Online sentiment about vaccines previews later vaccination rates, new Twitter study finds

May 15 2022

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Sentiments toward COVID-19 vaccines, whether positive or negative, previews subsequent vaccination rates, finds a study of related Twitter

posts. The results offer new insights into the influence of social media on public health measures.

The study, conducted by researchers at New York University's Courant Institute of Mathematical Sciences and NYU Grossman School of Medicine, showed that positive sentiment, expressed on Twitter, toward vaccinations was followed, a week later, by *increases* in vaccination rates in the same geographic area while negative sentiment was followed, in the same region, by *decreases* in vaccination rates the following week.

The study deployed a real-time big data analytics framework using sentiment analysis and natural language processing (NLP) algorithms. The system takes real-time tweets and identifies tweets related to vaccines and classifies these by certain themes and provides sentiment analysis, cataloging tweets as positive, negative, or neutral.

"We need to understand vaccine hesitancy and social media's impact on creating and spreading it," says Megan Coffee, MD, Ph.D. and a clinical assistant professor in the Division of Infectious Disease and Immunology within the Department of Medicine at NYU Grossman School of Medicine, one of the authors of the paper, which appears in the journal *Clinical Infectious Diseases*. "This is a first step toward creating a barometer to track sentiment and themes related to vaccine hesitancy."

"As the COVID epidemic has placed more of us in front of computers and vaccine hesitancy has shaped the epidemic, we need tools like this one to track and understand social media's impact on vaccine hesitancy for this epidemic and for future epidemics," adds Anasse Bari, a clinical associate professor in computer science at NYU's Courant Institute of Mathematical Sciences and an author of the paper.

Vaccination can help end the continuing surges and new variants of the COVID pandemic, the researchers note. But vaccine hesitancy, they

observe, undermines the impact of vaccination individually and collectively. Compounding this is the role of social media, which increasingly amplifies both information and misinformation regarding vaccination, raising questions about how, specifically, these platforms affect vaccination rates.

To address this, the paper's authors developed a big data analytics application based on Natural Language Processing (NLP), Sentiment Analysis (SA), and Amazon Web Services (AWS).

This tool allowed the researchers to track several vaccine-related topics as they appeared in dozens of phrases. Topics included: conspiracy, fear, heath freedom, natural alternatives, side effects, safety, trust/distrust, vaccines companies, established sources, and hesitancy, among others. These topics and related phrases allowed them to attach "sentiment scores" to vaccination—positive, negative, or neutral.

They also used a commonly deployed dataset, the Institute of Electrical and Electronic Engineers (IEEE) Dataport dataset, which tagged tweets' sentiment scores pertaining to the coronavirus by U.S. geographic location. The analyzed dataset included over 23,000 vaccine-related tweets from March 20, 2021 to July 20, 2021. The researchers also examined state-by-state daily U.S. COVID vaccination data.

Overall, the data showed that once vaccines were available for all adults—around mid-April 2021—an increase in positive sentiment in certain regions of the U.S. was followed by an increase in vaccination rate a week later. By contrast, in regions where there was a downturn in sentiment, a downturn in vaccination rates followed a week later.

Notably, the big data analytics framework showed that in the first several months of the pandemic, and before the vaccine rollout commenced at the end of 2020, positive and negative sentiment toward vaccines was

similar, with slightly a higher positive sentiment. By contrast, *after* the vaccine rollout commenced, negative sentiment tweets exceeded positive ones.

"Because vaccination rates were found to track regionally with Twitter vaccine sentiment, a more advanced analytics tool could potentially predict changes in vaccine uptake or guide the development of targeted social media campaigns and vaccination strategies," says Bari, who leads the Courant Institute's Predictive Analytics and AI Research Lab.

"This method allows us to begin to identify patterns in vaccine hesitancy over time and place," adds Coffee. "But, it can only monitor, and not influence, vaccine hesitancy, which is constantly changing. More work is needed to build trust in life-saving vaccines and undo the influence of vaccine negativity."

The paper's other authors were Madeline DiLorenzo from NYU Grossman School of Medicine, as well as Matthias Heymann, Ryan Cohen, Robin Zhao, Levente Szabo, Shailesh Apas Vasandani, Aashish Khubchandani, and Alankrith Krishnan—researchers at the Courant Institute's Predictive Analytics and AI Research Lab.

More information: Anasse Bari et al, Exploring Coronavirus Disease 2019 Vaccine Hesitancy on Twitter Using Sentiment Analysis and Natural Language Processing Algorithms, *Clinical Infectious Diseases* (2022). DOI: 10.1093/cid/ciac141

Provided by New York University