“Understanding perceptions of Twitter users towards precaution dose of covid-19”

A PROJECT SUBMITTED TO DR. D.Y. PATIL VIDYAPEETH (DEEMED TO BE UNIVERSITY) IN PARTIAL FULFILLMENT OF TWO YEARS FULL-TIME PROGRAMME M. Sc. BIOTECHNOLOGY

SUBMITTED BY

PAYAL SAKHRE

UNDER THE GUIDANCE OF

DR. RASHMI G SHINDE AND DR. SHEELA GODBOLE
at
ICMR – NATIONAL AIDS RESEARCH INSTITUTE (NARI)
PUNE

DR. D. Y. PATIL BIOTECHNOLOGY & BIOINFORMATICS INSTITUTE, TATHAWADE, PUNE – 33
(JANUARY – JUNE, 2022-23)

CERTIFICATE

This is to certify that Ms. **Payal Sakhre** has prepared this project titled "**Understanding Perceptions of Twitter users towards precaution dose of COVID-19 Vaccine**", under my guidance and to my satisfaction, in fulfillment of the requirement for M. Sc. degree in Biotechnology.

Rashmi Shinde

Signature & Seal of Guide

Guided By

Dr. Rashmi G Shinde and Dr. Sheela Godbole

at

ICMR – NATIONAL AIDS RESEARCH INSTITUTE (NARI)
PUNE

Director
Dr. D. Y. Patil Biotechnology & Bioinformatics Institute,
Tathawade, Pune - 33

ACKNOWLEDGEMENT

It has been an immense pleasure for me that I am getting this great opportunity of writing this dissertation project report on the work I have done at **ICMR - National Aids Research Institute (NARI), Pune.**

I am immensely grateful to my co-guide **Dr. Sheela Godbole, Director and Scientist G, ICMR - National AIDS Research Institute, Pune**, for granting me the invaluable opportunity to benefit from her guidance.

I would like to express my gratitude to my mentor, **Dr. Rashmi G Shinde, Scientist B, Division of Disease Elimination Sciences, ICMR-National AIDS Research Institute, Pune** for assisting me in conceptualizing and effectively executing my project, as well as for her patient instruction, passionate support, and helpful feedback for my project work.

I want to express my gratitude to **Dr. Megha Mamulwar, Mrs. Suvarna Sane, Dr Amrita Rao and Dr. Prajakta Kadale,** for their constant suggestions and assistance during my project work. Their suggestions helped me significantly in completing a high- quality project. I am grateful to them for assisting me with many methods required for the findings and keeping me motivated throughout the project duration.

I would like to convey my heartfelt appreciation to our college's Director **Dr. J. K. Pal** and **Dr. Neelu Nawani** for providing me a great opportunity to work in this institute.

I extend my heartfelt appreciation to **Dr. Harsha Chandwani** for their unwavering support, continuous communication, and invaluable assistance throughout the duration of this project.

I am glad to express my thanks to all my teachers **Dr. Minal Wani, Dr. Rajesh Kumar Gupta, Dr. Rachna Pandey, Dr. Supriya Kore, Mr. Amol Salagare, Dr. Amit Ranjan, Dr. Swapnil C. Gaikwad, Dr. Sarika Vishnu Pawar, Dr. Arvind Goja, Dr. Satish Sasikumar, Dr. Manisha Junnarkar, Mr. Sampatkumar Ashok Jadhav, Dr. Ashwini Puntambekar, Dr. Allika Sailaja, Dr. Ganesh Patil, Dr. Jyoti Amol Deshpande, Dr. Satish Raut, and Dr. Supriyo Chowdhury** for their valuable advice and teaching and support and not only for internal presentation but also for their participation in my Master's journey.

Then I want to express my gratitude to my **parents** and **friends** for their invaluable ideas and advice during the project's different stages.

And special thanks to my dearest friends **Ms. Pooja Singh** and **Mr. Jayprakash Chouhan** for their support and always being there for me when I need them.

-

- **Payal Sakhre**

CONTENT

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1:

INTRODUCTION

INTRODUCTION

A new worldwide public health catastrophe (disaster) emerged as a result of the rapid spread of the coronavirus illness COVID-19, which first appeared in Wuhan, China, in early December 2019. There are confirmed cases of COVID-19 in practically every country in the world. The respiratory illness COVID-19, which is brought on by the SARS CoV-2 virus, has symptoms ranging from asymptomatic to mild or severe consequences, such as respiratory distress, pneumonia, and death. [1] The use of non-pharmaceutical therapies, including facemasks, quarantines, and social distancing, has shown some promise in reducing the spread of the illness. [2] When implemented globally, a safe immunization program with significant therapeutic advantages is thought to be a good long-term option.

The vaccine was administered to different age groups of people. In terms of the effectiveness of the vaccine, WHO found that some people who are vaccinated against COVID-19 will still get sick and have a vaccine breakthrough infection because no vaccine is 100% effective. [3]

The vaccines which had received Emergency Use Authorization in India by August 2022 included Covishield, Covaxin, Sputnik-V, CORBEVAX™, Covovax, ZyCoV-D, GEMCOVAC™-19. However, currently in India, Covishield, Covaxin, Sputnik-V, CORBEVAX™, and Covovax are the vaccines that are readily accessible. International vaccines include CONVIDECIA, NUVAXOVID™, CoronaVac, SpikeVaz, VAXZEVRIA, COMIRNATY, COMIRNATY®Original / Omicron BA.1, BA.4-5 but not all of them are available in market. [4, 5, 6, 7].

While the initial two doses of the COVID-19 vaccination can protect people against serious COVID 19 cases and death, protection eventually starts to decrease unless it is boosted. [8] The Indian government declared a precautionary dose of COVID vaccinations available to the demographic group of 18 and over at private vaccination facilities. The administration of the precautionary dose to the 18+ population began on April 10 (Sunday), 2022, through private vaccination centers. [9]. Starting from 15th July 2022, a 75-day event called 'COVID Vaccination Amrit Mahotsava' provided free Precaution Dose at all Government COVID

Vaccination Centres (CVCs) for adults aged 18 years and above. This special COVID vaccination drive was being implemented in a 'Mission Mode' as part of the celebration for Azadi ka Amrit Mahotsav. [10]

A COVID-19 booster shot improves the body's immune response. [11] As per World Health Organization, "Booster doses are administered to a vaccinated population that has completed a primary vaccination series (currently one or two doses of COVID-19 vaccine, depending on the product)". The objective of a booster dose is to restore the effectiveness of a vaccine that has been deemed no longer sufficient. The objective of an additional dose in the primary series is to enhance the immune response and establish a sufficient level of effectiveness against disease [12]. In particular, immunocompromised individuals often fail to mount a protective immune response after a standard primary series [13]. The vaccination must significantly lower morbidity and mortality, which is advantageous for both the public and healthcare professionals. [14].

It was reported by the CDC (Centers for Disease Control and Prevention) that 27.1% adults and 18.5% adolescents took the booster dose, they also mentioned that additionally, "39.4% of adults and 52.0% of adolescents had parents who are open to booster vaccination" in the month of September 2022. [15]

As of July 2022, WHO reported, over 567 million confirmed cases and over 6.3 million deaths had been reported globally. [16] Worldwide, mass vaccination was one of the major strategies for ensuring immunity and protection in the general population. The most urgently required invention was a COVID-19 vaccine, on which numerous research and development organizations worldwide were actively engaged.

Social media is a platform for people to connect globally and exchange stories, advice, knowledge, and opinions. [17] Twitter has grown to be a significant social media outlet, providing researchers with a means of observing how the public is reacting to the outbreak. [18] Twitter has made a significant contribution by making it simple for everyone—from

public officials to people—to share and consume visual and multimedia infection prevention and control information. [19]

Twitter is used in health research by network analysis, content analysis, surveillance, engagement, recruiting, and engagement. The most popular research areas are infectious disease and public health [20].

Numerous viral messages related to the COVID-19 outbreak have been circulated on social media, with people seeking feedback on social media for the effectiveness of vaccines before deciding to get vaccinated. Various research has highlighted doubts regarding the acceptability of the vaccinations regarding safety, effectiveness, efficiency, adverse effects, the necessity of the COVID-19 vaccine, misalignment with the current healthcare system, and a lack of public awareness of vaccine-treatable disorders. [21]

Prior to the vaccine's availability, studies have revealed that vaccination uptake differed significantly between nations and regions; currently, there is a rising level of COVID-19 vaccine hesitation worldwide. To obtain herd immunity, which is necessary to protect the most susceptible populations, vaccination hesitancy is a key obstacle to vaccine uptake. Misinformation is a multifaceted element that affects acceptance and demand for vaccinations in different contexts and times. Other factors include culture, religion, and other beliefs, as well as perceptions of dangers and diseases. [22]

Therefore, it is important to explore the perceptions of Indians towards COVID-19 booster doses after introducing precaution dose in India so as to understand the vaccine hesitancy and vaccine-related concerns for the precaution dose.

This study will help understand the beliefs and perceptions of citizens regarding COVID 19 vaccination and booster doses. This can help inform policy, and aid in planning and implementing adequate disease prevention strategies and public safety measures.

CHAPTER 2:

AIM & OBJECTIVE

AIM

The aim is to gain insight into public opinion towards precaution dose of COVID-19 after the government announced free precaution doses to all eligible adult population in India as expressed on Twitter.

OBJECTIVE

The objective of this study is to explore the perceptions of Twitter users in India towards precaution dose of the COVID-19 vaccine during the months of July and August 2022.

CHAPTER 3:

LITERATURE REVIEW

LITERATURE REVIEW

As per WHO, the novel coronavirus (COVID-19) rapidly spread from China to 20 other countries in early 2020, prompting the World Health Organization (WHO) to declare the outbreak a Public Health Emergency of International Concern (PHEIC). The international community mobilized to accelerate the development of interventions, using the WHO R&D Blueprint. The plan aimed to expedite the availability of effective tests, vaccines, and medicines to save lives and prevent a large-scale crisis. The need for the research community to engage in discussions, consensus-building, scientific collaborations, and efficient research was felt during the early stages of the pandemic. [23]

Chavez S et al, highlighted key aspects of COVID-19, a novel coronavirus that has significantly impacted a large number of individuals worldwide. It emphasizes the typical symptoms, the importance of considering exposure history, and the need to pay special attention to vulnerable populations. Emergency physicians are advised to gather comprehensive travel histories and suspect COVID-19 in patients displaying symptoms of an acute upper respiratory illness accompanied by fever. The prompt recognition and isolation of COVID-19 cases in the emergency department can help reduce the risk of transmission to other patients and healthcare personnel. [24]

Watson OJ et. al, work findings emphasize that COVID-19 vaccination has had a significant positive effect on the pandemic, saving millions of lives worldwide. However, the limited access to vaccines in low-income countries has hindered the full impact of vaccinations in those settings, highlighting the importance of global vaccine equity and coverage to address this disparity. [25]

In a study by Menni et al, the primary vaccination efficacy was found to be between 76- 92% within six months, but it decreased to 34-80% after six months. Booster doses were found to decrease SARS-CoV-2 infections by 65% COVID-19 related hospitalizations and deaths by 69% and 97%, respectively, compared to vaccine efficacy after six months. However, booster doses also decreased SARS-CoV-2 infections by 39% compared to vaccine efficacy within

six months. So, this study found that the vaccines currently available are effective against the COVID-19 disease, although for a short time. [26]. This lays the basis for the need for a COVID-19 booster dose because research has revealed that the impact of vaccine protection against symptomatic disease gradually diminishes over time [27].

P. Kamakshi discussed the significance of social media, particularly Twitter, in providing valuable information about health-related issues, remedies, food, and medications. also highlighted how Twitter enables users to share opinions, cooperate, and exchange messages known as "tweets." Sentiment analysis, a commonly used metric to determine positive or negative opinions, can be applied to Twitter healthcare research. Also analyzed how it helps users gain a better understanding of available alternatives and enables healthcare organizations to use reliable data for improvement. The main objective of their paper is to develop an algorithm that accurately classifies Twitter messages as positive or negative, contributing to the enhancement of healthcare standards in society.[28]

Kumar et al. from the ICMR-NIE conducted a study in Chennai, Tamil Nadu to examine community members' perceptions of COVID-19 vaccines. The results showed that although they were eager to receive the vaccine, they had concerns about its safety due to a lack of factual information, dramatic media stories, and rumors. The rapid development and approval of the vaccine as well as the drop in cases were also noted as potential barriers to its uptake. The uptake of the COVID-19 vaccination among people over 18 has been good, despite barriers, but the precaution dose has received less uptake than the first and second doses.[29]

Lyu JC et al. found their study on topic modeling of COVID-19 vaccine-related tweets. The study identified 16 topics, categorized into five overarching themes. Opinions about vaccination were the most frequently discussed topic, followed by vaccine progress and instructions on getting vaccines. The sentiment expressed in the tweets showed an overall increase in positivity, with trust being the predominant emotion. Their analysis suggests that public discussion on Twitter regarding COVID-19 vaccines was influenced by major events and reflected global perspectives. The positive sentiment and trust expressed in the tweets may indicate a higher acceptance of COVID-19 vaccines compared to previous vaccines. [30]

Wankhade M. et al. provided an overview of sentiment analysis and its associated techniques. The main objective was to explore various classification methods used in sentiment analysis, highlighting their advantages and disadvantages. They covered different levels of sentiment analysis, data collection, feature selection, and categorization systems. Supervised machine learning methods, such as NB and SVM algorithms, are widely employed due to their simplicity and high accuracy. They also discussed common application areas and addressed challenges in sentiment analysis, emphasizing the importance of domain dependence. The comparison reveals that sentiment analysis is still a relatively unexplored field, and future work aims to expand the research and address remaining challenges. [31]

Wouter van Atteveldt et al. conducted a comprehensive comparison of sentiment analysis methods, focusing on Dutch economic headlines. The performance of manual annotation, crowd coding, dictionaries, and machine learning algorithms (including deep learning) is evaluated. Their study concluded that trained humans or crowd coding achieve the best performance, while existing dictionaries do not meet acceptable levels of validity. Machine learning, especially deep learning, outperforms dictionary-based methods but still falls short of human performance. Their findings emphasized the need to validate automatic text analysis methods and provide a recommended step-by-step approach for efficient and valid text analysis projects. [32]

CHAPTER 4:

METHODOLOGY

METHODOLOGY

4.1 STUDY DESIGN

The study design employed was retrospective study design, which is used for events which have already happened in the past and the outcomes have already occurred. In this study, we used existing data of tweets made by Twitter users in India during July- August 2022 to study their perceptions towards precaution dose of COVID-19 vaccine. We employed content analysis and thematic analysis for the tweets.

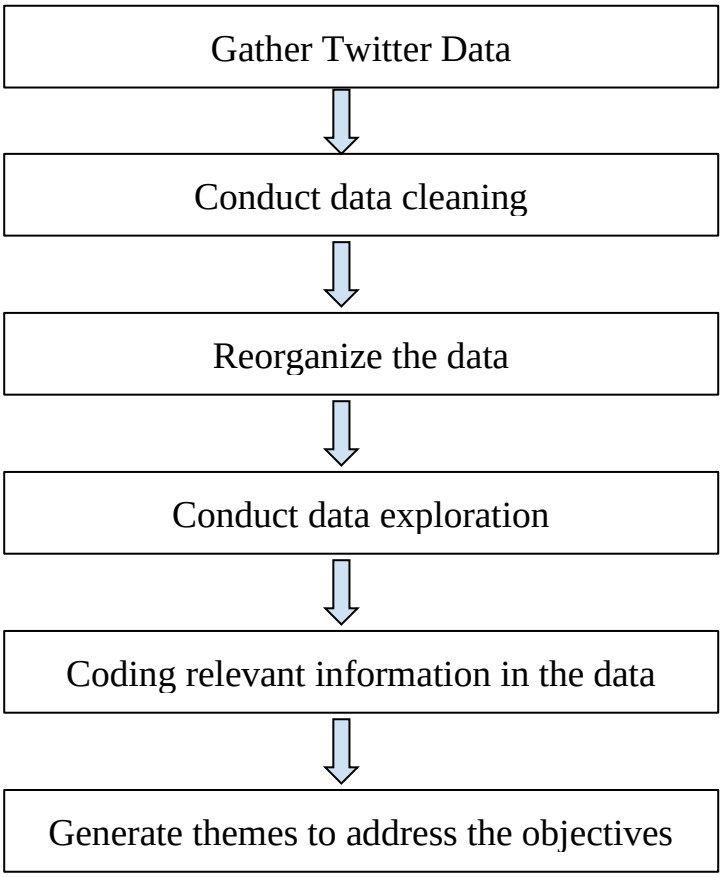


Fig 1: Flowchart outlining the methodology

4.2 DATA RETRIEVAL AND PREPROCESSING

Overview:

Tweets on COVID-19 and precaution dose were extracted under the study titled ‘Sentiment analysis of Twitter posts about COVID19 precaution dose between July 2022 and November 2022’. Of these, tweets from the month of July and August were used for the present study.

Two search strategies were used to extract the tweets. The primary distinction between the two was that the first strategy incorporated the 'OR' operator with the search terms "precaution" and "booster dose," (Search strategy number #1), while the second strategy employed the 'AND' operator for the same terms (Search strategy number #2). The first strategy was expected to produce a large number of results (many of which would possibly be irrelevant).

Our plan involved analyzing exclusively the text content of the collected tweets using Search strategy number #1. Our aim was to establish specific codes and generate a coding frame based on this larger dataset.

To facilitate the extraction of key tweets, we employed another search strategy (Search strategy number #2). By utilizing the 'AND' operator, we aimed to minimize the inclusion of irrelevant tweets, resulting in a limited number of highly relevant tweets that could be thoroughly analyzed. This in-depth analysis would help us gain insights into the perceptions of Indian twitter regarding COVID-19 precaution dose using the tweet context, related tweets, and metrics.

Ethical Considerations: The data used in this project is from an ongoing study, ‘Sentiment analysis of Twitter posts about COVID-19 precaution dose between July 2022 and November 2022’, which has been approved by the Institutional Ethics Committee of ICMR-National AIDS Research Institute.

Extraction:

Responses related to COVID-19 and precaution dose from Twitter platform were extracted using keywords from Twitter from July to November 2022 in English. Keywords, hashtags and mentions were finalized through a stakeholder consultation meeting. The keywords used for extraction are covid19, covid vaccine, Covishield, Corbevax sputnik vaccine, covaxin, Precaution Dose, Booster Dose

@JSIhealth, @MahaHealthIEC, @MantralayaRoom, @MoHFW_INDIA , @UNDP_India OR @moayush OR @COVIDNewsByMIB. The hashtags used are: #GiveSafetyAShot, #We4Vaccine , #GotTheDose, #IndiaFightsCorona, #Unite2FightCorona, #LargestVaccineDrive, #VaccinEquity , #VaccinesWork.

Search strategy number #1 incorporated the 'OR' operator with the search terms "precaution" and "booster dose,"

Search strategy number #2 employed the 'AND' operator for the search terms "precaution" and "booster dose".

Before extracting the Twitter posts, the search terms were determined. The primary focus was on keywords related to COVID-19 precaution doses and/or booster doses. The standard Twitter API, specifically the 'Tweepy tweeter version 2' library in Python version 3.8.10, was used to collect the data. Tweets were extracted using premium Twitter access , which is a paid service, to overcome limitations related to geotags and language-specific tweets that are associated with academic research API access. Initially, a quick extraction was conducted to obtain preliminary findings, which involved a limited number of keywords, hashtags, and handles. No specific limit was set on the number of tweets to be extracted.

In this study, the data preprocessing methods employed included stopword removal, tokenization, cleaning, and filtering. A qualitative approach was used to further develop themes in the Twitter data. Qualitative analysis is a valuable research approach when we want to explore complex, nuanced, or sensitive issues and gain a deep understanding of the perspectives and experiences of individuals or groups [33].

After data preprocessing, we reorganized the data, generated the code by reading the text line by line without losing the meaning of the text. We then searched for themes, reviewed the themes, and defined and named those themes. We assigned themes to each Tweet.

4.3 CODING OF THE DATA

For coding the tweets, we used content analysis and thematic analysis, which are forms of qualitative analysis: Content analysis and thematic analysis are two research methods used to analyze various forms of communication. Content analysis is used to organize and elicit meaning from the data collected and to draw realistic conclusions from it, while thematic analysis is used to identify the underlying themes and patterns within the data. By using both methods, researchers are able to gain a more complete understanding of the data, and draw more accurate and meaningful conclusions. [34, 35]

There is one more method of analysis: the machine learning approach. Machine learning enables forecasters to predict accurately without intervention. Machine learning is advantageous for producing predictions due to its speed and adaptability to changes. However, there are some limitations, too. Machine learning algorithms require time to train and learn, which requires time investment and spells increased complexity. Diagnosing and correcting prediction errors due to the complexity of algorithms and processes may be difficult as well.

In comparison with machine learning, qualitative analysis allows for a deeper understanding of complex phenomena that cannot be captured by quantitative methods alone. While machine learning (ML) could provide insights based on patterns and correlations in data, qualitative analysis could provide context and meaning to those patterns. In this study we only analyzed the data via manual qualitative analysis.

4.4 CODEBOOK

First, the coding was done manually, then each tweet was read line by line, assigning a code for each tweet. After completing the coding process, a codebook was created.

Table 1: This table showed the format of the initial version of the codebook.

themes	description	sub-themes	statement

The search strategy for extraction of tweets is detailed below:

4.5 SEARCH STRATEGY

Table 2: Search Strategy 1:

duration	July and august 2022
location	India
Search terms	Precaution or booster dose
language	English
Govt & Govt collaborators	@MoHFW_INDIA @ICMRDELHI @OfficeOf_MM @mansukhmandviya @_DigitalIndia @NHMBhadrak

	@GoI_MeitY @PIB_India @UNICEFIndia @MIB_India
News channels	@DDNewslive @ANI @PTI_News @PBNS_India @PBNS_Hindi @PBSC_Beijing
Frequently used hashtags	#AzadiKaAmritKaal #COVID19Vaccination #2YearsOfVaccineDrive #CovidIsNotOver #AmritMahotsav #BreakingNews #DigitalIndia

Table 3: Search Strategy 2:

duration	July and November 2022
location	India
Search terms	Precaution and booster dose
Language	English
Govt & Govt collaborators	@MoHFW_INDIA

	@ICMRDELHI @OfficeOf_MM @mansukhmandviya @_DigitalIndia @NHMBhadrak @GoI_MeitY @PIB_India @UNICEFIndia @MIB_India
News channels	@DDNewslive @ANI @PTI_News @PBNS_India @PBNS_Hindi @PBSC_Beijing
Frequently used hashtags	#AzadiKaAmritKaal #COVID19Vaccination #2YearsOfVaccineDrive #CovidIsNotOver #AmritMahotsav #BreakingNews #DigitalIndia

4.6 Detailed analysis of key tweets extracted using search strategy 2

For the data we got from Search Strategy 1, we identified themes for all the tweets.

For the data obtained from Search Strategy 2, we conducted a detailed, in depth analysis to understand the discussion around, context, and dissemination of the tweet. We classified the

tweets into types (tweet, retweet, reply, quote tweet). We examined various metrics associated with the primary tweet (original tweet, i.e., the tweet that was extracted and is a part of our data set) including the number of likes, comments, retweets, quote, views, and whether any documents were attached or not. [*Please refer to Section 4.7: Classification of tweets*]

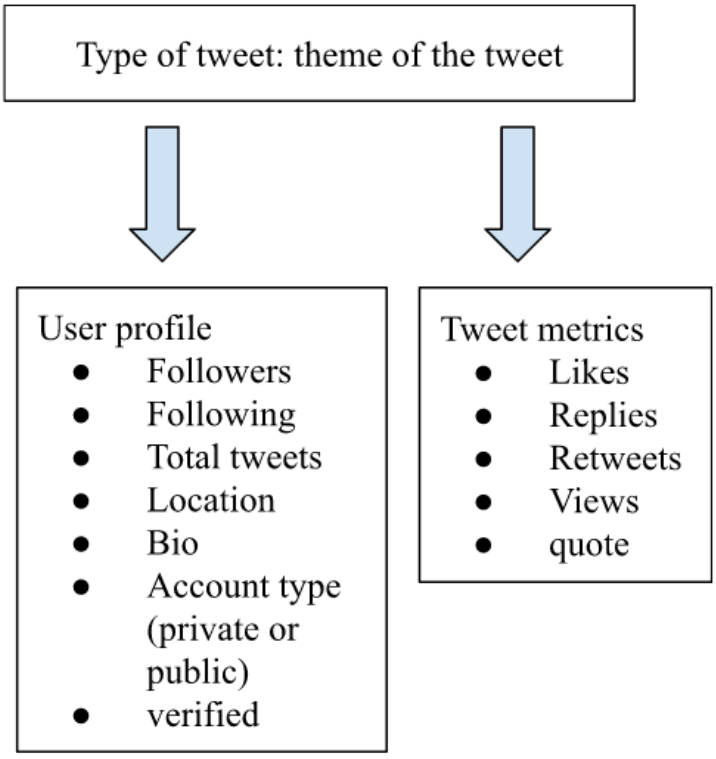


Fig 2: The workflow for conducting a detailed analysis of tweets extracted using search strategy 2 focuses specifically on original tweets.

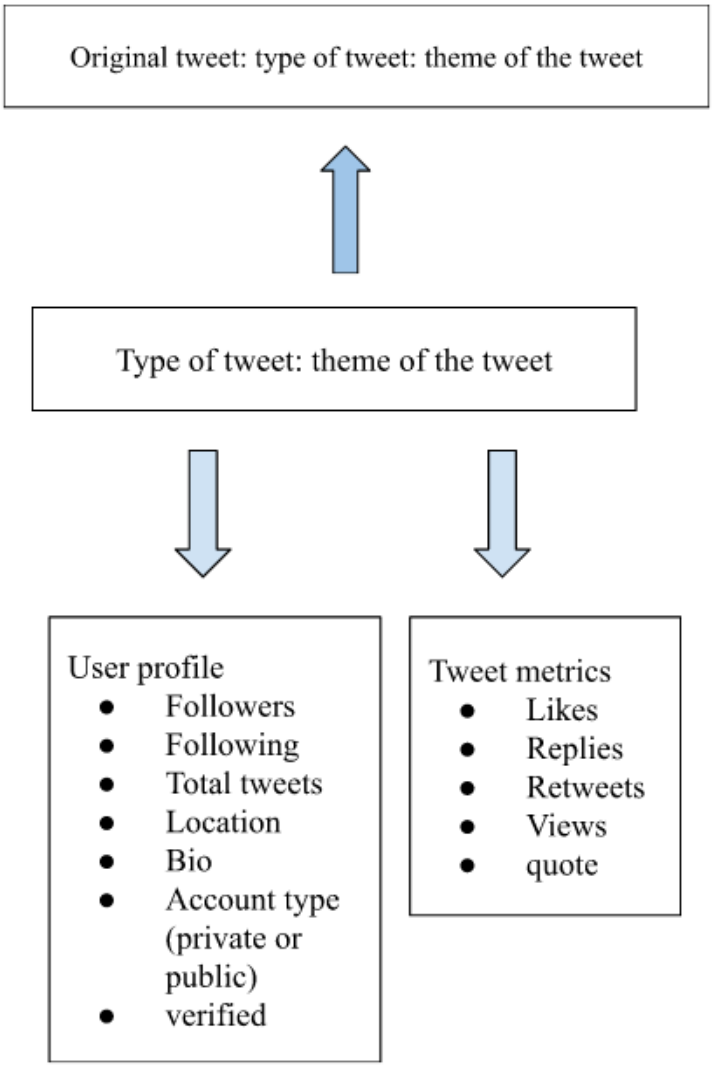


Fig 3: The workflow designed for performing an in-depth analysis of tweets obtained through search strategy 2: This was specifically customized to address situations in which the extracted tweet was either a reply or a quote retweet.

Table 4: Given below are the definitions and explanations for each of the data types that we have explored in this study. [36]

metrics	description
Tweet type	Tweet, reply, retweet, quote retweets
Likes	Likes are a feature on social media platforms, including Twitter, that allow users to show appreciation or support for a particular post or message. The number of likes a tweet receives reflects its popularity and potential strength, indicating the level of engagement and impact it generated among users.
Replies	A reply on Twitter is a comment made in response to another user's tweet. The presence of replies within the tweet thread allows for a more comprehensive understanding of the discussion and provides context to the original tweet.
Retweet	A retweet on Twitter is a feature that allows users to share someone else's tweet with their own followers. The number of retweets give an idea of how much a particular message was amplified, how viral it was, and expanded the network of the posting user on the platform.
Quote retweet	Quote retweeting plays a crucial role in facilitating conversations, sharing perspectives, amplifying content, and promoting meaningful engagement on social media platforms. If a tweet received more quote retweets, it indicates that the tweet had generated a significant level of engagement and interest among users.
Document attached	Attaching a document to a tweet enriches the information available for qualitative analysis by providing additional context, supporting evidence, source evaluation opportunities, content analysis possibilities, and facilitating deeper understanding and interpretation. Analyzing the tweet after considering the content of the attached document expands the scope and

	depth of analysis beyond the limitations of a tweet's character count, allowing researchers to gain a more comprehensive understanding of the topic or issue being discussed.
Links	The user shared new article and YouTube links in their tweet.
User profile	A user profile refers to an individual's or an organization's public-facing page that represents them on the platform. It serves as a personal or professional identity, allowing users to share information about themselves, their interests, and their activities.
Followers	Followers on Twitter represent the audience who have opted to subscribe to a user's tweets and receive updates from that user in their Twitter timeline. The follower count can indicate the size of a user's audience, this tells us many people follow a user's account and want more interaction and engagement with that user.
Following	When a user follows another user, it means they have chosen to subscribe to that user's tweets. The tweets of the user being followed will then appear in the follower's Twitter timeline, which is the feed of tweets they see when they log in or browse Twitter. These counts give an indication of the user's reach and engagement on the platform.
Bio	The bio is a short description or summary of the user's profile, which can include information about their background, interests, profession, or any other details they choose to share. It is limited to a certain character count (currently 160 characters). The bio in a Twitter profile is a valuable space to communicate identity, establish relevance, attract the right audience, and build credibility.
Location	Users can choose to display their location on their profile, indicating where they are based or where they are currently located. This information can be helpful for connecting with users in the same geographic area.

	Including location in a Twitter profile enhances the understanding of localized concerns, facilitates targeted engagement, and enables users to connect with others who share similar geographic interests or are invested in specific local issues.
Account type public or private	Public accounts offer broader visibility, reach, and networking opportunities, while private accounts provide a more restricted and intimate space for targeted communication and personal privacy. Both account types contribute to the diverse conversations and perspectives on Twitter, each with its own distinct role and set of expectations. Public or government accounts have a responsibility to share valuable and important information with the public, while private accounts offer individuals the opportunity to express personal opinions and engage in discussions within a more restricted circle.
Verified	A verified account on Twitter is typically associated with individuals, brands, or organizations that have undergone a verification process to confirm their authenticity. Verified accounts often prioritize sharing important and beneficial content for the public, the specific topics covered can vary based on the account's niche, goals, and target audience. Verified accounts strive to maintain their reputation and follower expectations by providing valuable information, engaging with their audience, and balancing public interest with personal expression.
Total tweets	This refers to the cumulative count of all the messages or posts that the user has published on the platform since they joined. It represents the overall level of activity and engagement of that particular user on Twitter. A high number of tweets suggests an active and engaged user who likely covers diverse topics, may have established themselves as a thought leader or influencer, enjoys conversations and community engagement, and potentially creates or curates content of interest to their followers.

We noted the tweet metrics of the primary tweet. Subsequently, we examined the text and identified themes. If there were any replies in the primary tweet, we extracted them.

By conducting a detailed analysis of the context of tweets, related tweets, and various metrics, and documenting the data types mentioned in the table mentioned above, valuable insights were obtained regarding certain aspects like:

- Details of the person who posted the tweet, including their occupation, location, whether they were a government agency, news agency, media outlet, a public figure or had a private account
- The user's perspective while writing the tweet
- The level of activity displayed by the user
- The user's reach, participation in discussions and engagement on the platform
- The level of engagement, interest and impact generated by the tweet.
- The discussions around topics related to precaution dose of COVID-19 vaccine
- The propagation of a particular message.

The above helped us gain an in-depth understanding of the context of the key tweets in terms of the context and the extent of the discussion and dissemination of the content of the tweet. The identified themes provide insights into the perspectives of Twitter users in India regarding the precaution dose of the COVID-19 vaccine.

We classified certain tweets into categories of positive, negative or neutral sentiment. This classification aimed to generate increased audience engagement and encourage more replies. Additionally, we analyzed all comments, examining the level of reaction to the primary comment.

4.7 CLASSIFICATION OF TWEET

Now there are three types of tweets

1. Primary tweet
2. Secondary tweet
3. Tertiary tweet

1. **Primary tweet:** Also referred to as the original tweet, the user shares a formal and appropriate tweet.
2. **Secondary tweet:** If someone retweeted or replied to the primary tweet, it would be considered a secondary tweet. For instance, when an individual posts a tweet and another person comments on it or retweets it with additional remarks, it qualifies as a secondary tweet.
3. **Tertiary tweet:** If someone retweeted or replied to a secondary tweet, it would be referred to as a tertiary tweet. For example, when an individual posts a tweet and a second person comments or retweets that tweet, and then a third person comments on the second person's comment or on the retweet, it qualifies as a tertiary tweet.

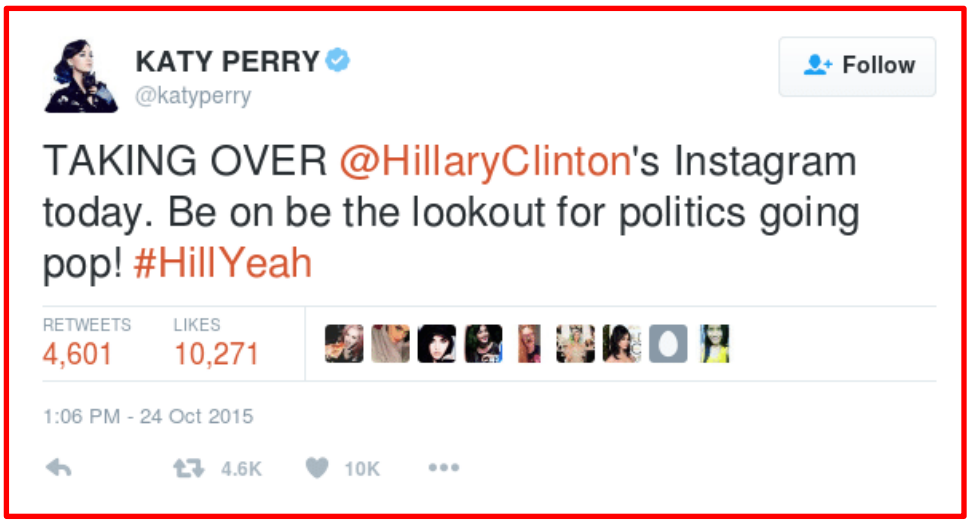
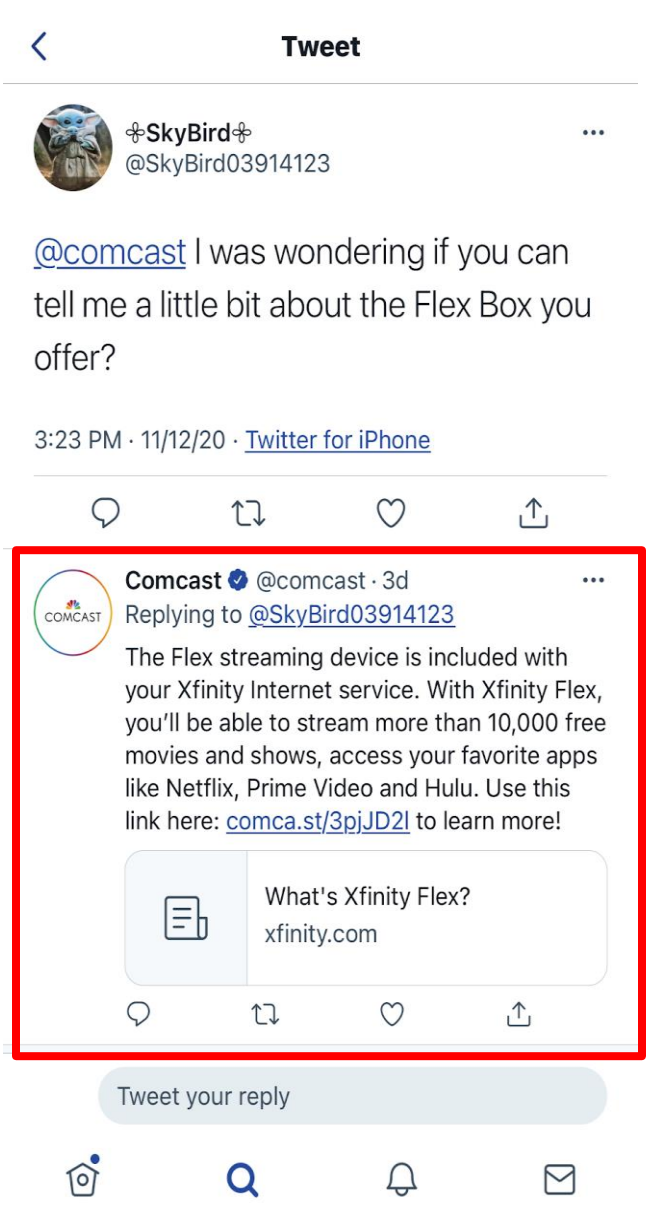


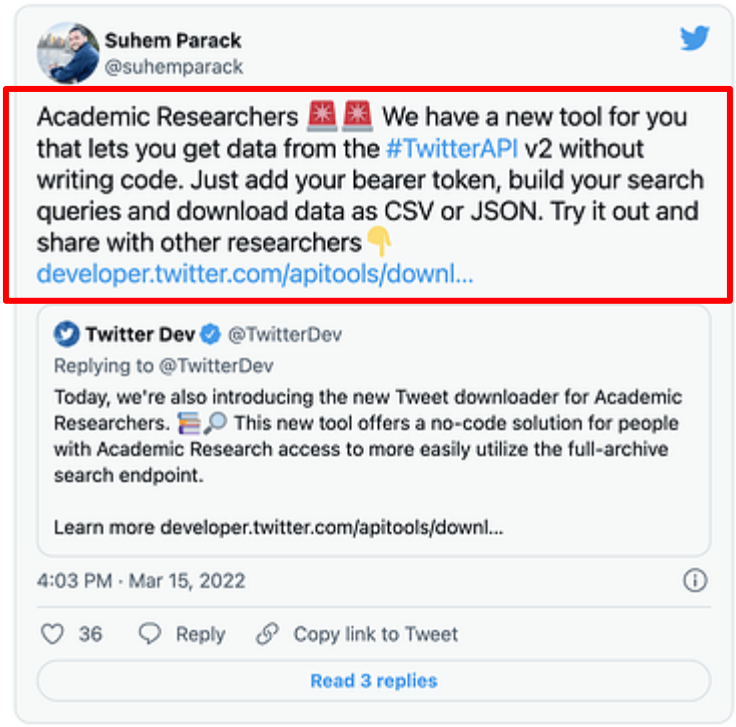
Fig 4: Representation of primary tweet [37]


Tweet
⁜SkyBird⁜
@SkyBird03914123
@comcast I was wondering if you can tell me a little bit about the Flex Box you offer?
3:23 PM · 11/12/20 · Twitter for iPhone
Comcast @comcast · 3d
Replying to @SkyBird03914123
The Flex streaming device is included with your Xfinity Internet service. With Xfinity Flex, you'll be able to stream more than 10,000 free movies and shows, access your favorite apps like Netflix, Prime Video and Hulu. Use this link here: comca.st/3pjJD2l to learn more!
What's Xfinity Flex?
xfinity.com
Tweet your reply

(a)


Thread
Podia
@podia
Our goal at Podia is to be the only platform a creator needs to go from first sale to full scale.
Over the years, creators have asked us for more help taking already-growing businesses to the next level.
Today, we're excited to launch the Earthquaker plan.
1:28 PM · Apr 15, 2021 · Twitter Web App
2 Retweets 1 Quote Tweet 14 Likes
Podia @podia · Apr 15
Replying to @podia
Starting today, upgrading to Earthquaker gets you access to a suite of advanced benefits designed to help you save time and increase revenue.
You'll get:
Podia @podia · Apr 15
1. A dedicated account manager whose job is to know your business, ensuring that your support requests are handled by the same contact whenever you need help.
Podia @podia · Apr 15
2. A 1:1 Zoom call with your account manager to walk you through any areas of Podia you need some extra help with and answer any questions — or find an answer to any questions — you might have about your business.
Podia @podia · Apr 15
3. Five team seats, so you can easily manage access for your virtual assistant, designer, or anyone else you work with on your site.
Podia @podia · Apr 15
4. White-labeling. You'll have the option to remove Podia branding from your site.

(b)



(c)

Fig 5: Representation of secondary tweet (a) reply (b) thread (c) quote tweet. [38, 39, 40]

Fig 6: Representation of Tertiary tweet [41]

Just after the announcement of the free precaution dose, people sought feedback on twitter before getting vaccinated in order to obtain right information, and not rumours or false information.

In this study, we extracted and analysed the different metrics of the tweets, based on the type of tweet to which the extracted tweet belonged. If it was a quote tweet that was retweeted (ie. a user's post with a quote), then, we analysed all tweet metrics of that tweet as well as primary tweet. This helped us better understand the thread, and follow the discussion around that tweet. This was done to understand the extracted tweet in context of the primary tweet. The thread between conversations is really helpful to understand the context of conversation, identify the

theme emerging from the discussion and understand what people thought of covid-19 booster dose.

We also extracted user details of both primary and secondary tweets. The user details gave us an idea about the background of the person writing the tweet. Below are some of the inferences that can be drawn looking at the user details.

- Tweets from government agencies and public figures are frequently regarded as authoritative and tend to be widely propagated due to their large follower base.
- Information shared by doctors, health officers, scientists, and researchers is often perceived as reliable and factual, based on scientific data. As a result, the general public tends to trust and consider such information as authentic. The discussions among scientists and researchers are frequently followed with interest by the general public.
- News outlets/ journalists have a wide following on twitter, resulting in their tweets having a broader reach in comparison to private accounts.
- If a user has a private account or is a general individual, they typically post their opinions, express their emotions or thoughts regarding something, or share their understanding of other tweets or replies.

By understanding the tweet we related the tweet context with our themes such that the theme summarized its dissemination patterns and the discussion that had occurred around it. This helped us in analysing tweets in a broader way.

The detailed content analysis of 36 tweets with the key terms of "precaution and booster dose" helped to not only find out the themes on perceptions of people towards COVID-19 precaution dose, but also explored the context of what someone wants to express. This is very useful in many areas like in psychology, public health, engineering, science, physics, etc.

Tweets are not only reflecting the perception, it also reflects someone's activity, how the user views the world, how the user is connected with the world, how professional the user is, what mindset the user has.

As we saw in the period of COVID-19, people were hesitant about taking vaccines, and vaccine acceptability was not universal. Understanding the views and perceptions of the community is important to researchers so that we can find solutions to address this issue. It would also guide government policy makers to take action so that people's concerns and queries related to health issues can be addressed in time.

4.8 SENTIMENT ANALYSIS OF TWEETS

The classification of tweets into positive, negative, and neutral categories is based on the sentiments expressed in the tweet towards COVID-19 booster doses.

In this context, positive tweets refer to those expressing support, approval, or advocacy for receiving the COVID-19 booster dose. These tweets may highlight the benefits of boosters, such as enhanced protection against the virus, reassurance of immunity, or the importance of staying updated with vaccinations. Positive tweets can also express gratitude towards healthcare workers or authorities involved in administering booster doses. **These tweets generally indicate a favorable stance towards receiving the booster dose and are considered supportive of the vaccination strategy.**

On the other hand, negative tweets are characterized by sentiments opposing or expressing skepticism towards COVID-19 booster doses. These tweets may question the necessity or effectiveness of boosters, express concerns about potential side effects or long-term consequences, or voice doubts about the overall vaccination approach. Negative tweets may also indicate hesitancy or reluctance to receive the booster dose, either due to personal beliefs, distrust, or perceived risks. These **tweets reflect a critical or dissenting perspective regarding the COVID-19 booster dose and indicate a lack of support or opposition.**

Neutral tweets, as described, are tweets that do not explicitly express a positive or negative sentiment towards COVID-19 booster doses. These tweets may acknowledge the importance of booster doses or the need for staying protected but do not indicate whether the individual has received the booster dose themselves. Neutral tweets may be informative, discussing general updates, guidelines, or precautions related to booster doses without taking a clear stance on personal preferences. These **tweets are considered neutral as they neither explicitly support nor oppose the COVID-19 booster dose.**

We used this classification only for some themes like experience and opinion.

Flowchart of our strategy

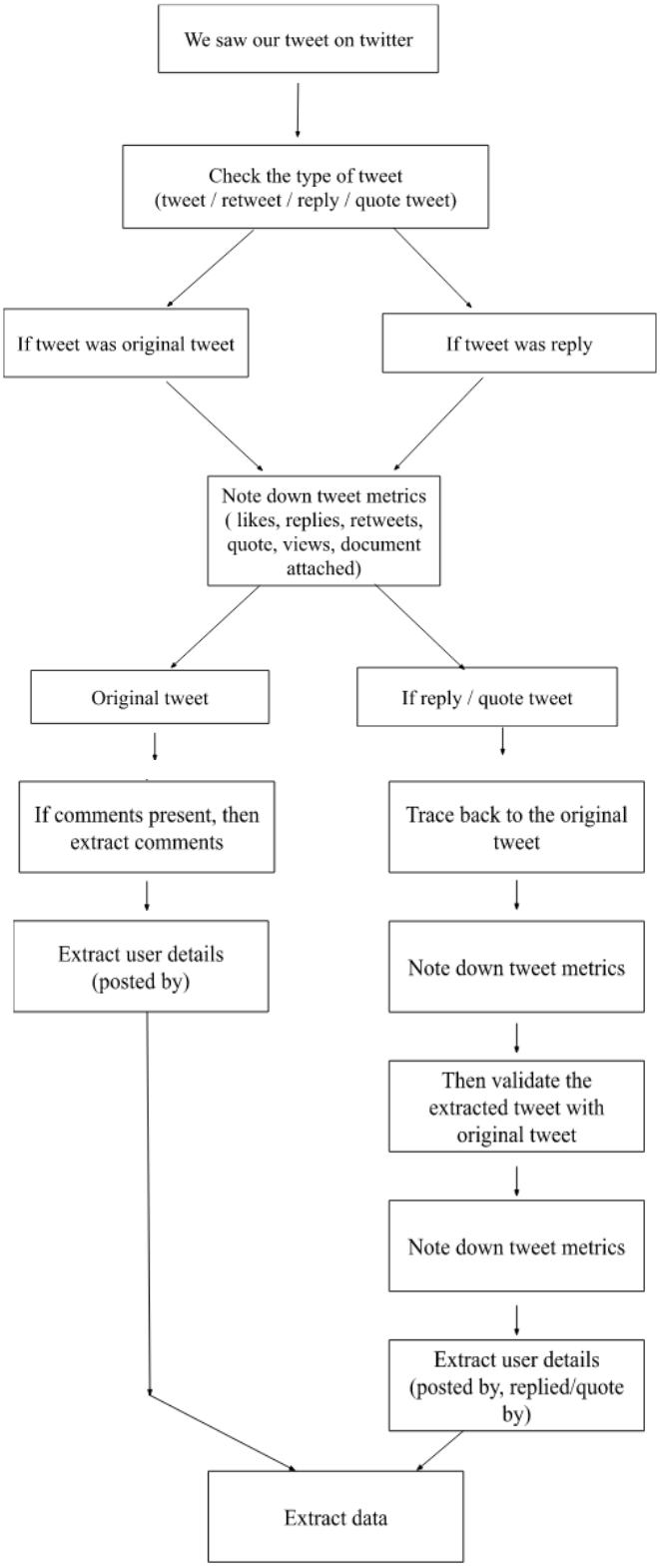


Fig 7: Workflow of tweet analysis

CHAPTER 5:

RESULTS

RESULT

A total of 1572 tweets were obtained through search strategy 1, and the qualitative thematic analysis of these tweets has identified the following themes.

Table 5: Themes classified in codes and sub-codes

themes	Codes	sub-codes
1. Resources	1.1 news	
	1.2 alert	
	1.3 information	
	1.4 update	
	1.5 Awareness and education	
2. Discussion	2.1 argument	
	2.2 despair	
	2.3 suggestion	
	2.4 caution/care	
	2.5 query/curious	
	2.6 sarcastic	
	2.7 experience	2.7.1 gratitude/appreciative
		2.7.8 proud feeling
	2.8 misinformation	

3. Concern	3.1 false message	
	3.2 side effects	
	3.3 vaccine unavailability	
	3.4 certificate issues	
4. Opinion		
5. Evidence	5.1 speculation of vaccine	
6. Promoting vaccine	6.1 vaccination camp	
	6.2 booster schedule	
	6.3 vaccination promotion	
	6.4 incentivization	
	6.6 appeal/request	
	6.7 encouragement	
7. unclassifiable		
8. Irrelevant		

Definitions of these themes are provided in annexure 1.

Findings from the analysis of the dataset consisting of 1572 tweets related to COVID-19 booster doses:

The analysis focused on identifying the prevalent themes and sentiments in these tweets. A total of eight themes were identified from the dataset, with the majority of tweets being

relevant to the topic at hand. However, there were a few tweets that were deemed irrelevant and were classified as such.

One of the dominant themes observed in the tweets was the dissemination of '**news'** and '**updates'** regarding COVID-19 booster doses. These tweets play a crucial role in providing valuable information to people who are interested in staying informed about the latest developments, guidelines, and the availability of booster doses.

By analyzing these tweets, individuals can access a wealth of information that helps them understand the current state of COVID-19 booster doses. This information can include **updates** on vaccine effectiveness, recommendations from health authorities, announcements regarding booster dose eligibility criteria, and details about vaccination centers where booster shots are available.

Tweets under the theme '**concern'** formed the next common set of tweets. These were related to covid-19 vaccination and included tweets on false information/ messages received, queries/worries on side effects and efficacy of vaccines, certificate issues or some traveling related issues.

The next common theme identified was '**discussion'** which were regarding the administration of booster doses to individuals who have already received or not received or thinking of taking booster shots. In this, many users expressed their experience after taking COVID-19 booster dose which was some of which were positive sentiment and appreciation for the useful information provided by others on twitter. Some users also expressed feeling proud to see progress related to the COVID-19 vaccine.

Tweets under **discussion** also included users giving suggestions to others or health authorities, making queries about vaccines, expressing despair on being infected, arguments with contrasting viewpoints on precaution dose, expressing caution and asking others to take precautions and care. A few had sarcastic comments while very few posted misinformation.

Tweets expressing users' opinions or views and emotions regarding the COVID-19 vaccine booster dose were categorized under the theme of '**opinion**'.

Tweets that disseminated scientific information about vaccines or on potential improvement in immune response and protection that the booster may provide were included under the theme '**evidence'.**

Some tweets promoted vaccine uptake by sharing information on vaccine camp, incentives for taking vaccines, booster schedules, these were included under the theme '**Promoting vaccine**'.

The remaining tweets were **irrelevant** (i.e. advertisements or other tweets including the word booster or precaution, but not related to vaccines).

We also found a few '**unclassifiable'** tweets which could not be classified based on the text alone. This again highlighted the need for analyzing other related information/metrics of a tweet, in order to better understand the context of a tweet and explain what the tweet is about, the discussion around it and also how much this particular content is disseminated.

Below, we present our findings from our detailed analysis which addresses the above points in order to get a richer understanding of the tweets.

The search strategy 2 yielded 36 key tweets. The following is the result of detailed thematic analysis done on the tweet context, related tweets and metrics of all the primary and secondary tweets:

1. **Resources**

   This theme encompasses tweets that provided information about the COVID-19 booster dose. While 5 subcodes were found in the larger data set of tweets (news,

updates, information, alerts, awareness, and education), the key tweets contained the following 3 themes through which people shared or received information:

1.1 News

In this code, there are tweets on news related to new vaccine approval, clinical trials, the availability of vaccines, and vaccine drives. Tweets on vaccine approval status constituted the majority of this sub-theme. For example,

"Government approves #Corbevax as #PrecautionDose for adults You can take Corbevax as Booster Dose after completion of 6 months / 26 weeks from the date of administration of the 2nd dose @MoHFW_INDIA #LargestVaccineDrive #IndiaFightsCrona"

This tweet was news shared regarding vaccines with an image promoting COVID-19 booster dose.

1.3 Information

This code refers to general information related to booster vaccines, vaccine approval, vaccine acceptance, and vaccine orders. This code informs people about their queries, or provides some general information. Vaccine orders are typically based on factors such as population size, prioritization guidelines, and the availability of vaccines from manufacturers. For example, one user posted a tweet

"The Japan visa information page. They don't call it either 'booster dose' or 'precaution dose' but simply 'third dose'"

This tweet is about precaution dose information.

1.4 Update

This code refers to update regarding COVID-19 boosters, like booster coverage or if someone is vaccinated, a new booster release. It is important to stay informed about

the latest updates on COVID-19 booster shots, as they can help prevent severe illness and hospitalization. For example, one user posted a tweet.

"*Hindustan Times: #Covid19: Only 12% of the 770 million people eligible for precaution (or booster) doses have so far shown up to get their third shot of the #vaccine, according to government data accessed by HT Read more https://bit.ly/3CJQxGX https://t …"*

This tweet mentions booster coverage with precaution dose.

2. Discussion

This code refers to recommendations, queries, advice, or discussions provided by individuals regarding booster doses that can play a role in shaping individuals decisions about receiving or considering booster shots. These conversations may include personal experiences, discussions of benefits and risks, sharing research findings, and addressing concerns.

2.1 Suggestion

This code refers to users giving suggestions to government officials or individuals in authority regarding COVID-19 booster doses, which involves offering insights and recommendations to shape policies and decisions related to the administration of booster shots. For example, one user posted a tweet:

"Biden ji must be given booster as well as precautionary dose in #Bengaluru"

This tweet is giving suggestion to Mr. biden related to COVID-19 booster dose.

2.2 Gratitude

This code expresses positive sentiment and appreciation and indicates a favorable perception of the content and suggests that the person is thankful for the useful and helpful information provided. Such positive feedback is an encouraging indicator that

the content has successfully met the person's needs, provided value, and left a favorable impression on them. For example, one user posted a tweet:

"ALLAH is sufficient to us Alhamdulillah #PrecautionDose #Booster #Covid_19 #Covishield completed Thank you @CMOTamilnadu @mkstalin @Subramanian_ma"

This tweet is showing gratitude of fully vaccinated with booster dose.this is an example of experience

2.3 Query/curious

This code refers to the queries related to slot booking, vaccination centers, and the benefits of booster vaccines highlight the public's engagement, eagerness, and concerns regarding the vaccination process. For example, one user posted a tweet:

"Who approved #Covid_Booster (Precautionary/Third) dose in #India?"

This tweet is asking a query to government officials.

2.4 Misinformation

This code refers to providing incomplete tweets suggests that some messages or posts on Twitter may lack essential information or provide only partial details about COVID-19 booster vaccines. This misinformation can range from inaccurate claims about the necessity, efficacy, or side effects of booster vaccines to conspiracy theories or baseless rumors. The spread of such misinformation can undermine public trust, create confusion, and hinder efforts to combat the COVID-19 pandemic effectively. For example, one user was posted a tweet:

"People should know Dat Precautionary booster dose is not approved by any Indian Health authorities!! People like @DBalasore are doing their best marketing for

vaccine mafias tossing millions of life into Risk. Stop involve in this Crime against Humanity !!"

This tweet was spreading negative misinformation on COVID-19 booster dose.

2.5 Experience

This code discusses individuals' experiences after receiving a COVID-19 booster dose, specifically focusing on how they felt and what they observed among their relatives or neighbors. These experiences serve multiple purposes, such as providing insights into potential effects and outcomes, dispelling any misconceptions, and building a comprehensive picture of the potential physical and emotional responses, as well as the broader impact on individuals' immediate social circles and communities. For example, one user was posted a tweet:

"Today I have taken my Booster or Precaution dose ..... জয় বাংলা"

This tweet described the user's experience after receiving COVID-19 booster shots. This tweet was provided as a personal experience.

3. Concern

This code discusses various concerns related to COVID-19 vaccination, such as false information, side effects, vaccine efficacy, certificate issues, and travel-related complications. It is important to provide reliable and scientifically backed information through trusted sources to combat misinformation and side effects. so, individuals can make informed decisions, trust in the vaccination process, and contribute to the collective effort to combat the COVID-19 pandemic. For example, one user posted a tweet:

"This Is Inform You That I Have Not Vaccinated Precautionary Dose (Booster), But I Got a Message That I Have Vaccinated Successfully With Precautionary Dose On

August 22nd August, I Request You @MoHFW_INDIA @HarishRaoOffice @mansukhmandviya @DrBharatippawar To Take (1/2)"

This tweet was showing a concern on twitter regarding false message.

4. Promoting vaccine

the promotion of COVID-19 booster doses through various strategies, including providing information about vaccination schedules, organizing vaccination camps, and incentivization. These approaches are employed to encourage individuals to receive the booster dose and enhance vaccination coverage in the population. appeals or requests made by government officials or public figures encouraging individuals to take the COVID-19 booster dose

4.1 Appeal or Request

Appeals or requests made by government officials and public figures regarding COVID-19 booster doses aim to inform, inspire, and motivate individuals to take necessary action. government and public figure appeals play a vital role in promoting public health initiatives and achieving vaccination targets. Their messages can mobilize communities, drive vaccination campaigns, and encourage individuals to actively seek out booster doses. For example, one user posted a tweet:

"I request everyone to take precautionary doses as our antibodies decrease after 6-8 months. Booster doses will act as insurance for our health in the future. According to the data, in last 8 months, 90% of patients admitted to hospitals haven't received booster doses: Dr NK Arora"

This tweet was appealing to take precaution dose with its benefit and losses by public figure in favour of promoting COVID-19 booster vaccination.

4.2 Encouragement

Encouraging individuals to take the COVID-19 booster dose involves promoting the importance, benefits, and urgency of receiving an additional dose of the vaccine. Government authorities and public health agencies use communication channels to emphasize the importance of booster doses in controlling the spread of COVID-19. People encouraging in their family, friends to protect individuals and communities, and contribute to the global fight against the pandemic. For example, one user posted a tweet:

Last day to take a free precautionary dose (Booster dose) against #COVID19 75 Days free period expiring today and it's unlikely to be extended. Go get your "shot" today #boosterdose

This tweet was encouraging people to take precaution dose.

5. Unclassifiable

This code refers to some tweets are unclassifiable even after traced back to context cannot able to classify them. Those tweets have incomplete phrases, some emojis, without addressing proper phrase. It was difficult to classify those tweet. For example, one user posted a tweet:

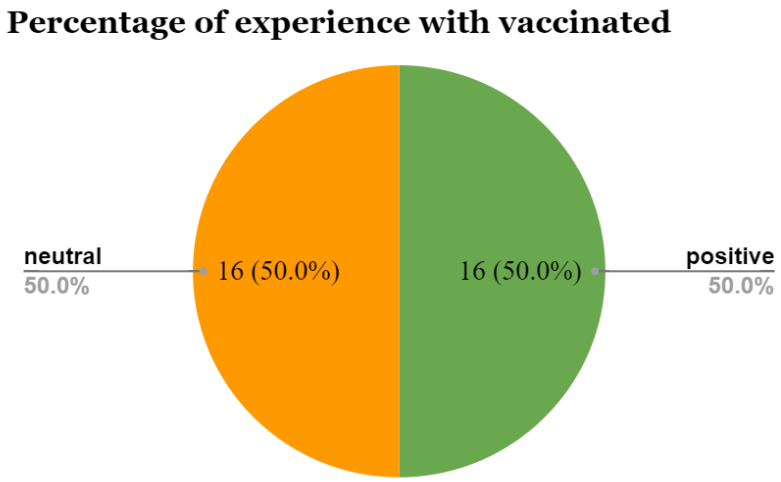
“Third Booster dose (as a precautionary measure)”

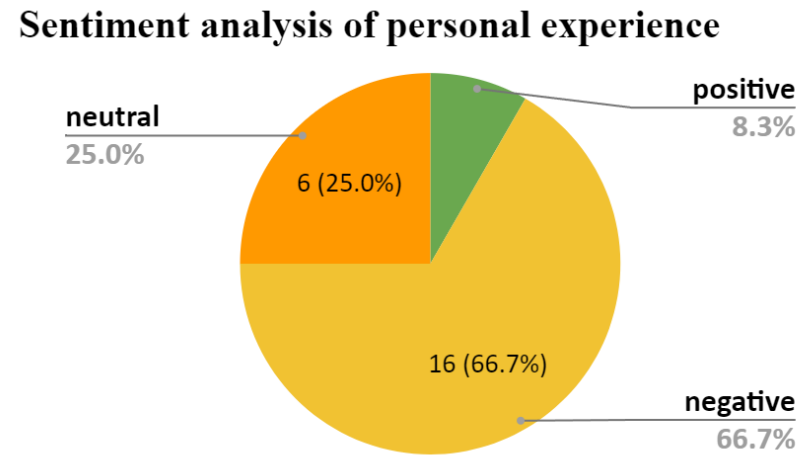
This tweet is unclassifiable because we don't understand what the user was trying to communicate.

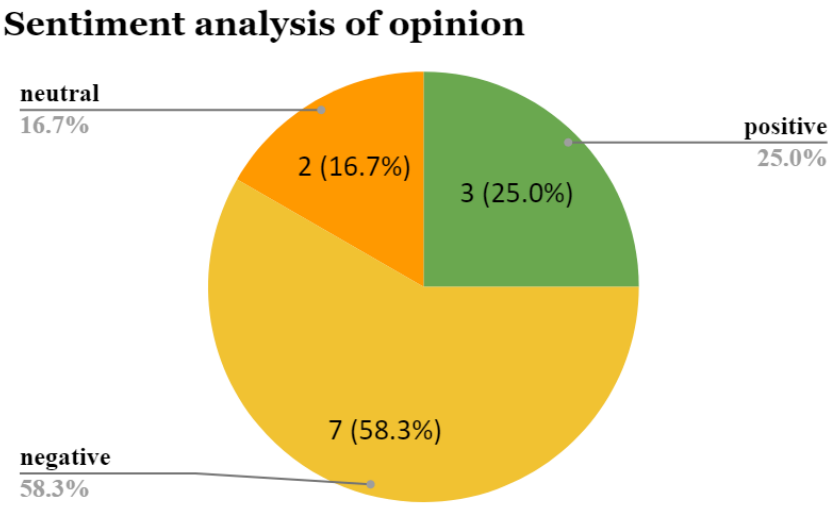
Graphical representation of experience and opinion

Table 6: sentiment analysis of two themes: experience and opinion

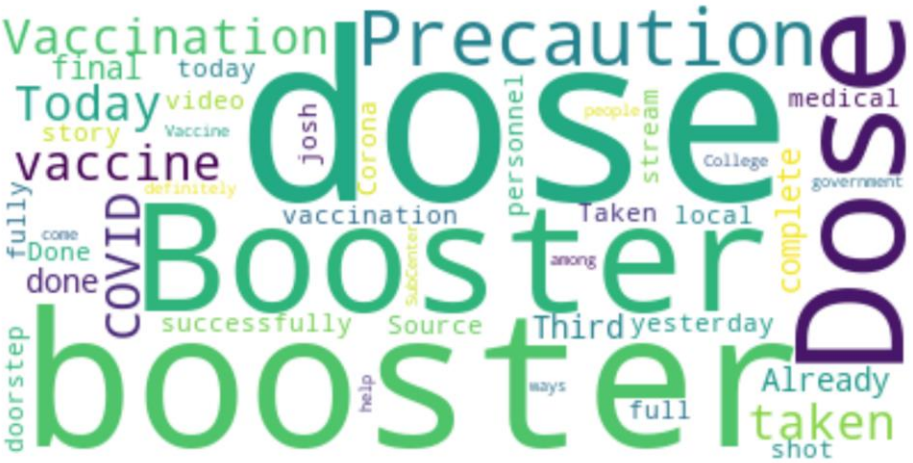
vaccinated	positive	16
	neutral	16
personal experience	positive	2
	negative	16
	neutral	6
general opinion	positive	3
	negative	7
	neutral	2
personal opinion	negative	7
	positive	0
	neutral	0



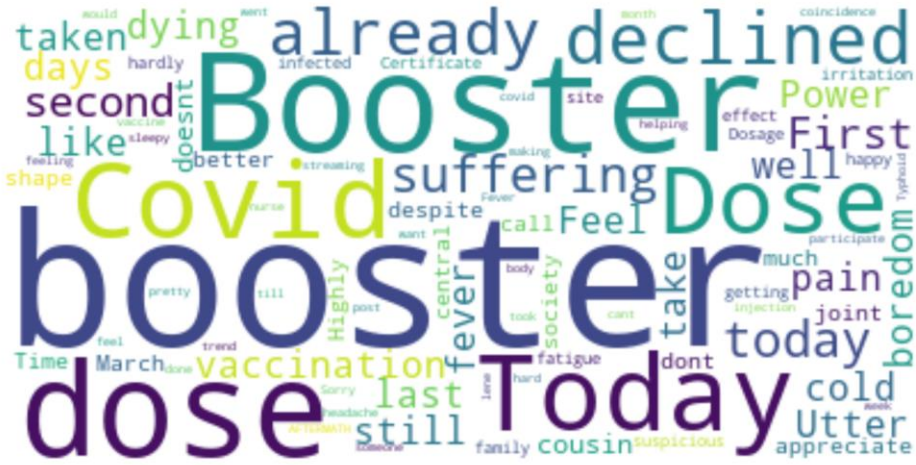




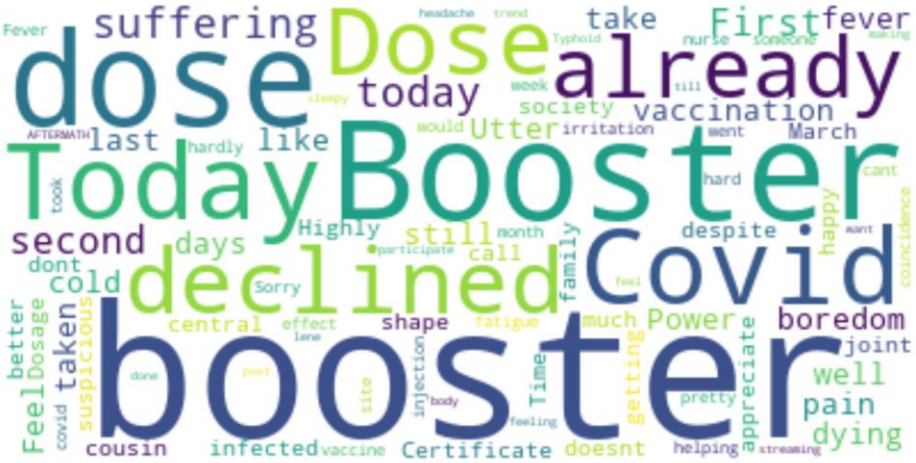
These are the pie charts of 1572 tweets, specially focused on two themes: experience and opinion. Here, the difference between personal experience and personal opinion is that personal experience is the direct encounter with a situation or event, while personal opinion is an individual's subjective viewpoint or belief about a particular matter. Personal experiences are derived from direct firsthand knowledge, whereas personal opinions are formed through individual thoughts, values, and subjective biases. Both personal experiences and personal opinions play a role in shaping an individual's understanding and perspective on various topics.



Word Cloud of tweets under the theme ‘experience’ and ‘vaccinated’



Word Cloud of tweets under the theme ‘personal experience’



Word Cloud of tweets under the theme ‘opinion’

CHAPTER 6:

DISCUSSION

DISCUSSION

The detailed description of tweets and themes was based on an analysis of 36 tweets. While this is a smaller sample size compared to the initial dataset of 1572 tweets, it provides valuable insights into the prevailing sentiments and themes expressed within this subset.

We conducted a thorough examination of the content, language, and underlying messages conveyed by each tweet to analyze the context of these 36 tweets. By carefully reviewing and interpreting the tweets, we categorized them into different themes based on the expressed opinions, experiences, or subject matter.

The themes and sentiments observed within the dataset of 1572 tweets related to COVID-19 booster doses: The dominant themes emerging from the tweets are primarily news and updates. These tweets serve as valuable resources through which people access information about COVID-19 booster doses, staying informed about the latest developments, guidelines, and availability of the booster shots.

Within this dataset, there is a mixture of sentiments expressed by individuals sharing their personal experiences. Some experiences are neutral or positive, indicating that individuals have had satisfactory or favorable encounters with the booster dose. These tweets may include stories of individuals feeling protected, experiencing minimal side effects, or having a sense of reassurance regarding their immunity.

However, a significant portion of the tweets expressing personal experiences tend to be negative. These tweets likely contain accounts of individuals who encountered challenges or negative outcomes related to the booster dose. These negative experiences could include side effects, dissatisfaction with the vaccination process, or concerns regarding the efficacy of the booster shot. Such tweets may express disappointment, frustration, or uncertainty surrounding the booster dose.

In terms of opinions expressed within the dataset, they predominantly lean towards the negative side. This indicates that individuals sharing their views on COVID-19 booster doses tend to have more critical or unfavorable perspectives. These opinions may highlight skepticism, concerns about the necessity or effectiveness of boosters, or express doubts about the overall vaccine strategy.

These findings are significant for planning education, raising awareness, and implementing interventions aimed at promoting the acceptance and administration of the COVID-19 booster vaccine. Future studies should delve into the detailed experiences shared by Twitter users, allowing for a comprehensive understanding of the wide range of critical and unfavorable perspectives that influence vaccine uptake. It is essential to thoroughly examine the negative sentiments surrounding the COVID-19 booster dose, as well as the corresponding discussions and dissemination, in order to effectively address them.

It is important to note that the analysis of sentiments and opinions within this dataset of tweets provides a snapshot of the public discourse on COVID-19 booster doses. However, it may not necessarily represent the overall sentiment or opinion of the wider population. The views expressed on social media platforms may be influenced by various factors, including individual experiences, biases, and the nature of online discussions.

CHAPTER 7:

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

After analyzing a dataset of 1572 tweets, we identified 8 distinct themes. To delve deeper into the context of each theme, we analyzed 36 key tweets using the same coding frame.The detailed analysis yielded more meaningful insights as compared to thematic analysis of only the tweet text. We discovered that relying solely on the text of a tweet often led to misleading interpretations, as understanding the context necessitates considering related tweets, replies, and additional metrics like the user's bio.

Based on our analysis, we observed that the perception of Twitter users who had experience with vaccination was predominantly positive and neutral. However, when it came to sharing personal experiences, the majority of tweets leaned towards the negative side. Within the theme of opinions, we found a prevailing negative sentiment. These findings indicate that there is a general reluctance among individuals regarding the precaution dose. Many express hesitation in taking it and describe significant hardships experienced after vaccination. These findings are relevant and provide evidence for planning education, awareness and intervention to help promote uptake of COVID-19 precaution dose vaccine.

Through the insights gained by this study we would also suggest that computer-based sentiment analysis of Twitter should incorporate an approach similar to the one used by us in our detailed analysis when analyzing data so that the context of a tweet may be understood better. We recommend the development of an algorithm that captures relevant information to comprehend the broader context, discussion and dissemination of any tweet beyond its text.

To enhance the implementation of machine learning (ML) in tweet analysis, we suggest the following recommendations:

1. Apply labels such as "reply," "quote," "retweet," etc., to categorize tweets accurately.
2. Extract and analyze tweets posted as threads separately to capture their full context.
3. Consider the replies to each tweet to establish the discussion surrounding it.
4. Extract user bio/profile details to provide a better understanding of the tweet's context.

5. For quote tweets or retweets, extract the above mentioned data for the original tweet as well.
6. Retrieve and analyze the metrics associated with each tweet.
7. The machine should be capable of analyzing Indian languages in addition to English.

CHAPTER 8:

REFERENCES

REFERENCES

1.Harapan H, Itoh N, Yufika A, et al. Coronavirus disease 2019 (COVID-19): A literature review. Journal of Infection and Public Health. 2020;13(5):667-673. doi:https://doi.org/10.1016/j.jiph.2020.03.019

2.Fong MW, Gao H, Wong JY, et al. Non Pharmaceutical Measures for Pandemic Influenza in Non Healthcare Settings—Social Distancing Measures. Emerging Infectious Diseases. 2020;26(5):976-984. doi:https://doi.org/10.3201/eid2605.190995

3.World. Vaccine efficacy, effectiveness and protection. Who.int. Published July 14, 2021. Accessed March 15, 2023. https://www.who.int/news-room/feature-stories/detail/vaccine-efficacy-effectiveness-and-protection

4. Union Minister DrJitendra Singh says, India has developed four indigenous Vaccines in just two years. Pib.gov.in. Published 2023. Accessed May 20, 2023. https://www.pib.gov.in/PressReleasePage.aspx?PRID=1894167#:~:text=2022)%3B3.-,GEMCOVAC%E2%84%A2%2D19%20%2D%20World's%201st%20and,India's%20indigenously%20developed%20mRNA%20vaccine.

5. Super User. Vaccine information, ICMR New delhi - COVID-19 Vaccine. Icmr.org.in. Published 2022. Accessed May 20, 2023. https://vaccine.icmr.org.in/covid-19-vaccine

6. COVID-19 Vaccines with WHO Emergency Use Listing. WHO - Prequalification of Medical Products (IVDs, Medicines, Vaccines and Immunization Devices, Vector Control). Published November 3, 2021. Accessed May 20, 2023. https://extranet.who.int/pqweb/vaccines/vaccinescovid-19-vaccine-eul-issued

7.Mukim M, Sharma P, Mohsina Patweker, Faheem Patweker, Rajiv Kukkar, Patel R. Covid-19 Vaccines Available in India. *Combinatorial Chemistry & High Throughput Screening*. 2022;25(14):2391-2397. Accessed March 15, 2023. https://www.eurekaselect.com/article/121584

8.World. Interim statement on the use of additional booster doses of Emergency Use Listed mRNA vaccines against COVID-19. Who.int. Published May 17, 2022. Accessed March 15, 2023. https://www.who.int/news/item/17-05-2022-interim-statement-on-the use-of-additional-booster-doses-of-emergency-use-listed-mrna-vaccines-against-covid 19

9. Precaution Dose to be now available to 18+ population group from 10th April, 2022, at Private Vaccination Centres. pib.gov.in. Published April 10, 2022. Accessed March 3, 2023. https://pib.gov.in/PressReleasePage.aspx?PRID=1814804

10. 75 days - "COVID Vaccination Amrit Mahotsava" to commence from tomorrow to provide free Precaution Dose at all eligible adult population at Government Vaccination Centres. Pib.gov.in. Published 2022. Accessed May 27, 2023. https://pib.gov.in/PressReleasePage.aspx?PRID=1841501

11. Abdollahi A, Afsharyzad Y, Vaezi A, Meysamie A. Importance of the COVID-19

Vaccine Booster Dose in Protection and Immunity. Vaccines. 2022;10(10):1708.

doi:https://doi.org/10.3390/vaccines10101708

12.World. Interim statement on booster doses for COVID-19 vaccination. Who.int.

Published October 4, 2021. Accessed March 10, 2023.

https://www.who.int/news/item/04-10-2021-interim-statement-on-booster-doses-for-

covid-19-vaccination

13. Interim Recommendations for an Extended Primary Series with an Additional

Vaccine Dose for COVID-19 Vaccination in Immunocompromised Persons Interim

Guidance.; 2021.

14. Schaffer DeRoo S, Pudalov NJ, Fu LY. Planning for a COVID-19 Vaccination Program. *JAMA*. 2020;323(24):2458. doi:https://doi.org/10.1001/jama.2020.8711

15. Lu P, Zhou T, Santibanez TA, et al. COVID-19 Bivalent Booster Vaccination Coverage and Intent to Receive Booster Vaccination Among Adolescents and Adults — United States, November–December 2022. *MMWR Morbidity and Mortality Weekly Report*. 2023;72(7):190-198. doi:https://doi.org/10.15585/mmwr.mm7207a5

16. item. Who.int. Published 2022. Accessed March 6, 2023.

https://www.who.int/publications/m/item/weekly-epidemiological-update-on-covid-19---

27-july-

2022#:~:text=As%20of%2024%20July%202022,the%20global%20and%20regional%20levels.

17. De Gagne JC, Cho E, Park HK, Nam JD, Jung D. A Qualitative Analysis of Nursing Students' Tweets During the COVID-19 Pandemic. *Nursing & Health Sciences*. 2021;23(1). doi:https://doi.org/10.1111/nhs.12809

18. Ahmed W, Bath PA, Sbaffi L, Demartini G. Novel insights into views towards H1N1 during the 2009 Pandemic: a thematic analysis of Twitter data. *Health Information & Libraries Journal*. 2019;36(1):60-72. doi:https://doi.org/10.1111/hir.12247

19. Sleigh J, Amann J, Schneider M, Vayena E. Qualitative analysis of visual risk communication on twitter during the Covid-19 pandemic. *BMC Public Health*. 2021;21(1). doi:https://doi.org/10.1186/s12889-021-10851-4

20.Twitter as a Tool for Health Research: A Systematic Review. American Journal of Public Health. Published 2017. Accessed March 29, 2023. https://ajph.aphapublications.org/doi/abs/10.2105/AJPH.2016.303512?journalCode=ajph

21. Mohan B, Vinod N. COVID-19: An Insight into SARS-CoV2 Pandemic Originated at Wuhan City in Hubei Province of China. *Journal of Infectious Diseases and Epidemiology*. 2020;6(4). doi:https://doi.org/10.23937/2474-3658/1510146

22. Liu T, He Z, Huang J, et al. A Comparison of Vaccine Hesitancy of COVID-19 Vaccination in China and the United States. *Vaccines*. 2021;9(6):649.

doi:https://doi.org/10.3390/vaccines9060649

23. item. Who.int. Published 2023. Accessed May 22, 2023. https://www.who.int/publications/m/item/covid-19-public-health-emergency-of-international-concern-(pheic)-global-research-and-innovation-forum

24. Chavez S, Long B, Koyfman A, Liang SY. Coronavirus Disease (COVID-19): A primer for emergency physicians. 2021;44:220-229. doi:https://doi.org/10.1016/j.ajem.2020.03.036

25. Watson OJ, Barnsley G, Toor J, Hogan AM, Winskill P, Ghani AC. Global impact of the first year of COVID-19 vaccination: a mathematical modelling study. 2022;22(9):1293-1302. doi:https://doi.org/10.1016/s1473-3099(22)00320-6

26. Menni C, May A, Polidori L, et al. COVID-19 vaccine waning and effectiveness and

side-effects of boosters: a prospective community study from the ZOE COVID Study.

The Lancet Infectious Diseases. 2022;22(7):1002-1010.

doi:https://doi.org/10.1016/s1473-3099(22)00146-3

27. Andrews N, Tessier E, Stowe J, et al. Duration of Protection against Mild and Severe Disease by Covid-19 Vaccines. *New England Journal of Medicine*. 2022;386(4):340- 350. doi:https://doi.org/10.1056/nejmoa2115481

28. Sentiment analysis on Healthcare Tweets. Published online June 26, 2020. doi:https://doi.org/10.37506/ijphrd.v11i6.9841

29. Panda, Samiran, et al. Community Voices around COVID-19 Vaccine in Chennai, India: A Qualitative Exploration during Early Phase of Vaccine Rollout. Vol. 0, no. 0, 1 Jan. 2022, www.ncbi.nlm.nih.gov/pmc/articles/PMC9807211/,https://doi.org/10.4103/ijmr.ijmr_668_22

30. Joanne Chen Lyu, Eileen Le Han, Luli GK. COVID-19 Vaccine–Related Discussion on

Twitter: Topic Modeling and Sentiment Analysis. 2021;23(6):e24435-e24435. doi:https://doi.org/10.2196/24435

31. Mayur Wankhade, Sekhara C, Kulkarni CA. A survey on sentiment analysis methods, applications, and challenges. 2022;55(7):5731-5780. doi:https://doi.org/10.1007/s10462-022-10144-1

32. The Validity of Sentiment Analysis: Comparing Manual Annotation, Crowd-Coding, Dictionary Approaches, and Machine Learning Algorithms. Communication Methods and Measures. Published 2021. Accessed May 18, 2023. https://www.tandfonline.com/doi/full/10.1080/19312458.2020.1869198

33. Steckler A. Toward Integrating Qualitative and Quantitative Methods: An Introduction - Allan Steckler, Kenneth R. McLeroy, Robert M. Goodman, Sheryl T. Bird, Lauri McCormick, 1992. Health Education Quarterly. Published 2018. Accessed March 30, 2023. https://journals.sagepub.com/doi/10.1177/109019819201900101

34. Giannantonio CM. Book Review: Krippendorff, K. (2004). Content Analysis: An Introduction to Its Methodology (2nd ed.). Thousand Oaks, CA: Sage - Cristina M. Giannantonio, 2010. Organizational Research Methods. Published 2018. Accessed March 16, 2023. https://journals.sagepub.com/doi/10.1177/1094428108324513

35. Braun V, Clarke V. Using Thematic Analysis in Psychology. Qualitative Research in Psychology. 2006;3(2):77-101. doi:https://doi.org/10.1191/1478088706qp063oa

36. “Twitter Account Activity Analytics – Engagement, Impressions and More.” *Twitter.com*, 25 Mar. 2021, help.twitter.com/en/managing-your-account/using-the-tweet-activity-dashboard.

37. “Fig. 1 Example of Message from Twitter.” *ResearchGate*, ResearchGate, 2017,

www.researchgate.net/figure/Example-of-message-from-Twitter_fig1_318578772. Accessed 18 May 2023.

38. Needle F. How To Use Twitter for Beginners. Hubspot.com. Published November 30, 2020. Accessed May 17, 2023. https://blog.hubspot.com/marketing/tweet-formulas-to-get-you-started-on-twitter

39. Rachel. How to write the perfect Twitter thread (with examples). Podia. Published June 4, 2021. Accessed May 17, 2023. https://www.podia.com/articles/twitter-threads

40. Twitter I. Introducing the Quote Tweets lookup endpoint to the Twitter API v2. Twitter Developers. Published March 17, 2022. Accessed May 17, 2023. https://twittercommunity.com/t/introducing-the-quote-tweets-lookup-endpoint-to-the-twitter-api-v2/168370

41.Twimg.com. Published 2017. Accessed May 19, 2023. https://pbs.twimg.com/media/FMXQZ0rXwAMqBOM.jpg

CHAPTER 9:

ANNEXURE

ANNEXURE - I

Definitions of themes

sr. no.	tags	description
1	Alert	This refers to alerting people that cases are increasing so take precautions
2	Appeal/request	This refers to government or public figures' appeals or requests to take covid-19 booster doses.
3	Appreciative / gratitude	This expresses positive sentiment and appreciation and indicates a favorable perception of the content and suggests that the person is thankful for the useful information provided.
4	Argument	This refers to a contrasting viewpoint put forward by individuals or groups regarding the booster dose of a vaccine during discussions
5	Awareness and education	this refers to tweets spreading awareness and educating the reader about precautionary measures for COVID-19 and monkey pox
6	Evidence	This information includes guidelines, recommendations, and scientific data provided by health authorities and experts regarding the timing, eligibility criteria, effectiveness, safety, and potential benefits of COVID-19 booster shots.
7	Booster schedule	this refers to the recommended timing and interval for receiving a booster dose of a COVID-19 vaccine
8	Caution/care	It includes tweets where a user is taking or suggesting others to take necessary tips and precautions and following guidelines recommended by health authorities to minimize the risk of transmission
9	Concern	This refers to concerns related to covid-19 vaccination which include false information, side effects, related to the efficacy of vaccine, certificate issues or some traveling related issues.
10	Curious	This refers to queries from people related to slot booking, vaccination centers, benefits of taking booster vaccines, etc.
11	Despair	These tweets refer to users expressing a sense of hopelessness that arises from the realization that despite their efforts to prevent infection, they have still contracted the virus.

12	Discussion	This refers to a recommendation or advice or talk provided among individual users regarding the administration of booster doses to individuals who have already received or not received or thinking of taking booster shots
13	Encouragement	These tweets encourages people to take covid-19 booster dose
14	Experience	This refers to users sharing their experience after taking covid-19 booster dose about how they feel and what they saw in their relatives or neighborhood.
15	Healthcare dedication	this refers to efforts taken by healthcare workers to vaccinate the people
16	Incentivization	this refers to the act of providing incentives or rewards to motivate or encourage people to take booster shot
17	Information	this refers to general information related to booster vaccine, vaccine approval, vaccine acceptance, vaccine orders
18	Irrelevant	this refers tweets are not related to covid-19 booster or precaution dose
19	Misinformation	this refers to some tweets that provide incomplete or false information related to covid-19 booster
20	News	this refers to news related to vaccine approvals, clinical trials, availability of vaccine stocks, vaccine drives
21	Opinion	This included tweets where people shared their views about covid-19 vaccine booster dose, their feelings
22	Proud feeling	this refers to users sharing that they feel proud to see progress related to the COVID-19 vaccine
23	Sarcastic	this refers the users posting sarcastic answers in discussions regarding booster dose
24	Speculation	It implies looking forward to the potential improvement in immune response and protection that the booster may provide.
25	Suggestion	This refers to users giving suggestions to government officials or someone
26	Update	This section refers to the updates regarding covid-19 booster like booster coverage, new booster vaccine made available
27	Vaccination camp	This refers to vaccination camps organized by groups of people or individuals to provide vaccination to people at some places on certain dates

28	Vaccination promotion	this refers to promoting booster uptake dose and vaccination camps
29	Unclassifiable	This included tweets that could not be classified into any of the above