Council (NRC) Sentiment Lexicon developed by Saif Mohammad (Mohammad & Turney, 2013) to classify the tweets into emotions “anger”, “anticipation”, “disgust”, “fear”, “joy”, “sadness”, “surprise”, and “trust”. The NRC Lexicon employs a different sentiment lexicon called Negated Context Lexicon to detect the emotion of words in negated connotation. Furthermore, we conducted topic modeling to learn further about the ongoing booster shot discussion. Topic modeling is an unsupervised Natural Language Processing technique for representing text documents using a set of topics that describe the content in each document. Topic modeling was performed using the Latent Dirichlet Allocation (LDA) (Blei, 2003) method.

RESULTS AND DISCUSSION

We mined a total of 23,244 tweets between September 1st, 2021, to February 15th, 2022. As seen in Figure 1, there was a slight rise in the number of tweets at the beginning of September. However, the trend did not continue in October but began to pick up in November. Late November has a sharp spike, which might be attributed to the approval of booster doses for all adults, which was announced on November 19th, 2021. (Commissioner, 2021b). While there was a brief drop in the first week of December, it quickly rebounded with over three thousand tweets by late December. The number of positive cases in the United States surged in December and January as a result of the new variant discovered. (CDC, 2020). Furthermore, from January through February there is a steady decrease in tweets. So much so that on February 15th, there were only 50 tweets about Covid-19 booster doses. This can be linked to a drop in the number of Covid-19 positive cases in the United States. (CDC, 2020).

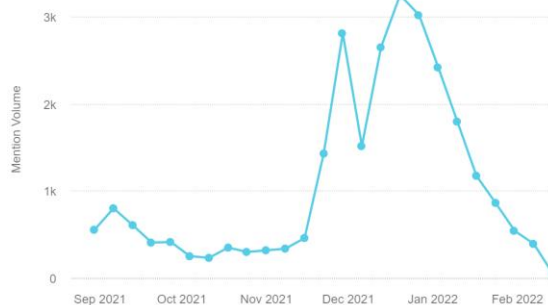


Figure 1. Tweet volume on Covid-19 booster doses

Sentiment and Emotion Analysis

Sentiment Analysis offered an overview of the opinions by categorizing them as positive, negative, or neutral. Figure 2 illustrates that the public's general opinion of booster doses is negative (31%). On the other hand, only a small percentage of tweets are positive (8%). In addition, a large portion of tweets are classified as neutral (61%).

Emotion analysis enhanced sentiment analysis results by providing insight into the various emotions expressed in tweets. From figure 2. b. it is evident that negative emotions such as fear (18%) and sadness (14%) predominate. In addition, anger, and disgust account for 10% and 8%, respectively. Positive attitudes of trust and anticipation, on the other hand, are prevalent, with trust being the highest reported emotion (19%) and anticipation being 14%. In addition, 9% of tweets indicate joy, while 8% express surprise. The public is fearful about the surge in cases caused by the new strain and urging the unvaccinated population to get vaccinated and boosted to avoid severe illness and to curb the pandemic. This indicates that people are still not confident about the vaccine. People have also voiced their anger with the unvaccinated, condemning them for endangering the lives of others. On the other hand, a substantial number of tweets express trust in medical authorities and science.

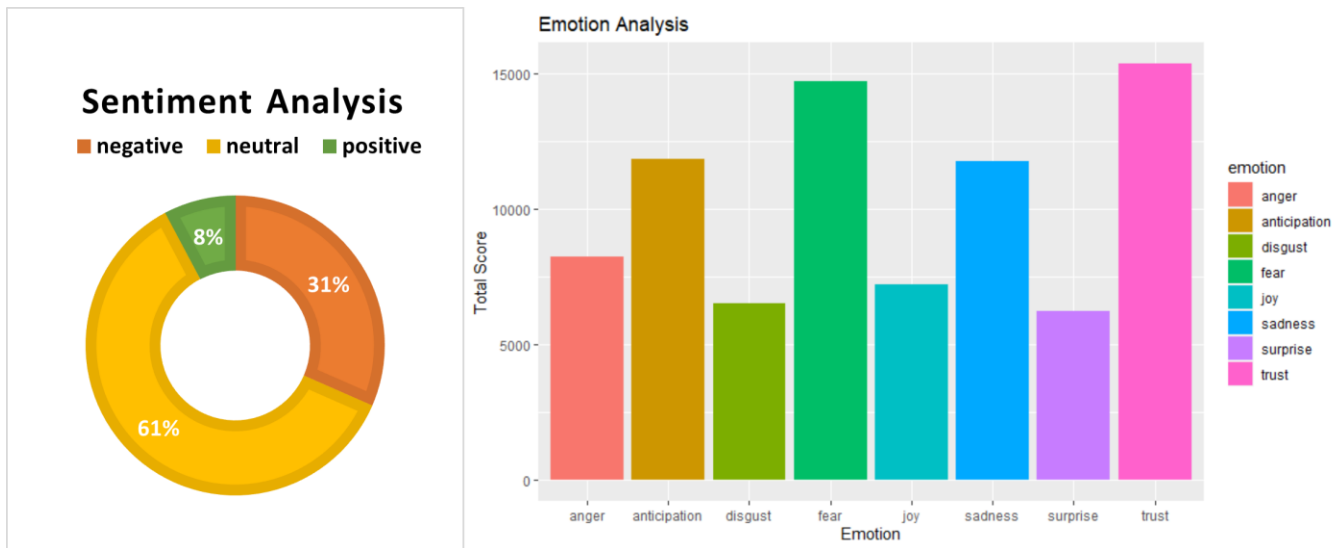


Figure 2.a. Sentiment Analysis on booster dose and Figure 2.b. Emotion Analysis using NRC lexicon

Topic Modeling

We then performed topic modeling to learn about the popular themes discussed related to the Covid -19 booster doses. We calculated topic coherence scores for various numbers of topics before deciding on the ideal number of topics that produced the best coherence score. We discovered a total of ten topics with four positive topics and six negative topics.

Table 1 shows the four topics that are related to positive sentiment tweets, as well as the top ten most prevalent keywords in each topic. Topic 1 is related to people expressing their happiness to receive their booster doses. Topic 2 is linked to encouraging friends to get vaccinated and get booster shots as an increase in cases is observed due to the Omicron variant. Topic 3 can be attributed to people feeling happy that they had little to no side effects after receiving the booster shot. Topic 4 pertains to sentiments of safety and gratitude for science owing to booster shots. All these topics demonstrate people's faith in vaccines. It also indicates that individuals are willing to follow recommendations and take measures like getting fully vaccinated with booster doses, wearing masks, avoiding social contact, and encouraging others to become fully vaccinated and boosted.

No.	Topic 10 words	Labeled Topic
1	['booster', 'grateful', 'win', 'forward', 'health', 'wear', 'boostershot', 'glad', 'look', 'mask']	Happy to receive the booster shot.
2	['spread', 'boost', 'community', 'friend', 'mask', 'vaccine', 'safe', 'pandemic', 'good', 'protect']	Encouraging others to get vaccinated and wear masks as the number of cases are rising due to the Omicron variant.

3	['life', 'flu', 'effect', 'make', 'arm', 'thank', 'vaccine', 'boost', 'great', 'feel']	People express that they had little to no side effects after receiving the booster shot.
4	['hope', 'holiday', 'science', 'thank', 'proud', 'mask', 'safe', 'boost', 'love', 'happy']	Happy to feel safe during holidays and thankful to science.

Table 1. The positive topics related to the Covid-19 Booster shots

Table 2 describes the negative topics. Topic 1 can be associated with people being worried about the risks that the unvaccinated might cause. Based on the top words of topic 2, it can be related to people being upset with the government measures taken to curb the virus and blaming the unvaccinated for spreading the virus. Topic 3 concerns those who have had symptoms because of testing positive for omicron and the results of rapid tests. Anti-vaxxers are outraged with the government for enforcing vaccination requirements because they believe in natural immunity, therefore many are refusing to get vaccinated or boosted for Covid-19. Topics 5 and 6 are related to people who are upset at those who refuse to get vaccinated and demand them to get vaccinated to prevent the virus from spreading. And they are concerned about the overwhelming effect of the increase in cases, which is hurting health personnel, as well as the general cancellation of activities and flights, as well as lockdowns. People expressing concerns about the unvaccinated and the overall harmful impact of the new Covid-19 variant are among the negative themes. Furthermore, there is still a group of people who do not believe in vaccinations and are unwilling to get vaccinated or receive booster doses.

No.	Topic 10 words	Labeled Topic
1	['kill', 'care', 'health', 'risk', 'pandemic', 'week', 'unvaccinated', 'life', 'death', 'case']	Worried about the risk of life due to the unvaccinated.
2	['surge', 'live', 'blame', 'government', 'spread', 'life', 'covidvariant', 'unvaccinated', 'pandemic', 'die']	People blame the government and the unvaccinated for the surge in cases.
3	['rapid', 'cold', 'negative', 'boost', 'day', 'positive', 'feel', 'symptom', 'sick', 'test']	People falling sick due to the omicron variant.
4	['mandate', 'thank', 'protect', 'bad', 'tell', 'immunity', 'government', 'boost', 'travel', 'die']	Unhappy with the government due to vaccine mandates.
5	['pandemic', 'mask', 'variant', 'refuse', 'covidiot', 'make', 'spread', 'antivaxxer', 'vaccine', 'kill']	People are upset with anti-vaxxers and encourage them to get vaccinated.
6	['shut', 'negative', 'cancel', 'positive', 'nurse', 'die', 'doctor', 'shit', 'hospital', 'test']	People are worried due to the increase in hospitalizations and anticipate shutdowns.

Table 2. The negative topics related to the Covid-19 Booster shots

CONCLUSION

In this study, we presented a detailed evaluation of Twitter posts about Covid-19 booster shots. We looked at attitudes and conversations about booster doses in the early stages. The results of this study indicate that people are fearful of the new variant and how unvaccinated can further delay the end of the Covid-19 pandemic. However, it was also observed that many people are willing to take booster doses to reduce the risk of severe illness. The study also demonstrated how machine learning could be used to gain insights from large datasets. Automating the examination of social media data may be utilized to efficiently monitor public sentiment in real-time. The administration can take necessary efforts to enhance vaccination uptake by analyzing the elements that lead to positive and negative emotions. The data is only collected for a short period and primarily focuses on tweets written in English; thus, it does not represent the entire population. Future studies could incorporate data from a broader sample of the population and over a longer period. Furthermore, other features such as demographic data, the number of retweets, and the impact factor may be evaluated using complicated text analysis algorithms to obtain additional insights.

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