Studying Public Perception of Covid-19 Vaccination in Pediatric Age Group: A Sentiment Analysis of Tweets

Pranav Aiyer[1]; Aysushi Mendiratta[2]*; Alaa Sheta[3]; Munish Sharma[4]; Salim Surani[5]

[1]Quarry Lane High School, Dublin, CA, USA.

[2]Internal Medicine Resident, Parkview Health System, Pueblo, CO, USA.

[3]Division of Computer Science, Southern Connecticut University, New Haven CT, USA.

[4]Division of Pulmonary & Critical Care Medicine, Baylor, Scott & White, Temple, Texas, USA.

[5]Division of Pulmonary Critical Care, Texas A&M University, Corpus Christi, TX, USA.

Abstract

Purpose: The COVID-19 pandemic in 2019 led to the biggest public health crisis in modern times and triggered a global effort to rapidly develop and deploy covid vaccines. This, in turn, led to a sharply divided opinions in the public about the safety of the vaccines, particularly around vaccine mandates and especially more polarized in children. The goal of this study was to use Twitter sentiment analysis to gauge public attitudes as expressed on social media towards the kids' vaccination for COVID-19.

Methods: To collect data for this sentiment analysis project, the Twitter Application Programming Interface (referred to as "API" from here on) was used to scrape relevant tweets containing the keywords "covid vaccine" and "kids" for the time frame December 2020-December 2022, and the number of tweets to ensure a manageable dataset. The data was then converted into a readable format for further analysis. After data cleaning and preprocessing, we performed sentiment analysis on the-leaned and pre-processed tweets using Text Blob. The results were then visualized using Tableau to clearly and concisely represent the sentiment analysis results and identify any trends or patterns.

Results: The sentiment analysis showed that overall, 48% of tweets scored a positive sentiment, while only 21% had a negative sentiment, with 31% neutral. Over 50% of the tweets were from the USA, with India having the next highest number of tweets based on location. Verified users accounted for only 17% of the tweets.

Conclusions: The positive sentiment towards the COVID-19 vaccine and kids suggests that there is a general acceptance and support for the vaccine among the public. Public perception tends to correlate with the perception of risk and fear, as well as with media efforts aimed at promoting vaccination adoption.

Introduction

The COVID-19 pandemic represented one of the biggest public health crises of our time [1]. The sheer scope of morbidity and mortality associated with the disease as well as the social and economic impact of a shutdown, led to an unprecedented global development program for covid vaccines to help mitigate the rapid spread of covid virus and enable the easing of stringent global lockdowns [2]. The ensuing rapid development and distribution of vaccines generated substantial public debate and discourse about the safety and efficacy of vaccines and particularly over issues related to informed consent and vaccine mandates. These discussions became especially amplified in the context of the use of covid vaccine in children, with vaccine hesitancy becoming more prominent than it had been in adults. Since most children with covid19 infection either are asymptomatic or have a very mild illness, there was significant controversy about the role of covid vaccination in the pediatric age group [3,4]. A survey study from Singapore found about one-third of the parents were somewhat hesitant about COVID-19 vaccination for their children [5]. Another survey-based study done in Taiwan to assess parental hesitance showed that 64.1% of parents were hesitant to get their children vaccinated [6]. Sentiment analysis has emerged in recent times as a useful way of assessing the public's attitudes towards many healthcare topics and has been particularly helpful in relation to vaccination, including children's vaccination [7,8]. The objective of this report is to provide insight into public sentiment toward kids' vaccination for COVID-19 based on data collected from Twitter. The report will provide a comprehensive overview of the methodology and results of the sentiment analysis, along with key findings and conclusions about the public sentiment toward kids' vaccination for COVID-19.

Methods

Data collection and preparation

Twitter API was used to scrape relevant tweets containing the keywords "covid vaccine" and "kids." The data collection process was limited to a certain time period and the number of tweets to ensure a manageable dataset. The data was collected in JSON format and converted into a readable format for further analysis.

Data cleaning and preprocessing steps

To ensure that the dataset was as clean and accurate as possible, the following data cleaning and pre-processing steps were performed:

1.	Removing duplicates: Any duplicate tweets were removed.

2.	Removing retweets: Retweets were also removed.

3.	Removing URLs, Special Characters, and Stop Words: Any URLs, special characters, and stop words were removed.

4.	Text Normalization: The remaining tweets were normalized by converting all text to lowercase, removing punctuation, and stemming or lemmatizing words to reduce them to their root form. These processes are internally done in TextBlob.

Sentiment analysis

Sentiment analysis was performed on the cleaned and pre-processed tweets using TextBlob, which is a Python library used for processing textual data and performing various NLP tasks, including sentiment analysis. The sentiment polarity generated by TextBlob ranges from -1 (strongly negative) to 1 (strongly positive), allowing for easy categorization of the tweets as positive, neutral, or negative. Tableau, which is a powerful data visualization tool that allows for the creation of interactive and engaging visualizations from large datasets, was used to visualize the results of the sentiment analysis performed on the tweets collected from Twitter about the topic of COVID-19 vaccination for kids.

Results

47.81% of tweets expressed a positive sentiment, with 31.48% classified as neutral and only 20.71% expressing a negative sentiment. Analysis of the data using Tableau software produced several visualizations that provided further insights into the sentiment trends. The Sentiment Pie Chart revealed that public sentiment towards COVID-19 vaccination for kids was largely positive, with only a relatively small proportion of negative tweets. The chart helped us understand the overall sentiment distribution and provided valuable insights into the topic, as shown in Figure 1.

The Sentiment Trend Analysis, which analyzed the sentiment fluctuations per month over a period of two years, showed that the positive sentiment remained consistently good throughout the period. However, sentiment peaked from September 2021 to December 2021 (Figure 2).

The Top 10 Location Wise Tweet Count Horizontal Bar Chart provided a clear representation of the geographic distribution of the tweets. It helped us to understand which areas were discussing the topic of COVID-19 vaccination for kids the most (Figure 3). The Top Source Label Bubble Chart displayed the distribution of tweets based on the source used to post them, Figure 4 and the Hour Wise Tweets Line Chart revealed that most of the tweeting about COVID-19 vaccination for kids took place in the afternoon and evening, with relatively low activity in the early morning (Figure 5,6). The Engagement Trend-Line Chart showed the trend of multiple engagement matrices of tweets, such as retweets, replies, likes, and quotes, and highlighted the period of high engagement during October and November 2021 (Figure 7).

The Word Clouds, which displayed the most frequently occurring words in a set of text data, provided insights into the most commonly used hashtags related to the topic (Figures 8-10). Overall, the sentiment analysis and subsequent visualizations revealed a largely positive sentiment toward the COVID-19 vaccination for kids and identified areas and periods of higher engagement with the topic.
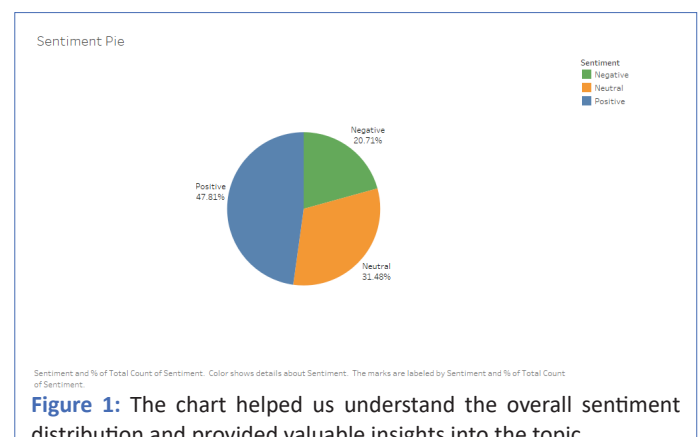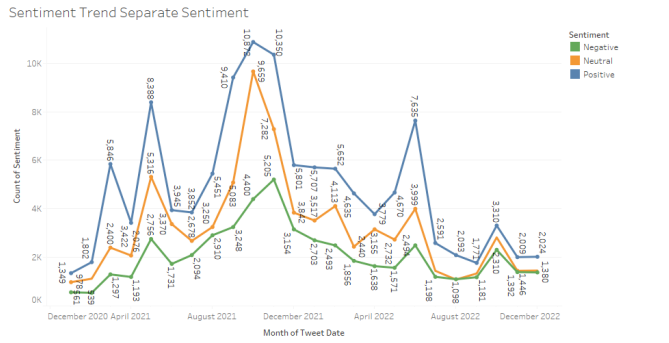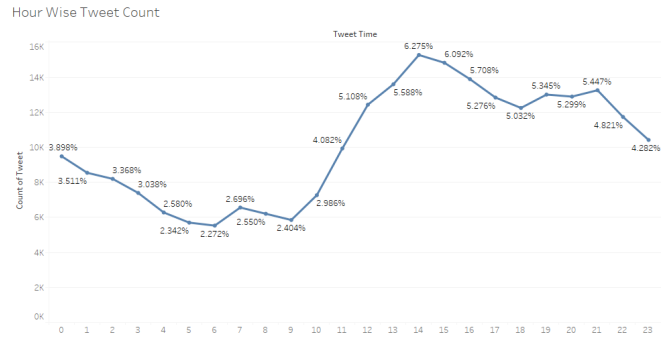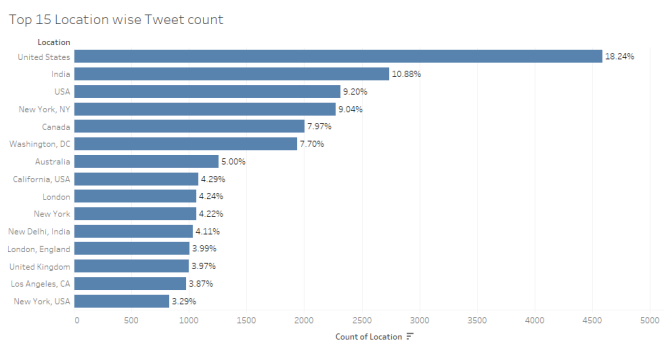

Figure 1: The chart helped us understand the overall sentiment distribution and provided valuable insights into the topic.

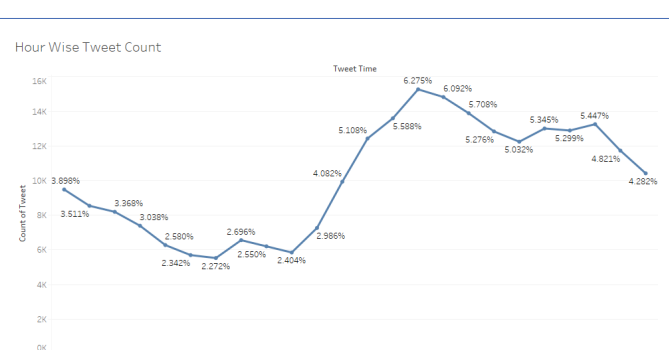**Figure 2:** September 2021 to December 2021.

Figure 3: Areas discussing the topic of COVID-19 vaccination for kids the most.
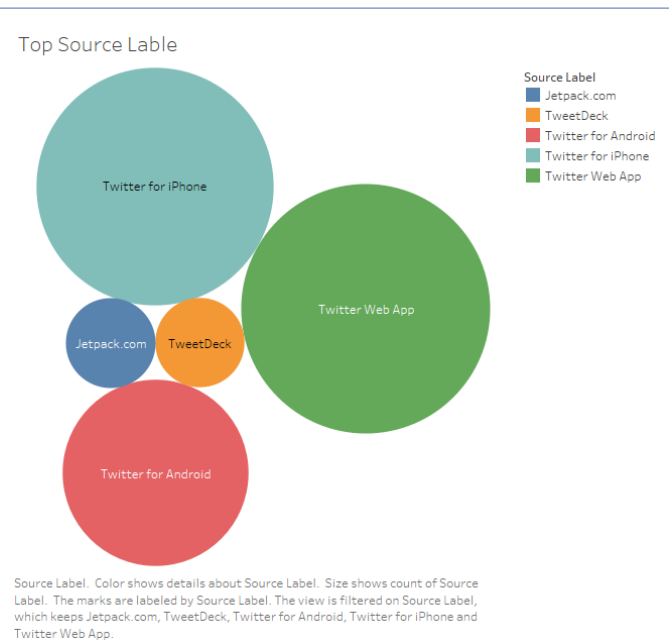
Figure 4: The top source label bubble chart displayed the distribution of tweets.
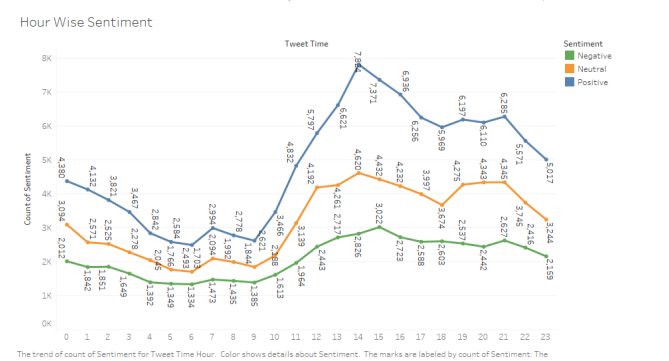
Figure 5: The top source label bubble chart displayed the distribution of tweets.

Figure 5 & 6: The top source label bubble chart displayed the distribution of tweets.

Figure 7: Highlighted the period of high engagement during October and November 2021.

Discussion

Sentiment analysis of tweets can provide insights into public perceptions and attitudes towards the vaccination, and the study presented here has analyzed the sentiment towards the kids' vaccination for COVID-19 on Twitter. Our study found that only a small proportion (21%) of the tweets expressed a negative sentiment, while 47% were positive. This finding aligns with previous studies investigating the public sentiment toward COVID-19 vaccination [9-12]. Hussein et al. (2021) studied sentiment analysis on both Twitter and Facebook in 2 countries and found that the prevalence of positive sentiment in the USA and UK was 56% & 58%, respectively [9]. On the other hand, Yousefi-

naghani et al., in their study, found that 34% of the tweets were positive while 41% were neutral, and 25% were negative [10]. Similarly, in a study in India, Praeen et al. also found that 47% of the tweets were neutral, with 17% negative [11]. Kwok et al., in their study from Australia, classified tweets as either positive or negative and found that nearly two-thirds of the tweets were positive [12]. It is important to note that all these studies were
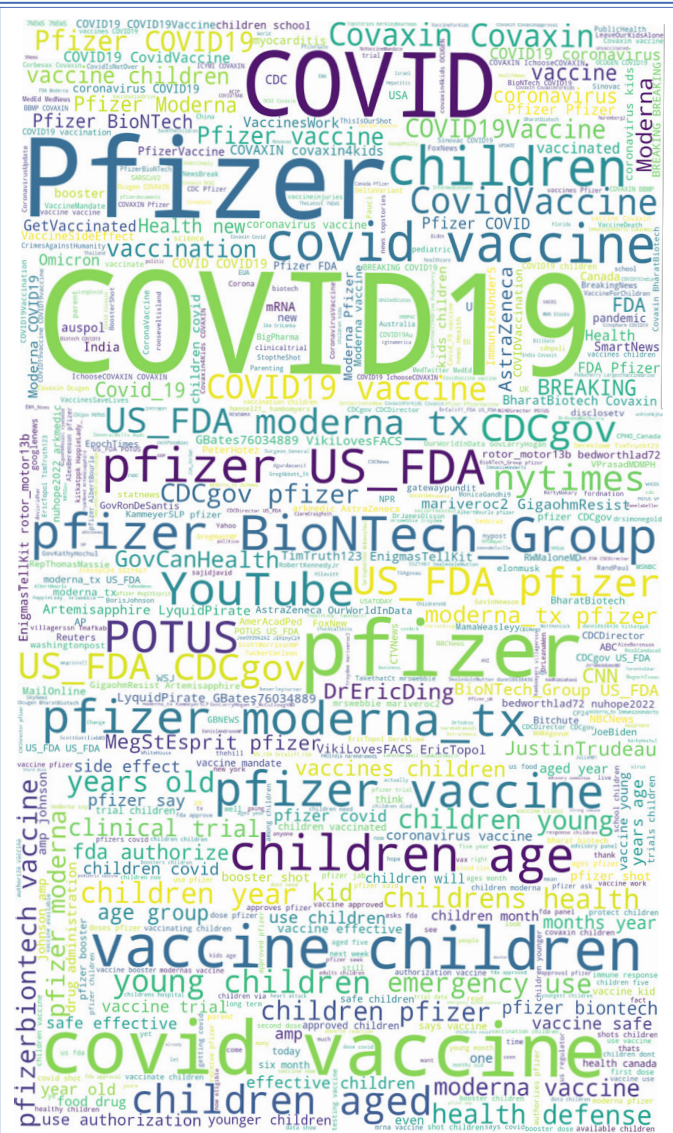
Figure 8, 9, 10: The Word Clouds, which displayed the most frequently occurring words in a set of text data, provided insights into the most commonly used hashtags.

on the sentiment towards COVID-19 vaccines in Switzerland, where positive sentiment increased following the announcement of vaccine availability (Fadda et al., 2021) [16]. Tokiya et al. also found a rise in vaccine hesitancy during the time vaccine was first launched and changed as the vaccination rollout progressed or the epidemic evolved [17].

The geographic distribution of tweets and the source used to post them provided additional insights into public engagement with the topic. Other studies have highlighted similar regional variance, with an online survey in China finding 89% of parents were willing to vaccinate their kids against covid, while another survey in Italy found that nearly 84% of parents were categorized as "pro-vaccine" [19,20].

Limitations and future work

Future studies may consider analyzing sentiments expressed on other social media platforms or in different languages to comprehensively understand public perceptions and attitudes toward vaccination. Moreover, studies should explore the impact of misinformation and vaccine hesitancy on public sentiment toward vaccination, as they have been shown to play a significant role in vaccine acceptance [21]. Sentiment analysis done in real-time could be particularly impactful for effective decision-making. Since our survey was restricted only to English, it did not adequately represent parental vaccine attitudes from non-English speaking countries. Future research should also focus on subgroup analysis of parental sentiment analysis based on ethnicity and socioeconomic status. Vaccine hesitancy has been especially notable in African Americans and in those with lower socioeconomic status [21,22]. Specific outreach efforts via social media can be targeted towards these groups as they also tend to be the demographic most severely affected during the pandemic [23].

Conclusions

In conclusion, the study presented here found largely positive sentiment toward the kids' vaccination for COVID-19 on Twitter. The findings suggest that the authorization of vaccines for children may have positively influenced public sentiment toward vaccination. The study's results can inform public health communication strategies and interventions to promote vaccine uptake and support vaccination programs.

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primarily focused on the entire population, while our study was unique in that it was specifically focused only on the pediatric use of covid vaccine. In a cross-sectional study using an online survey, Yilmaz et al., only 36% of parents were willing to have their children immunized with covid vaccine [13]. Interestingly, in a hypothetical scenario of higher mortality rates with covid in kids due to a mutation, and the parental willingness increased to 83.9%. In a similarly designed study using an online survey Babicki et al. found that 44% of those surveyed wanted their kids vaccinated as early as possible, whereas 25% of parents did not want covid vaccination for their kids [14].

The study also analyzed the sentiment fluctuations per month over a period of two years and found that positive sentiment remained consistently good throughout the period. However, sentiment peaked from September 2021 to December 2021, which coincided with the time when vaccines for children aged 5 to 11 years were authorized for emergency use in the United States. This finding suggests that the authorization of vaccines for children may have positively influenced public sentiment toward the kids' vaccination for COVID-19. A study by Lyu et al., 2021 also found that sentiment on Twitter showed changing patterns concordant with progress in vaccine development, including major milestones as well as the emergence of novel strains [15]. Similar findings were reported in a study

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