Addressing Vaccine Hesitancy in the Digital Age

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Abstract

Vaccine hesitancy remains a significant challenge in global health, exacerbated by the rapid proliferation of misinformation through social media platforms. This study investigates which social media platform in India displays the greatest trend of COVID-19 vaccine hesitancy and examines the platform characteristics contributing to this trend. A qualitative comparative analysis of Twitter, Instagram, and YouTube was conducted, focusing on sentiment analysis, user demographics, and platform-specific features. The findings highlight the unique roles that these platforms play in shaping public perceptions, with implications for adjusting health communication strategies. For instance, Twitter was found to heighten political and news-driven content, whereas Instagram's reliance on influencer-based content resulted in a wide range of mixed sentiments. YouTube's user-friendly video-sharing interface made it a more prominent medium for both educational and misleading content. Such insights not only reveal the influence of social media on vaccine attitudes in India, but also have broader implications for understanding global trends in misinformation and public health behavior. Ultimately, by investigating the relationship between platform-specific features as well as public sentiment, this study provides a foundation for designing targeted strategies in order to combat the spread of misinformation and improve the acceptance of vaccinations both in India and in other countries that are facing similar challenges.

Keywords: vaccine hesitancy, social media platforms, misinformation, public sentiment

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Research Question

The global COVID-19 pandemic has highlighted the essential role of vaccination in mitigating the spread of infectious diseases and achieving herd immunity, which is defined by the World Health Organization as the "indirect protection from an infectious disease that happens when a population is immune either through vaccination or immunity developed through previous infection." Despite the proven efficacy and availability of vaccines, vaccine hesitancy remains a laborious barrier to widespread immunization, particularly as misinformation continues to escalate across many digital platforms. While social media has emerged as a critical tool for health communication, it has also become a means for disseminating misleading content. The rapid growth of misinformation, along with algorithmic biases in social media, have intensified the challenge of promoting an accurate public understanding of concepts such as vaccination in our current society.

In the context of India, a country that is characterized by vast socio-cultural diversity as well as a high rate of social media usage, the influence of platforms like Twitter, Instagram, and YouTube on public opinions regarding vaccines is truly profound. This study aims to address the main research question: *Which social media platform in India demonstrates the greatest trend of COVID-19 vaccine hesitancy, and what platform characteristics contribute to this trend?* By leveraging advanced qualitative methodologies, this research explores the subtle connection between platform-specific dynamics, patterns in public sentiment, as well as demographic variables in shaping vaccine-related attitudes. In doing this, it allows for a comparative analysis of social media trends and their implications for health communication strategies, with a deeper focus on the external validity of these findings for other nations. Furthermore, this study contributes to the expanding field of research as well as the evidence required in order to develop effective public health interventions, emphasizing the need for preventing misinformation and promoting vaccine acceptance in the digital age.

Background and Literature Review

Social Media and Vaccine Hesitancy

The correlation between social media and public health has been a focal point of global health research, especially during the COVID-19 pandemic. Social media platforms, with their capability to rapidly spread information, have emerged as critical tools for communicating significant health information. However, they have also become modes of increasing misinformation as well as numerous conspiracy theories, thereby complicating the efforts that are in place to build public trust in programs designated towards encouraging vaccination. Studies indicate that an exposure to vaccine misinformation on social media can further increase hesitancy towards receiving vaccinations, contributing to delays in immunization, as well as reducing overall vaccine coverage, with a reported "3 to 4 times higher likelihood" of hesitancy among those engaging with such content.

India's Socio-Cultural Context

India's socio-cultural context significantly influences vaccine hesitancy, with unique challenges stemming from its diverse population, cultural practices, and historical distrust in health systems. The country's vast religious, ethnic, and linguistic diversity impacts public health outreach and the acceptance of vaccination programs. Social determinants such as education, poverty, and access to healthcare exacerbate vaccine-related challenges. For instance, misinformation and myths around vaccines, often tied to cultural and religious beliefs, can lead to reduced trust in medical interventions (Glass, 2013).

Religious beliefs play a critical role, as some communities perceive vaccines as incompatible with their faith. Additionally, cultural norms around decision-making in families, often influenced by elders or community leaders, can sway opinions toward or against vaccination. Addressing these concerns requires culturally sensitive messaging and trusted community partnerships.

Health initiatives like the Indo-U.S. Vaccine Action Program have demonstrated the importance of collaborative, culturally tailored approaches. Programs that emphasize the safety and benefits of vaccines, combined with community engagement, have shown promise in overcoming hesitancy. Incorporating educational strategies and leveraging local influencers can improve vaccine uptake in hard-to-reach communities.

Religious and Cultural Beliefs

Religious beliefs and religiosity add another layer of complexity to understanding attitudes toward vaccination. Historical accounts highlight that religious concerns about vaccinations have existed since the introduction of smallpox vaccines, indicating a long-standing intersection between faith and medical interventions (Williams, 2010). Religious convictions are often cited as a prominent factor in vaccine hesitancy, serving as one of the most common reasons for individuals or communities to resist vaccination efforts (Rutjens et al., 2018).

Faith traditions and religious practices profoundly influence societal norms, individual behaviors, and health-related decisions. These influences manifest in diverse ways, ranging from doctrinal opposition to medical interventions to concerns about specific vaccine components conflicting with dietary or ethical principles upheld by certain religions. Moreover, religious leaders and institutions often play a pivotal role in shaping community attitudes toward vaccines, either by endorsing or opposing vaccination campaigns. Consequently, understanding the interplay between religious beliefs and vaccine acceptance is crucial for developing culturally sensitive public health strategies that address these unique concerns while respecting religious freedoms.

Language Barriers

Language barriers pose a significant challenge in addressing vaccine hesitancy in a linguistically diverse country like India. With many different spoken languages and numerous dialects, public health messages fail to reach a large portion of the population effectively. Many vaccine-related campaigns and informational content are predominantly spread in English or

Hindi, excluding individuals who communicate in other regional languages. This communication gap limits the accessibility of accurate information and ultimately contributes to the spread of misinformation in local languages, further exacerbating vaccine hesitancy.

Digital Infrastructure

While the rapid expansion of internet access has democratized information sharing in India, it has also created an environment that contributes to the spread of misinformation. Factors such as limited digital literacy among significant portions of the population means that many individuals don't have the skills to critically evaluate the content that is posted online. Platforms like WhatsApp have been identified as major passages for the expansion of false information through private groups as well as chain messages.

Furthermore, the widespread dissemination of misinformation through social media has escalated panic to unprecedented levels. The rapid and pervasive nature of social media platforms amplifies fear and uncertainty, often distorting perceptions of health risks and interventions. A recent study assessed panic levels among 1,075 social media users on a scale of 0 (minimum) to 5 (maximum). The findings revealed notably higher panic levels among Indian users compared to those from other regions, underscoring the significant influence of social media in shaping public sentiment and health-related anxieties within specific cultural and societal contexts (Bhattacharya et al., 2021).

Methods

This study utilizes a qualitative comparative analysis to examine the relationship between social media platforms and vaccine hesitancy in India. The focus was placed on three major platforms—Twitter, Instagram, and YouTube—by analyzing publicly available datasets from previous studies. Given the limitations of using pre-existing data, we were able to focus on a qualitative assessment of sentiment, user demographics, as well as platform characteristics, rather than performing quantitative analyses such as regression.

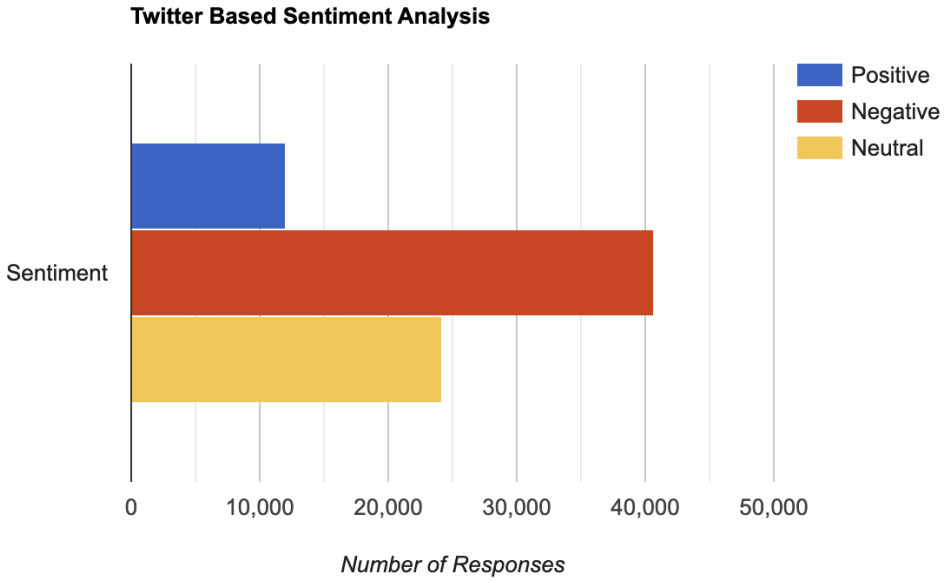
The data for each platform were collected during similar timeframes in order to mitigate any time-related biases. Since the datasets were already collected, they contained variations in sampling methods, keyword choices, as well as language use, which is acknowledged to be a significant confounding factor. For instance, different data sets utilized keywords such as "COVID-19 booster" for Twitter and "Covaxin" or "Sputnik" for Instagram. In addition, some of the datasets were limited to English-only content, whereas others combined English and Hindi, which could impact the overall sentiment results. Conducting a comparative analysis by reviewing the sentiment analysis and demographic patterns allowed us to assess the differences in sentiment across platforms while considering the unique characteristics of each platform.

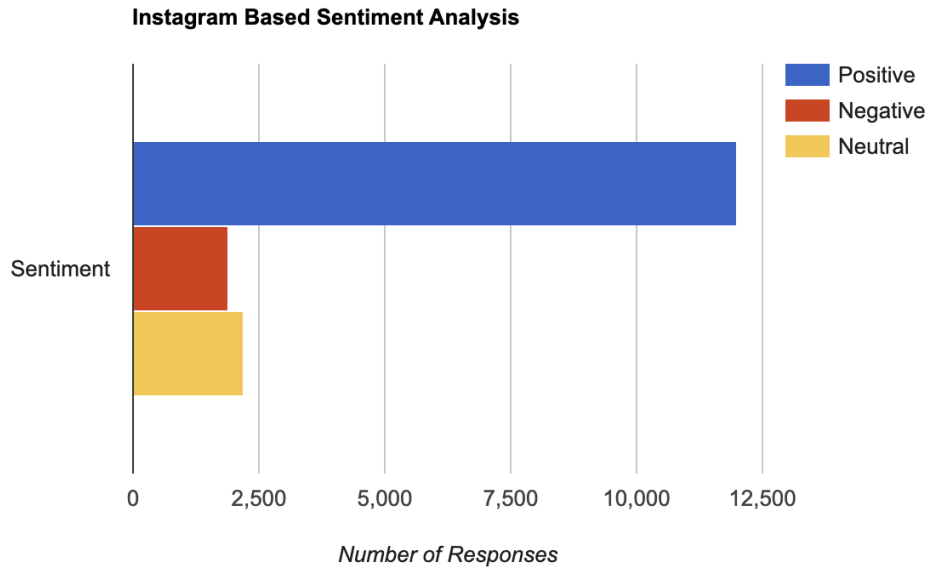
Findings and Results

This study focuses on India, with data specifically reflecting trends in social media activity and COVID-19 vaccination rates within the country. The analysis considers various age groups to ensure comprehensive insights into the population's engagement with social media and vaccination trends, with specific age group categorizations detailed in the methodology section.

The study utilizes estimates of social media engagement in India based on available reports for 2022. These estimates are drawn from industry reports and publicly available datasets that capture trends in digital behavior. Data on vaccination rates is sourced from official platforms, including the Ministry of Health and Family Welfare and the Co-WIN platform. The data covers the national COVID-19 vaccination campaign through the end of 2022. Due to variations in data collection methods for social media activity and vaccination rates, different sample sizes were used for each dataset. To ensure comparability and meaningful correlation analysis, the results were converted into percentages when conducting the analysis.

Each data set was converted into a graph to show the results in a visual format. The graphs were divided into content that was either promoting a negative, positive or neutral view on Covid vaccinations. The data set from each social media was then divided into content that was either positive or negative and compiled into two separate graphs. However, the key distinction in this graph was that the numeric values were converted into percentages since the sample sizes across all three datasets were not the same. The graphs with the compiled negative and positive content produced on all three social media platforms helps to serve as a visual comparison for our qualitative analysis of the different social media platforms. Therefore, it is necessary to keep in mind that the analysis of these different platforms was qualitative in nature and not quantitative and that the graphs only work to serve as a visual display of the data from the different studies. Since there is too much variability in the studies, such as with the sample size, search parameters such as keywords and languages used, it is not possible to conduct a valid quantitative analysis whether that be regression or correlation.

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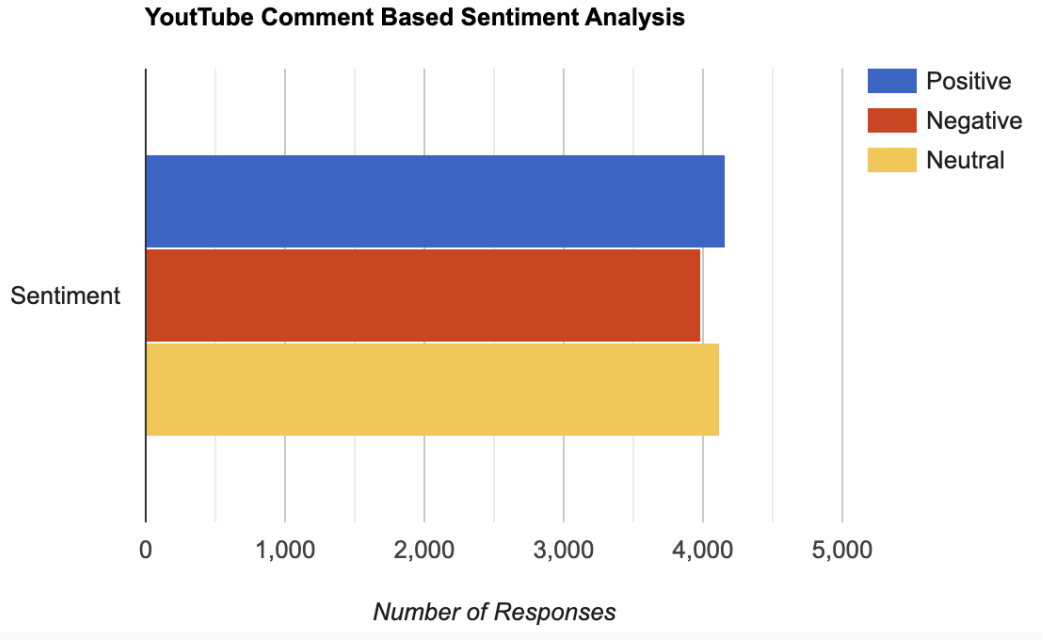
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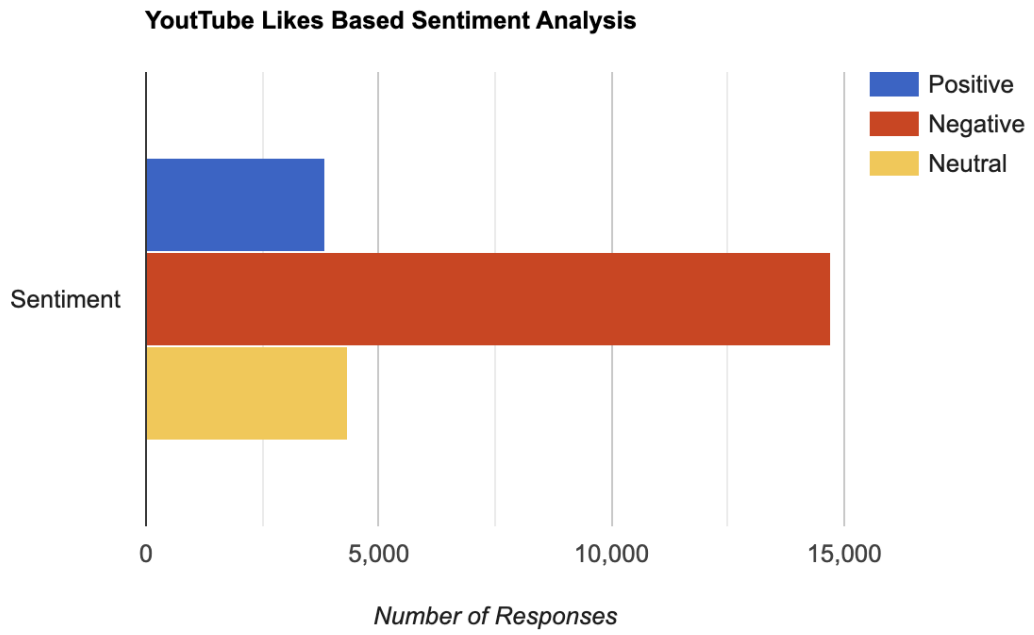
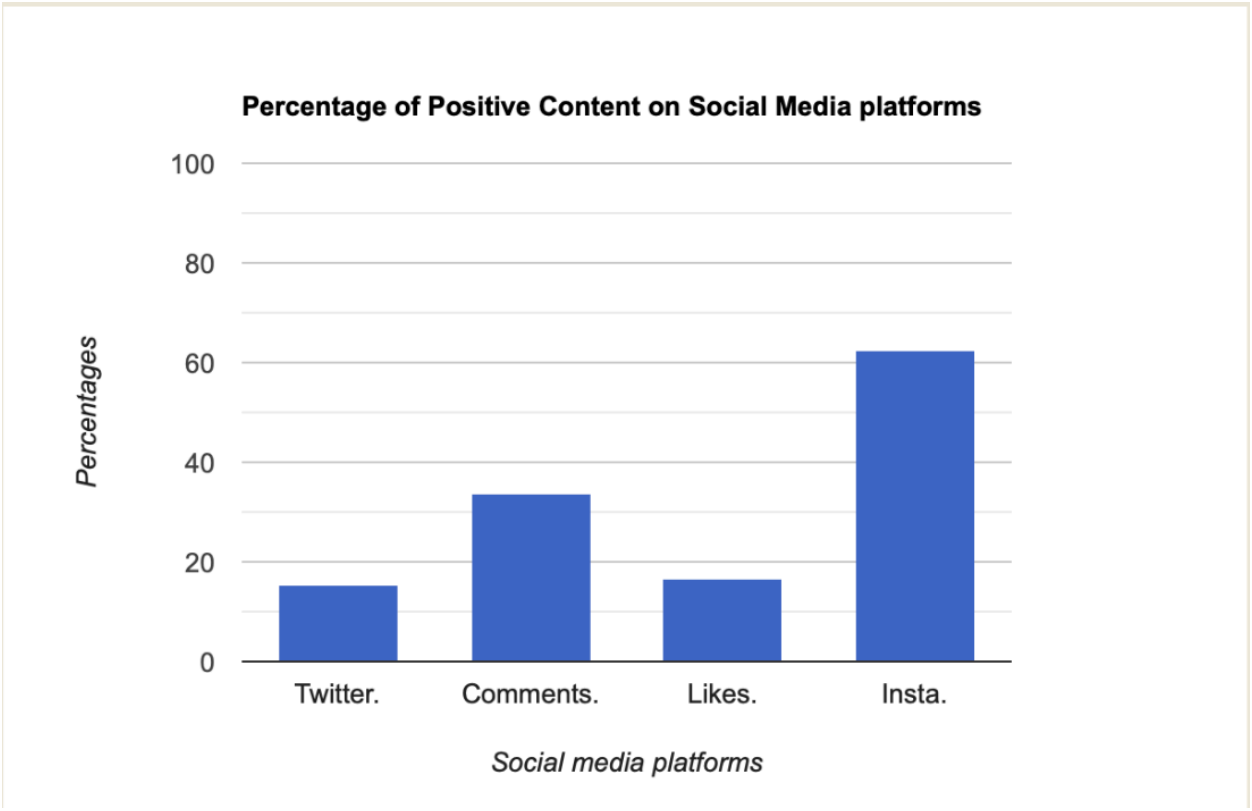


Discussion

This study focuses on the relationship between social media platforms and vaccine hesitancy in India. The analysis emphasized how social media, as a powerful tool for communication, shapes the perspectives of the public and influences the flow of information about COVID-19 vaccines. Each platform, whether it's Twitter, Instagram, or YouTube, reveals that each platform endures distinct characteristics that ultimately influence public sentiment as well as the circulation of information regarding COVID-19 vaccines. By comparing these platforms, patterns of vaccine hesitancy emerge, providing insights into how social media can both hinder and support public health initiatives. Through this exploration, the study offers more of an understanding regarding how social media is able to impact health-related attitudes, providing a path for future interventions aiming to improve public health outcomes. This study aims to focus on the specific characteristics of each social media platform, whether that be the kind of content or environment that is present on each app or the user demographics in terms of age, gender or education. Keeping the focus on the specific characteristics of each platform allows for a better understanding of what specific factors of a social media platform lend its user to develop either a positive or negative opinion regarding covid vaccines.


Percentage of Positive Content on Social Media platforms
100
80
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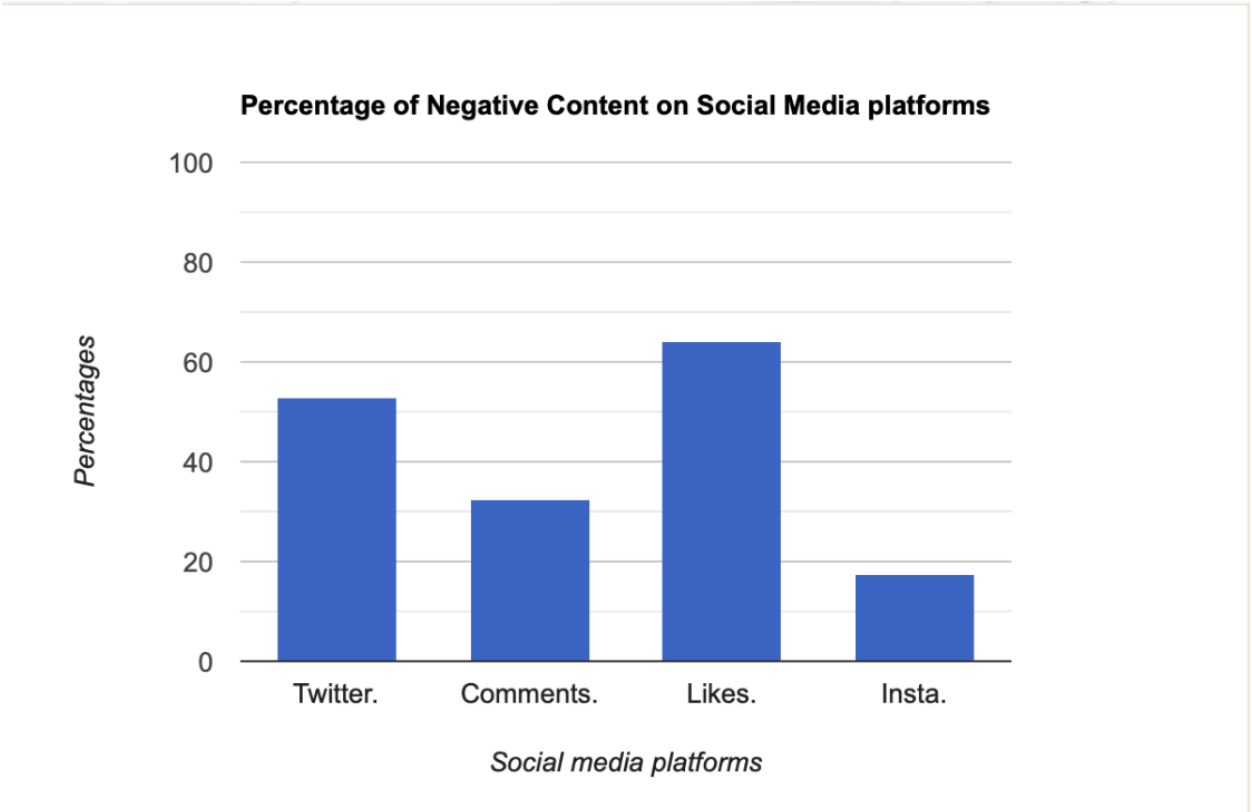
Percentages
Twitter.
Comments.
Likes.
Insta.
Social media platforms


Percentage of Negative Content on Social Media platforms
100
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Percentages
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Comments.
Likes.
Insta.
Social media platforms

Twitter: Politics and News-Driven Content

Twitter, with its character limit and real-time nature, is particularly relevant to the rapid dissemination of information. This platform was found to increase political content, often correlating with themes of vaccine hesitancy. Studies suggest that political polarization and sensational news headlines on Twitter could potentially exacerbate mistrust in health interventions (Sv et al., 2022). For instance, negative sentiments constituted 52.8% of analyzed tweets, overshadowing positive or neutral attitudes. The prevalence of such sentiments may originate from the algorithmic bias of the platform itself, prioritizing engagement over accuracy, thereby increasing controversial content (Wu et al., 2022). Therefore, when looking at the graph of negative content produced on each social media platform, Twitter is one of the top leaders in this category.

Instagram: Influence of Visual Media

Contrasted to certain platforms, Instagram's image-based and influencer-driven approach results in a more diverse range of vaccine-related sentiments. Although positive sentiments were the highest (62.42%), negative sentiments also comprised a significant proportion of the discourse. This mixed trend can be attributed to the platform's reliance on influencers, who may share their personal opinions or even anecdotal advice that do not align with scientific consensus, perhaps deviating from it (Alam et al., 2022). Additionally, many influencers or content creators tend not to address real world topics, or when addressing are less likely to take a polarizing negative or positive opinion on topics. This is often due to the fact that influencers must appeal to a larger audience base, meaning that more neutral views are less conflicting and makes them more agreeable with their viewers. This ensures that they are less likely to lose followers by making polarizing statements about any hot topics, whether that be politics, vaccinations, or wars. Furthermore, Instagram's younger demographic, especially the 18-24 age group, is more susceptible to visual media. This allows for the impact of different types of content, whether accurate or misleading, to be much more pronounced. Therefore, when looking at the graph of positive content produced on each social media platform, Instagram is the top leader in this category.

Youtube: The Role of Video Content

YouTube's video-sharing capabilities make it such a powerful tool for campaigns centered toward education, yet the same features facilitate the spread of misinformation. Negative sentiments accounted for 64.23% of vaccine-related content, overlooking positive sentiments at 16.83%. The platform's "one-click" sharing and recommendation algorithm generally promotes controversial, or even exaggerated content, increasing its reach and influence (Kumar et al., 2023). Subsequently, this highlights the significance of monitoring content and using the platform strategically in order to prevent the spread of misinformation. When looking at the graph of negative content produced on each social media platform, Youtube is the top leader in this category. While as mentioned before, much of the style of the content, often educational content in video format is a factor in making it the platform with the most produced

negative content, it is also necessary to consider the functionality of the platform. The graph with negative content produced shows that on Youtube, videos with a negative or poor opinion regarding vaccination received the most likes. It is necessary to keep in mind that liking a video on Youtube is easy as it is a single button that allows viewers to voice their opinion. Furthermore, the fact that Youtube does not display which user liked which video means that users are able to like content without the fear of their friends and family knowing. While such similar one-click button features are present in Instagram and Twitter, they also display which user liked which piece of content. This means that there is often a fear of friends and family not only knowing but also judging the kind of content a user is liking and interacting with on those social media platforms. Therefore, with the combination of the video format and one-click private liking feature, Youtube is the perfect ground for the spread of misinformation and negative content regarding Covid vaccinations.

Limitations

In any good research paper, it is necessary to acknowledge the limitations of the study. Doing so highlights the improvements that could be made in future versions of the study, but it also builds a sense of credibility and transparency with the readers, making sure that any factors affecting the quality or scope of the data are addressed.

Search Parameters

In our study, there are many limitations we must take into account, starting with the type of data used in the study. Due to time constraints, it was not possible to collect our own data set. For the purposes of our study, data may have involved some kind of survey or poll of students on campus asking about their opinions or views regarding covid vaccinations and their social media usage. However, conducting such a study, since it would involve human subjects, would require approval from the International Board of Research, and that was something that was not feasible in our given time frame.

Hence, we used data sets that had already been collected from other studies previously done. However, using already-collected data sets poses various issues. Firstly, the time frame of data collection for each study was different. In order to equalize our data from the aspect of time, we were only able to use data from a specific span of months that all studies had collected data for. The other issue that arises when using other researchers' data sets is that the search parameters for the data are not the same. As seen in our study, the keywords used to find the social media content varied in each study, such as the Twitter data set using keywords such as "Covid-19 booster" while the Instagram data set used multiple different keywords including "Sputnik," "CoviShield," and "Covaxin." The keywords used to compile the data are a significant confounding variable. The findings may have varied greatly if the same keyword or search parameter had been used across all social media platforms.

The issue of search parameters also applies to language. Since the data we used was collected from India, which is home to many diverse languages, the research studies often varied in which language their data was collected in. Some studies only used social media content produced in English, while others used a combination of both English and Hindi. The data sets we used had clearly listed the number of content they had collected in each language, allowing us to separate and utilize only the data collected in English. However, the analysis of the studies

using content from English as well as other languages may have varied if their original data only included content in English.

Since our study used data collected from other researchers, our analysis was limited in scope. This meant that we would not be able to conduct quantitative analysis since the data was not "equal" across many factors and there were not enough data points. The studies we used presented the data in demographics and percentages. Multiple single data points were not listed, meaning that conducting analyses such as multiple linear regression was not possible. Furthermore, it would be necessary to ensure that the data used in the quantitative analysis does not vary in sampling methods, search parameters, sample size, and more. Therefore, our study is strictly limited to qualitative and comparative analysis.

Confounding Variables

While there were limitations faced due to the type of data used, some issues arose due to the general nature of the research topic. While studying a topic such as social media, it is necessary to acknowledge that access to the internet and social media is something that is not equally available everywhere, especially when studying a third-world country such as India. Due to the socio-economic nature of India, there is still a huge portion of the population that lives in rural areas or areas that do not have access to the internet or social media. Therefore, it is necessary to acknowledge that the statements made regarding the views of the COVID vaccine and the effects of social media are limited to those who have access to it and are not indicative of the whole nation. Furthermore, our study only focused on social media that was communicated in English. There is also a huge population in India that does not communicate or converse in English. Due to the diverse and various languages in India, the findings of our study are limited to a certain population with both access to social media and the ability to communicate in English.

Another limitation to keep in mind is that social media is one of the many factors that can affect a population's views on vaccinations. Other factors not considered or researched in our study include the government and political environment of the country as well as the cultural, social, and religious makeup of the country. Given such variables, it is also necessary to point out that there was an adult vaccination campaign being run in India. This campaign encouraged those 18 and older to get vaccinated. This is just one example of the many other factors that can affect both the vaccination rates and the views regarding vaccination in a country.

External Validity

Another restriction of our study emerges due to the subject of our study. Specifically, since our study focuses on India, there is concern about the findings being valid in other countries. There are many factors that make India unique compared to other countries, including culture, religion, and diverse languages, as well as the socio-economic makeup of the country in terms of the percentage of rural and urban residents. Therefore, the findings of our study may not be applicable to other countries, such as the United States, where access to the internet and social media is more widespread and where communication in English is common for most, if not all, citizens. Furthermore, there are different governmental and political policies in place that affect the view citizens would have on vaccinations. Therefore, our findings are specific and limited to India. Reproducing such a study would be possible in other countries; however, the findings may

differ. Therefore, it is important to acknowledge the differences in terms of culture, politics, language, and more when it comes to studying the effects of social media in any given population.

Ecological Fallacy

While doing studies that involve data regarding a whole population, it is important to ensure that the study does not fall into the trap of ecological fallacy. Ecological fallacy occurs when someone makes assumptions about individuals based on data that was collected from the group. It is very easy to have this bias when studying social media since the data collected is information regarding how a group or the population in a country uses social media. Therefore, it is necessary to ensure that we do not make any statements that are specific to a single individual's behavior regarding social media usage or even opinions and attitudes regarding vaccinations.

Future Steps

WhatsApp

There are many future steps that could be done to expand the scope and findings of this study. The first step would be to expand the study to include WhatsApp. WhatsApp is a popular communication platform in India for families and friends to not only communicate with those living in India but also with those who are living outside of India. While WhatsApp is not specifically a social media platform, there is a great amount of social media content that circulates on the platform, whether that be YouTube videos, Facebook or Instagram posts, news articles, or something else. Furthermore, this content often circulates through different group chats and reaches a large audience. WhatsApp's user age varies greatly, meaning there are both older and younger generations using the platform. This would allow the study to be expanded to focus even more on social media and communication platforms in older demographics.

Another benefit of expanding future studies to include WhatsApp would be that it would allow the study to be opened to a population outside of India, specifically the South Asian diaspora. As mentioned before, Whatsapp is a very popular platform for communication between families who have members living both in India and internationally. Including WhatsApp in future studies would allow the study to be expanded to study the effects of social media content and covid vaccination rates in the South Asian diaspora, which is a niche area of research that has not been extensively studied.

Another key feature of WhatsApp is its artificial intelligence chatbot feature. Focusing on these features in WhatsApp would allow the scope of the study to expand from not just social media but to artificial intelligence as well. There is a study done that focused on the WhatsApp chatbot feature and the attitudes that Indians had towards covid vaccination. However, the study was specifically focused on pregnant women in rural north India. Taking inspiration from the previous study, the artificial intelligence feature of WhatsApp could be studied on a larger population, specifically all of India.

Regional Study

While the scope of our study was looking at data from all of India, there are also future possibilities to narrow the research down to specific regions or states of India. As mentioned before in the background and literature review, India is an extremely diverse country in terms of language and culture. Therefore, there are many regional and state differences that may play a role when looking at the influence of social media and COVID vaccination rates. While studying a specific state or region of India would lessen the scope or applicability of the data on a larger scale, it would allow more insight into the differences in data within different parts of the country itself.

Facebook

Another future step of this research would be to include data collected from Facebook. Facebook is another extremely popular social media platform, specifically in older age groups. This platform allows for written and visual content to be shared as well as includes a like and comment feature. Including Facebook in future studies would allow for the study to specifically collect data on older demographics. While there are a plethora of studies that have studied the effects of Facebook and covid vaccinations, there are none that are specifically focused on India. Prior studies could again be used as examples of how to collect and compile data when working with Facebook.

Many of the social media platforms studied have a relatively younger user age. However, including platforms such as WhatsApp and Facebook is effective only to a certain extent in expanding the scope of the study when it comes to the older generations. Therefore, studying "traditional" or non-online sources of media, such as the newspaper or news on the television, would help to give further insight into the effect that media has on older generations when it comes to covid vaccinations. While this would change the research focus from social media to more "traditional" forms of media, it would allow for the research to better understand a larger demographic when it comes to age.

Meta Study

Ideally however, a large meta study wherein all social media platforms including those of Facebook and Whatsapp would be studied. Combining the data collection of all these social media platforms into one study would allow for the same sample size, keywords, timeframe, language and natural processing tool to be used. This would allow for an equal comparison across the platforms and would even allow for a more quantitative analysis to be conducted on the collected data. Doing so would also allow the study to differentiate between content that was produced in regards to the initial covid vaccine and that referencing the covid vaccine boosters.

While there are many avenues on which this study could be expanded, it is necessary to keep in mind the issue at hand. Social media hinders younger populations to get vaccinated. Governmental organizations can work to promote vaccinations not only by producing content that is medically accurate but also ensuring that they are working to address common misinformation and hoaxes circulating around on social media. Through the assurance that medically accurate and scientifically backed information is being circulated on social media, it is possible to make social media a platform that promotes public health and safe vaccination habits.

References

Alam, M. T., Sohail, S. S., Ubaid, S., Shakil, Ali, Z., Hijji, M., Saudagar, A. K. J., & Muhammad, K. (2022). It's Your Turn, Are You Ready to Get Vaccinated? Towards an Exploration of Vaccine Hesitancy Using Sentiment Analysis of Instagram Posts. *Mathematics*, *10*(22), 4165. https://doi.org/10.3390/math10224165

Dhalaria, P., Arora, H., Singh, A. K., Mathur, M., & S., A. K. (2022). COVID-19 Vaccine Hesitancy and Vaccination Coverage in India: An Exploratory Analysis. *Vaccines*, *10*(5), 739. https://doi.org/10.3390/vaccines10050739

Glass, R. (2013). *New indian rotavirus vaccine provides Hope - Fogarty International Center @ NIH*. Fogarty International Center. https://www.fic.nih.gov/News/GlobalHealthMatters/may-june-2013/Pages/roger-glass-opinion-rotavirus-vaccine.aspx

Linares, D., & Marshall, V. (2024, March 7). *Moving from willingness to vaccination uptake: Strategies for promoting health through vaccines*. National Institute of Minority Health and Health Disparities. https://blog.nimhd.nih.gov/insights-2024/news_feed/moving-from-willingness-to-vaccination-uptake-strategies-for-promoting-health

Kumar, V., Ji, G., Deori, M., & Verma, M. K. (2023). Content analysis and sentiment analysis of pro- and anti-vaccine conversations on YouTube in India: intentions and causes. *Global Knowledge Memory and Communication*. https://doi.org/10.1108/gkmc-07-2023-0244

Our World in Data. (2021). *Coronavirus (COVID-19) Vaccinations - Statistics and Research*. Our World in Data. https://ourworldindata.org/covid-vaccinations

Sv, P., Lorenz, J. M., Ittamalla, R., Dhama, K., Chakraborty, C., Kumar, D. V. S., & Mohan, T. (2022). Twitter-Based Sentiment Analysis and Topic Modeling of Social Media Posts Using Natural Language Processing, to Understand People's Perspectives Regarding COVID-19 Booster Vaccine Shots in India: Crucial to Expanding Vaccination Coverage. *Vaccines*, *10*(11), 1929. https://doi.org/10.3390/vaccines10111929

World Health Organization. (2020, December 31). *Coronavirus Disease (COVID-19): Herd immunity, Lockdowns and COVID-19*. World Health Organization; World Health Organization. https://www.who.int/news-room/questions-and-answers/item/herd-immunity-lockdowns-and-covid-19

Bhattacharya C, Chowdhury D, Ahmed N, Özgür S, Bhattacharya B, Mridha SK, Bhattacharyya M. The nature, cause and consequence of COVID-19 panic among social media users in India. Soc Netw Anal Min. 2021 Jun 08;11(1):53–11. doi: 10.1007/s13278-021-00750-2. http://europepmc.org/abstract/MED/34122667

Wu, C. H.-J., Guttena, R. K., & Atmaja, F. T. (2022). Influence of Social Media Interactions on Vaccination Intention in India: An Application of the Stimulus-Organism-Behavior-Consequence Framework. *International Journal of* Human–Computer Interaction, 1–12. https://doi.org/10.1080/10447318.2022.2092952

Feasibility and acceptability of Saheli, a WhatsApp Chatbot, on COVID-19 vaccination among pregnant and breastfeeding women in rural North India. (2023). The Benioff Center for Microbiome Medicine. https://microbiome.ucsf.edu/publications/feasibility-and-acceptability-saheli-whatsapp-chatbot-covid-19-vaccination-among

Williams G. Angel of death: the story of smallpox. Springer; 2010 May. p. 17.

Rutjens BT, Sutton RM, van der Lee R. Not all skepticism is equal: exploring the ideological antecedents of science acceptance and rejection. Pers Soc Psychol Bull. 2018. https://www.frontiersin.org/journals/public-health/articles/10.3389/fpubh.2022.979424/full