

The spread of fact-checks and the myths they debunk on Twitter: A case study of the graphene oxide myth during the COVID-19 pandemic

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Table of Contents

Original Manuscript..... 5
Supplementary Files..... 16
 Multimedia Appendixes 17
 Multimedia Appendix 1..... 17



The spread of fact-checks and the myths they debunk on Twitter: A case study of the graphene oxide myth during the COVID-19 pandemic

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Abstract

Background: COVID-19 was the first large-scale global pandemic coinciding with widespread use of social media. On social media platforms, misinformation, including vaccine conspiracy theories, is common and spreads further and faster than facts. Several interventions attempt to combat misinformation. Among these strategies, third-party fact-checking debunks misinformation via independently published articles and has the potential to address misinformation diffusion, awareness, and beliefs. During the COVID-19 pandemic, fact-checks increased; however, fact-checking organizations were only mentioned in 6% of responses to misinformation on Twitter (now X), Facebook, and YouTube. Improved dissemination is key to the success of this strategy.

Objective: We measured and examined the spread of a myth about graphene oxide in COVID-19 vaccines and its fact-checks on Twitter to answer the following questions: What is the volume of fact-checks and misinformation? Which fact-checks and misinformation spread the furthest? What is the structure of the network that formed around tweets and retweets of fact-checks and misinformation? Who is influential in the network?

Methods: We used descriptive statistics and data visualization to examine the distribution of tweets, retweets, and quote tweets over time. We developed network graphs and statistics to identify network structures to better understand the spread of misinformation and fact-checks.

Results: There were far more misinformation tweets, retweets, and quote tweets and more Twitter users posting misinformation than fact-checks. However, fact-check tweets spread the furthest through retweets and quote tweets compared to misinformation tweets.

Conclusions: While misinformation overwhelmed by volume and number of accounts involved, individual fact-checks spread further. This suggests the potential to improve the dissemination of fact-checking by posting more fact-checks and engaging more Twitter accounts in retweeting or quote tweeting fact-checking posts. Clinical Trial: NA

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Original Manuscript

The spread of fact-checks and the myths they debunk on Twitter: A case study of the graphene oxide myth during the COVID-19 pandemic

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Abstract

Background. COVID-19 was the first large-scale global pandemic coinciding with widespread use of social media. On social media platforms, misinformation, including vaccine conspiracy theories, is common and spreads further and faster than facts. Several interventions attempt to combat misinformation. Among these strategies, third-party fact-checking debunks misinformation via independently published articles and has the potential to address misinformation diffusion, awareness, and beliefs. During the COVID-19 pandemic, fact-checks increased; however, fact-checking organizations were only mentioned in 6% of responses to misinformation on Twitter (now X), Facebook, and YouTube. Improved dissemination is key to the success of this strategy.

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vaccines and its fact-checks on Twitter to answer the following questions: What is the volume of fact-checks and misinformation? Which fact-checks and misinformation spread the furthest? What is the structure of the network that formed around tweets and retweets of fact-checks and misinformation? Who is influential in the network?

Methods. We used descriptive statistics and data visualization to examine the distribution of tweets, retweets, and quote tweets over time. We developed network graphs and statistics to identify network structures to better understand the spread of misinformation and fact-checks.

Results. There were far more misinformation tweets, retweets, and quote tweets and more Twitter users posting misinformation than fact-checks. However, fact-check tweets spread the furthest through retweets and quote tweets compared to misinformation tweets.

Conclusions. While misinformation overwhelmed by volume and number of accounts involved, individual fact-checks spread further. This suggests the potential to improve the dissemination of fact-checking by posting more fact-checks and engaging more Twitter accounts in retweeting or quote tweeting fact-checking posts.

Break

Introduction

Severe acute respiratory syndrome coronavirus 2 (COVID-19) spurred the sixth pandemic of the twenty-first century, causing widespread death and damage.¹⁻⁸ Consistent with prior pandemics, misinformation, defined as false or misleading information regardless of intent, was common during the COVID-19 pandemic. However, COVID-19 was the first large-scale pandemic coinciding with ubiquitous use of social media. Misinformation, including vaccine conspiracy theories, is common on social media and spreads further and faster than facts.^{6,9-11}

Among its negative effects on public health, misinformation beliefs are associated with vaccine hesitancy and lower vaccination rates. For example, belief that COVID-19 vaccines are unsafe is correlated with vaccine hesitancy,¹² and studies of social media users find associations between sharing COVID-19 misinformation and anti-vaccination sentiment.¹³ Natural experiments demonstrate a relationship between vaccine misinformation exposure and lower vaccination rates.^{14,15}

Third-party fact-checking to debunk misinformation via independently published articles and shows promise. For example, fact-checking has a positive effect on misinformation beliefs,^{16,17} attenuates misinformation spread,¹⁸ and increases misinformation awareness.¹⁹ During the COVID-19 pandemic, fact-checks and engagement with fact-checking content increased.^{20,21} Despite this, fact-checks were posted on social media less frequently than misinformation,¹⁸ and fact-checking organizations were only mentioned in 6% of responses to misinformation on Twitter (now X), Facebook, and YouTube.¹⁹

Although increases in third-party fact-checking are encouraging, dissemination is key to its success. The current study is the first we know of using network analysis to investigate the spread of third-party fact-checks and the misinformation they debunk on social media. We focus on the myth that COVID-19 vaccines contain graphene oxide, a popular material in nanotechnology that has been the subject of conspiracy theories regarding population control. This myth gained attention after a June 2021 report claimed Pfizer's COVID-19 vaccine contains graphene oxide.²² Although this report was proven false by several fact-checking organizations, the myth gained attention in the United States after promotion by anti-vaccination media outlets. We measured and examined the spread of the graphene oxide myth and its fact-checks on Twitter to answer: What is the volume of fact-checks and misinformation? Which fact-checks and misinformation spread the furthest? What is the structure of the network that formed around tweets and retweets of fact-checks and misinformation? Who is influential in the network?

Methods

We collected tweets with URLs of fact-checks or misinformation about the graphene oxide myth. To identify fact-check URLs, we reviewed fact-checking organization websites for articles debunking the myth. Organizations included PolitiFact, Lead Stories, Full Fact, AFP-Hub, Reuters, The Associated Press, USA TODAY, Check Your Facts, Science Feedback, Snopes, Factcheck.org, and The Dispatch. We reviewed all fact-check articles for one or more hyperlinks to misinformation. The appendix lists URLs corresponding to fact-checks and the misinformation they debunk.

Using Twitter's API for academic research, we retrieved 10,619 original tweets, retweets, and quote tweets. All tweets were in English and contained hyperlinks to URLs listed in Appendix 1. Given the timing of the graphene oxide myth report, we limited the tweets analyzed to June 30 to November 30, 2021. We classified each tweet by information type, fact-check or misinformation, and week. Week was the number of weeks between the tweet's publication date and June 30.

We examined the distribution of tweet volume and the structure and composition of retweet networks. Retweets and quote tweets were combined since they play a similar role in information diffusion. We counted total tweets, original tweets, and retweets/quote tweets by URL and information type for each week (Appendix) and graphed the totals over time.

We examined retweet / quote tweet networks at week 1, week 4, and the end of data collection. Weeks 1 and 4 were selected because they correspond to peaks in tweet volume. The network visualizations include dots (nodes), which represent a Twitter account, and arrows between them (links), which represent retweeting or quote tweeting. The direction of the arrows between accounts represents the flow of information. For example, if user B retweeted user A, the relationship is depicted as $A \rightarrow B$ showing the flow of information from user A to user B. Network visualizations and statistics exclude isolates, or nodes that were not connected to other nodes. For each network we computed the number of accounts and number of retweets or quote tweets in each network.

Spread of information through directed networks can also be understood by measuring information cascades formed by a tweet and its retweets. A cascade can start from an original tweet or a retweet / quote tweet. We removed tweets not retweeted nor quoted from the cascade analysis. The size of a cascade is the number of retweets or quote tweets it received; the smallest cascade size is 1. We compared the distribution of cascades for misinformation and fact-check tweets.

Results

Twelve fact-checking websites included 22 articles debunking the graphene oxide myth published by: PolitiFact, Lead Stories, Full Fact, AFP-Hub, Reuters, The Associated Press, USA TODAY, Check Your Facts, Science Feedback, and Snopes. Two tweets from PolitiFact and Lead Stories were the first to debunk and were 62.4% of total fact-checking tweets (Appendix).

Fact-checking articles contained 48 URLs to sources promoting the myth. Rumble, Bitchute, Facebook, and Instagram were over-represented among misinformation sources. Rumble and Bitchute are video-sharing platforms touted as alternatives to YouTube. Two videos posted on Rumble, a tweet, and a copy of the report that originally asserted the myth received 90.4% of misinformation tweets (Appendix).

The volume of misinformation tweets far exceeded the volume of fact-checking tweets. There were 9,737 misinformation and 882 fact-checking tweets in the 22 weeks following June 30, 2021, when the myth began circulating. Figure 1 shows the volume of tweets over time. Major spikes in misinformation tweets in weeks 1 and 4 correspond to media coverage by the Stew Peters Show, a conservative news outlet produced by Red Voice Media and broadcasted on Rumble.

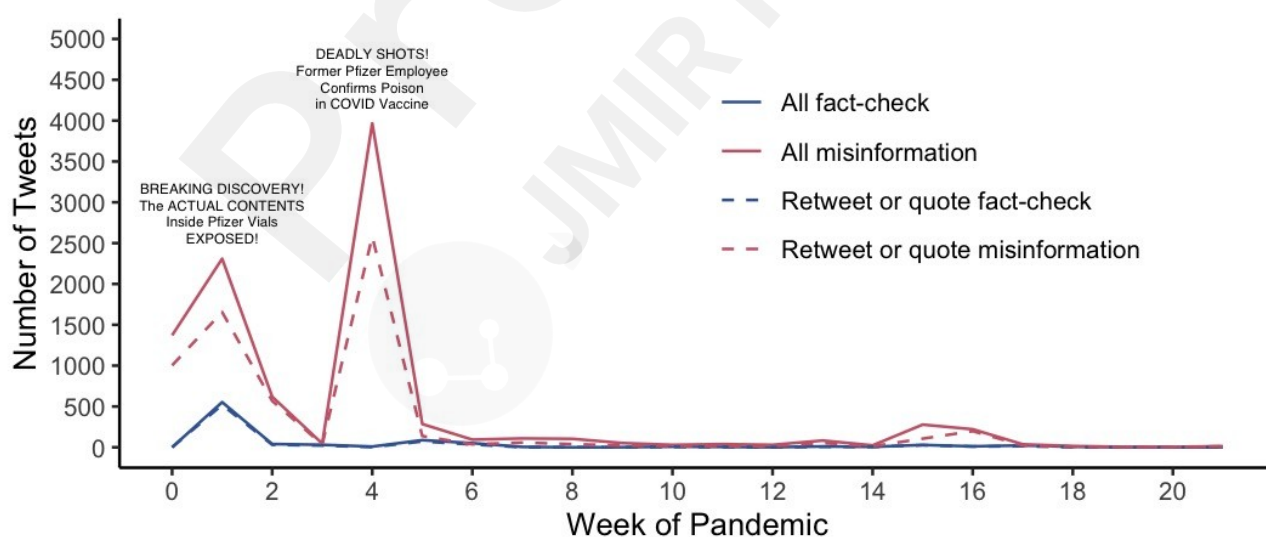


Figure 1: Fact-check and misinformation tweets about the graphene oxide myth starting June 30, 2021 (week 0). Peaks in misinformation tweets correspond to media coverage by the Stew Peters Show with headlines shown in the graph.

More accounts spread misinformation and were active for longer compared to fact-checks

There were 6,287 accounts spreading misinformation and 693 accounts fact-checking. The misinformation network remained active for a longer period, with more tweets (Figure 1) and more accounts retweeting and quote tweeting (Figure 2) misinformation four weeks after the myth started spreading. The fact-checking network was active primarily in the first week (Figure 1 and Figure 2).

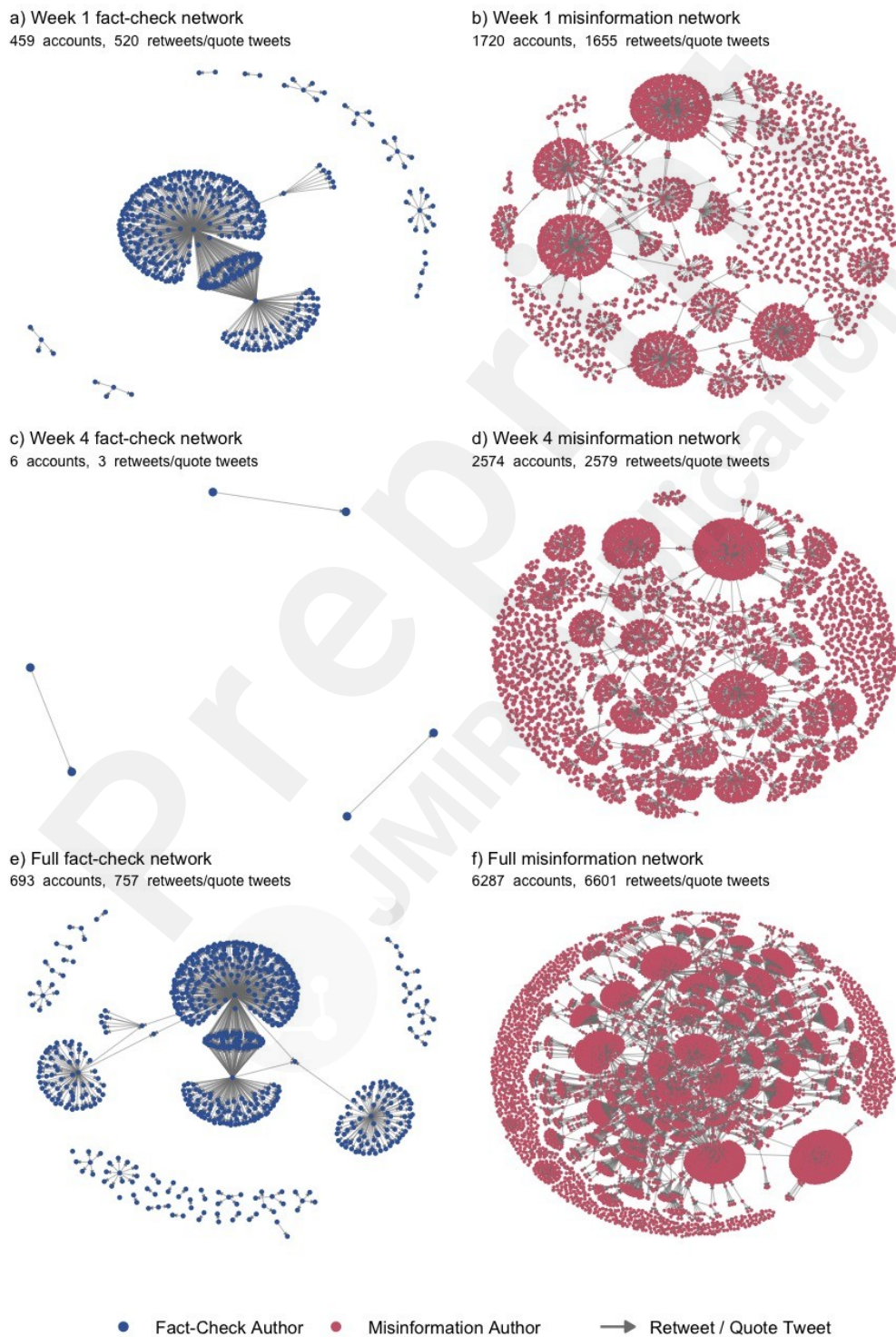


Figure 2: Retweet / quote tweet networks stratified by information type for week 1, 4, and the full network at the end of 22 weeks.

More accounts were central to misinformation spread compared to fact-check spread. Visually, influential or central nodes are at the centers of the dandelion formations (Figure 2). The large number of arrows beginning at these nodes indicates many retweets or quote tweets, critical to spreading information. In the fact-checking networks, PolitiFact, Lead Stories, and Full Fact were central. In the misinformation network, central nodes were unverified accounts appearing to be individuals.

The misinformation network had more cascades and the largest cascade but the fact-check network had a higher median cascade size

Although the largest cascade was a misinformation cascade (Table 1), the median cascade size was twice as large for fact-check tweets compared to misinformation and the interquartile range (IQR) suggests a quarter of fact-check tweets were retweeted between 2 and 6.75 times.

Table 1: Cascade sizes for fact-check tweets and misinformation tweets about the graphene oxide myth in mid-2021

Type	Number of Cascades	Max Cascade Size	Mean Cascade Size	Std Dev Cascade Size	Median Cascade Size	IQR
Fact Check	50	341	15.14	51.18	2	1–6.75
Misinformation	1209	558	5.46	25.65	1	1–3

Discussion

Falsehood will fly, as it were, on the wings of the wind, and carry its tales to every corner of the earth; whilst truth lags behind; her steps, though sure, are slow and solemn, and she has neither vigour not activity enough to pursue and overtake her enemy.^{23(p233)}

This 1787 quote²³ is consistent with our findings about misinformation spread on Twitter in 2021. We examined the volume and network structure of tweets, retweets, and quote tweets about the graphene oxide myth during the COVID-19 pandemic. There were far more tweets, retweets, and quote tweets and more Twitter accounts involved in spreading misinformation compared to fact-checking, consistent with prior studies of public health misinformation spread on Twitter.²⁴ Ways of spreading information have changed since 1787 and this could facilitate opportunities for truth to “pursue and overtake her enemy.” For example, the cascades of information across the two social media networks suggests opportunities to increase the “vigour” with which truth spreads. Specifically, information cascades were much larger on average for fact-check tweets compared to misinformation tweets. So, an increase in fact-checking tweets has the potential to result in fact-checking volume overtaking misinformation volume on social media, which could impact

misinformation beliefs,^{16,17} attenuate misinformation spread,¹⁸ and increase misinformation awareness.¹⁹



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Conflicts of Interest: None noted.

Data Availability: Data will be available on GitHub after acceptance.

Abbreviations:

- IQR: Interquartile range or the range containing 50% of observations
- URL: Uniform resource locator or a web address
- API: Application programming interface or a way to connect to data or other sources of online information
- COVID-19: Severe acute respiratory syndrome coronavirus 2

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Supplementary Files

Multimedia Appendixes

Fact-check and misinformation URLs about the graphene oxide myth in 2021.
URL: <http://asset.jmir.pub/assets/b04691020e963fbedaa1fbfabde7f98.docx>