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# Temporal study of the social conversation on Twitter (X): The case of the COVID-19 pandemic



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**Background:** During the coronavirus disease 2019 (COVID-19) pandemic, social media platforms played an important role for various purposes and involved many participants. The global issue of the pandemic was communicated and shared on social media platforms, converging and manifesting as a global social conversation.

**Objectives:** This study examined the conversation on #covid19 on the social platform X (formerly Twitter) to identify key discussions and participants.

**Method:** The evolving pattern of discussions was traced over 7 months, from March 2020 to September 2020, to obtain a deeper understanding of the conversation on social platforms. The most frequently used hashtags, mentions, and keywords were also identified. Furthermore, topic modelling was conducted, and the main themes that emerged in the social conversation were determined.

**Results:** Five clusters of players were identified, that is, governments, individuals, professionals, organisations, and non-profit organisations, who shared the same interest in being involved in #covid19, but with diverse stakes.

**Conclusion:** The findings are important for understanding how social media platforms can be effectively utilised during a pandemic.

**Contribution:** This study sheds light on leveraging the potential of social networks during crises such as pandemics, as well as the importance of managing global social involvement by various stakeholders.

**Keywords:** social media; Twitter; #covid19; COVID-19; topic modelling; social networking; social network analysis; pandemic.

## Introduction

Social media platforms, crucial tools for communication, also generate knowledge (Storey & O'Leary 2024). This is particularly true during crises such as pandemics (Fedorova et al. 2023; Hopkins et al. 2024). There are specific features of social media platforms, including hashtags (#), mentions (@), likes, and retweets, which enable diverse communities and individuals worldwide to share information and engage in one global conversation. In the context of healthcare, social media has influenced communication among organisations, practitioners, and patients (Rosen & Bock 2019). Connecting global public health professionals and enabling public engagement can help with healthcare development and contribute to alleviating the stagnation problems experienced by established physicians regarding current medical procedures and practices; this is made possible by helping enhance their awareness and knowledge of the developments in their field (Mandrola & Futyma 2020). One such social media platform is Twitter, renamed 'X' in July 2023, a microblogging platform that may be used to influence medical debates, developments, and practices as well as to help impose new norms among healthcare professionals regarding sharing clinical data on social media platforms (Mandrola & Futyma 2020).

The three primary functions of X are information sharing, problem-solving, and public relations (Leek, Canning & Houghton 2016). However, Leek et al. (2016) also found that using only X is inadequate for information sharing and problem-solving owing to limitations of content, issues related to public accessibility, and lack of instant feedback. Despite these limitations, X's embedded link features have enriched its ability to perform tasks. X can be harnessed for professional use in the healthcare context, as depicted in Table 1 (Thompson et al. 2015). Social media can help healthcare professionals regain their voice and role as influencers of patients, instead of staying in the background while patients consult the massive amount of health information available on social platforms (Oehler 2020).

**TABLE 1:** X for professional use in healthcare.

| X for professional purposes |
|---|
| Obtaining information on the latest research |
| Obtaining information relevant to the profession |
| Following key opinion leaders and experts |
| Sharing research findings and publications |
| Learning opportunities |
| Receiving patient feedback |
| Following non-medical interests |

*Source*: Thompson, M.A., Majhail, N.S., Wood, W.A., Perales, M.A. & Chaboissier, M., 2015, 'Social media and the practicing hematologist: Twitter 101 for the busy healthcare provider', *Current Hematologic Malignancy Reports* 10(4), 405–412. https://doi.org/10.1007/s11899-015-0286-x

Researchers have used X data for healthcare and medical purposes, for example, in the development of real-time flu surveillance, employing spatial, temporal and text mining analyses to predict outbreaks (Lee, Agrawal & Choudhary 2013). Furthermore, data generated on X have been analysed to advance public health knowledge and practices (Alotaibi et al. 2020; Ji, Chun & Geller 2013; Paul & Dredze 2011), and to detect influenza outbreaks (Byrd, Mansurov & Baysal 2016; Culotta 2010). X has also been found to positively influence patient pain by providing emotional relief as patients share their experiences with healthcare providers and others (Ashtari, Taylor & Lai 2020). Ashtari et al. also found that patients become involved in communities for emotional support, self-care education and pain management techniques. Another study analysed X data to identify medical errors experienced by patients, including their source and type, and patients' emotional responses (Nakhasi et al. 2019). Merolli et al. (2019) examined the communication behaviour of the physiotherapy community on X and found that the functionality of hashtags enabled professionals across 24 countries to participate in social exchange. They analysed the exchanged tweets and identified eight emerging themes: sharing information, promotion, positive feedback, networking, leadership, prompting discussion, clinical practice and requesting information.

Behaviours related to tweets by clinicians, patients, healthcare organisations and industry, including their characteristics, have been examined (Carroll et al. 2020). It was found that healthcare organisations tweet the most, followed by clinicians, patients and the industry. The degree to which the retweet and reply features were used by healthcare organisations varied (Park, Reber & Chon 2016). A data cloud containing patient experience was conceptualised, wherein data about healthcare providers on various social media platforms will be collected to identify poor healthcare performance (Greaves et al. 2013).

Using X to share information regarding treatment procedures and research has been found to contribute to improved healthcare. However, the use of X for direct interaction between doctors and patients compromises privacy and entails misinformation concerns (Pershad et al. 2018). The power of social media platforms comes with pitfalls and risks that manifest in the spread of misleading medical information, such as vaccine denial and fraudulent naturopathy (Mandrola & Futyma 2020). In addition, the credibility of sources and opportunity costs of using physicians' time must be considered (Pershad et al. 2018). X was found to sometimes be used improperly among healthcare professionals – for example, nursing professionals and students were found to be posting inappropriate content, including comments that demeaned patients, demonstrated interprofessional aggression and violated the *Health Insurance Portability and Accountability Act* (De Gagne et al. 2019). Pershad et al. argued for enacting new guidelines for health professionals on X and emphasised the need to maintain separate personal and professional accounts as well as clearly state affiliations in their X profiles. Mandrola and Futyma (2020) argued for the use of common sense and decency rather than enacting regulations or guidelines. In addition to health professionals, parents were found to use social media to access their children's health information, yet the majority did not discuss the acquired information with their healthcare providers (Bryan et al. 2020). However, many adult patients with intellectual and/or developmental disabilities were found not to use technology or social media because of their disability or the lack of support and training regarding it, preventing them from learning and using technologies (Patrick et al. 2020).

Examined in this study was the social conversation that took place on X over some months in 2020, during the coronavirus disease 2019 (COVID-19) pandemic that swept the world and affected businesses and social life, causing widespread economic losses and deaths. The following research question was formulated:

RQ: *How was the COVID-19 pandemic discussed, using the hashtag #covid19, on X?*

## Research methods and design

The aim of this study is to examine the conversation on #covid19 on X, to identify key discussions and participants. Thus, a qualitative methodology was adopted, focusing on analysing the content and meaning of social media posts interpretively using a single source. Text analysis involves the use of topic modelling, a natural language processing technique for uncovering abstract topics that occur in a collection of unstructured data. Topic modelling is an established technique for analysing massive amounts of social media data to uncover and identify hidden topics (Fedorova et al. 2023; Wicke & Bolognesi 2024). Topic modelling was conducted to extract inductively the most important topics discussed across a substantial number of tweets. The analytical tool R (Version 1.3.1056) was used for topic modelling, using the 'topicmodels' package. Therefore, the major topics discussed in this dataset were identified. Each tweet was considered a document. A 'document term matrix' was established from a tweet corpus, deriving a topic model from it. A topic is a collection of representative dominant keywords, which often occur simultaneously. A corpus is a collection of documents and each tweet is considered a document in the dataset. In this study, core topics were discovered in a vast dataset of tweets by using the latent Dirichlet allocation algorithm in R. Latent Dirichlet

allocation is a mathematical model that simultaneously estimates the mixture of words associated with a topic and the mixture of topics that describe each document.

## Data collection

Data (tweets) were collected using the Webometric Analyst tool (Thelwall 2017) from 17 March 2020 to 22 September 2020. Tweets were collected based on the hashtag #covid19. The data collection process yielded 21 497 092 tweets. An initial examination indicated that the percentage of original tweets (not retweets) was up to 24% (Table 2).

## Data analysis

### Hashtags, mentions, and keyword analysis

The evolution and changing patterns of discussions on COVID-19 on Twitter were traced over 7 months. The most frequently occurring hashtags, mentions and keywords by month are summarised in Table 3, Table 4, and Table 5, respectively.

The associations between hashtags and mentions were analysed by month (Figure 1 and Figure 2). The frequency of hashtags ranged from at least one occurrence to a maximum of 2 015 087 in April 2020 for #covid19. Hashtags change continuously by month depending on the events occurring in the physical world. Though hashtags are not case sensitive, they were distinguished in the analysis so as to recognise user preferences in hashtag spelling, and included retweets. Additionally, the associations among the variables were analysed by month. The frequency of mentions ranged from at least one occurrence to a maximum of 77 738 in April for @realDonaldTrump.

**TABLE 2:** A summary of the dataset.

| Month | Dataset size | Original tweets | Original tweets (%) | Unique hashtags | Unique mentions |
|---|---|---|---|---|---|
| March | 3 375 625 | 628 826 | 18.63 | 173 259 | 382 809 |
| April | 4 674 347 | 1 009 276 | 21.60 | 286 403 | 559 882 |
| May | 3 734 402 | 894 086 | 23.94 | 252 718 | 451 550 |
| June | 2 877 472 | 680 801 | 23.66 | 197 643 | 337 124 |
| July | 2 671 376 | 619 243 | 23.18 | 180 962 | 298 883 |
| August | 2 510 221 | 587 986 | 23.42 | 169 707 | 270 934 |
| September | 1 653 649 | 391 516 | 23.67 | 118 748 | 191 526 |

**TABLE 3:** Most frequent month-wise hashtags, in descending order.†

| Month | Hashtags |
|---|---|
| March | #COVID19 #coronavirus #COVID19. #Covid19 #covid19 #COVID19, #Coronavirus #COVID19: #COVID19? #StayHome |
| April | #COVID19 #Covid19 #COVID19. #coronavirus #covid19 #COVID19, #Coronavirus #COVID19: #SocialDistancing #StayHome |
| May | #COVID19 #Covid19 #covid19 #COVID19. #coronavirus #COVID19, #Coronavirus #lockdown #COVID19: #COVID19? |
| June | #COVID19 #Covid19 #COVID19. #covid19 #coronavirus #COVID19, #Coronavirus #GeorgeFloyd #COVID19? #COVID19 |
| July | #COVID19 #Covid19 #COVID19. #covid19 #coronavirus #COVID19, #Coronavirus #Blood #covid19. #COVID19? |
| August | #COVID19 #Covid19 #COVID19. #covid19 #coronavirus #COVID19, #Blood #WearAMask #NEET |
| September | #COVID19 #Covid19 #COVID19. #covid19 #COVID19, #coronavirus #Blood #Delhi #Coronavirus #BTSARMY |

†, Hashtag count, including retweets.

## Topic modelling analysis

Topic modelling was conducted multiple times per month, with prior numbers of topics ranging from 2 to 20. See Appendix 1 (Table 1-A1–Table 7-A1) for a summary of the identified topics. As the topics were traced by month, conversations evolved each month and were influenced by changes in the physical world.

## Ethical considerations

This article does not contain any studies involving human participants and/or animals performed by the author.

# Results and discussion

## Evolution of the discussion on #covid19

After examining the topics emerging from topic modelling, those based on the #covid19 conversation were categorised into five main themes: confronting the pandemic; impact of the pandemic; economic and environmental; collective action; governmental legislation; and connection and socialisation (Table 6). Michela et al. (2022) investigated the social communication on X during the pandemic and identified three main themes: sharing announcements, building and involving in the community, and unrelated communication to the pandemic. Fedorova et al. (2023) identified four pandemic-related Twitter narratives: governmental response policies, people's feelings, vaccination and pandemic-related international politics.

**TABLE 4:** Most frequent month-wise mentions, in descending order.

| Month | Mentions |
|---|---|
| March | @ANI: @NCDCgov: @realDonaldTrump @protectheflames: @DrDenaGrayson: @doctor_oxford: @bradshaaaw: @silv24: @WHO @DrEricDing: @DrTedros |
| April | @realDonaldTrump @ANI: @NCDCgov: @WHO @DrDenaGrayson: @DrEricDing: @WHO: @CDCgov: @BT21_: @SkyNews: @FLOTUS: @SecPompeo |
| May | @realDonaldTrump @ANI: @DrEricDing: @WHO @Laurie_Garrett: @DrDenaGrayson: @ajplus: @SkyNews: @himantabiswa: @WHO: @JamesOKeefeIII: @tedlieu |
| June | @YourAnonCentral: @realDonaldTrump @DrEricDing: @ANI: @DrRobDavidson: @GavinNewsom: @wendellpotter: @realdonaldtrump @Laurie_Garrett: @WHO @richardhine: @WHO |
| July | @DrEricDing: @realDonaldTrump @GavinNewsom: @DaniOliver: @ANI: @DrDenaGrayson: @tedlieu: @Craig_A_Spencer: @BloodDonorsIn: @Laurie_Garrett: @SenDuckworth: @DrZweliMkhize |
| August | @DrEricDing: @realDonaldTrump @BloodDonorsIn: @priteshgandhimd: @ANI: @DrTedros: @narendramodi @SonuSood: @F_Ansari_Godda: @WHO: @FijiPM: @zev_dr |
| September | @DrEricDing: @realDonaldTrump @BloodDonorsIn: @DrTedros: @juliaioffe: @ANI: @Tombx7M: @GavinNewsom: @DrDenaGrayson: @BTS_twt @WHO: @CTZebra |

**TABLE 5:** Month-wise keywords.

| Month | Keywords | Countries |
|---|---|---|
| March | Nitrogen, pollution, dioxide, vaccine, bonnievonduyke, finessabae, trump, closing | China, Italy, India |
| April | Lockdown, nurses, markaz, mask, social distance, elsalwilliams, ncdcgor, seven, fight | China, India, Nigeria |
| May | Emergency, thank, food | China, India |
| June | Protesting, georgefloyd, York, solidarity, isolate, protestors, applaud, back | India |
| July | Doctors, blood, economic, physical, face, weekend, question | India |
| August | Americans, School, kids, children, plasma, vaccine, garrett, benjalvarez, laurie, data | Berlin, Germany, India |
| September | Type, point, dr | India |

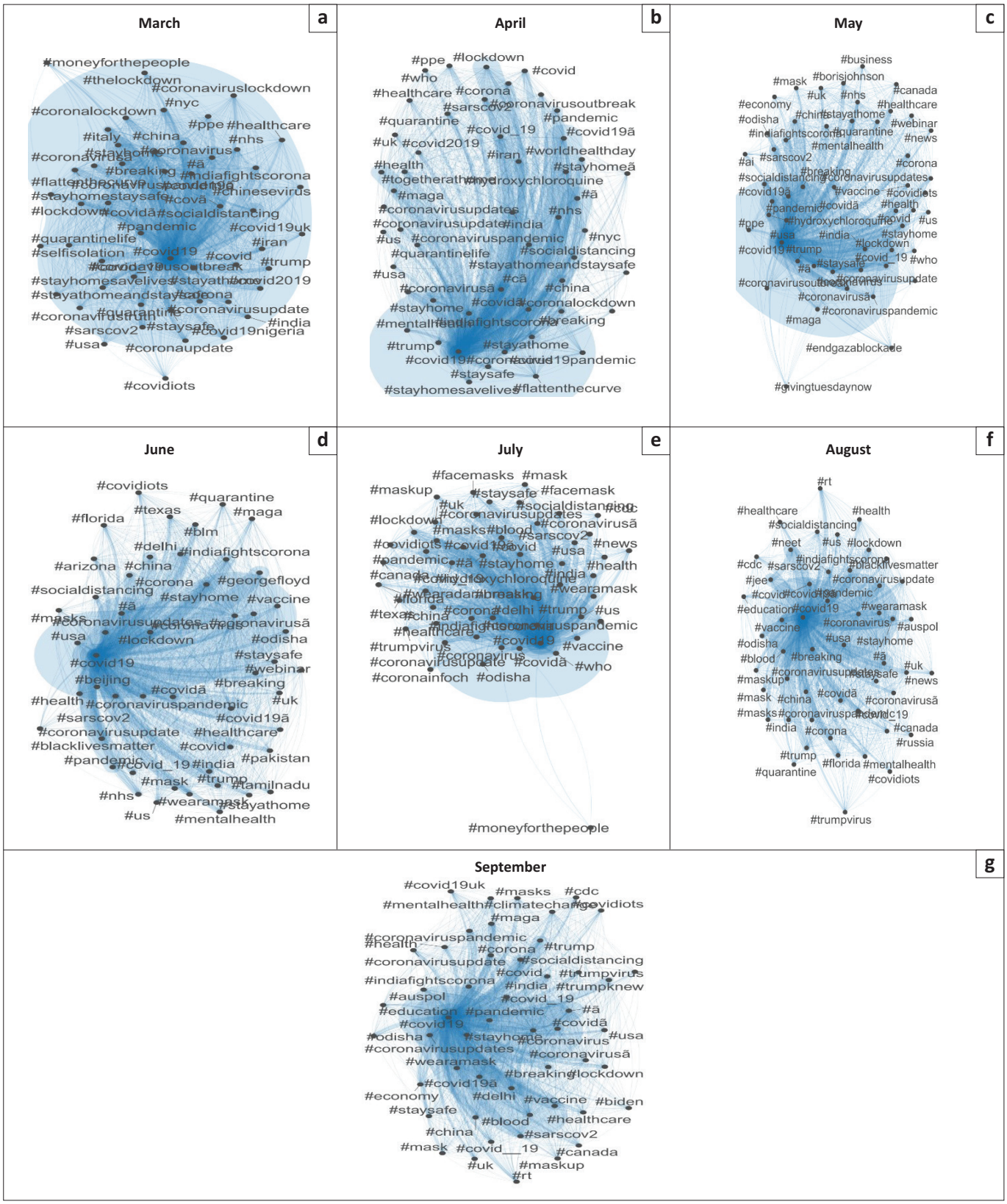


**FIGURE 1:** Hashtag clusters showing the association between #covid19 and other related hashtags. (a) March 2020. (b) April 2020. (c) May 2020. (d) June 2020. (e) July 2020. (f) August 2020. (g) September 2020.

## Clusters of key players

Each emerging topic was thoroughly examined using the keywords and associated extracted tweets. Through examination of the extracted tweets and observing the conversation on #covid19, five clusters of players were identified in the dataset: governments, individuals (average citizens), professionals (medical experts and health workers), business organisations and non-profit organisations. They shared an interest in the same topic but with diverse stakes and varying degrees of involvement and motives.


**FIGURE 2:** Mentions clusters showing the association between participants in the hashtag of #covid19. (a) March 2020. (b) April 2020. (c) May 2020. (d) June 2020. (e) July 2020. (f) August 2020. (g) September 2020.

## Governments and government bodies

Governments and government bodies are present on X and participated in #covid19, reflecting on political and social issues, connecting with the public, and sharing information and actions by redirecting to their websites through link sharing. The following is an example of how a city council, as an official body, connects with the public and disseminates helpful information:

> 'Going shopping today? Please do not drop used disposable gloves on the streets afterwards. They could spread #COVID19

**TABLE 6:** Main categories of the #covid19 conversation.

| Main themes |
|---|
| Confronting the pandemic |
| Impact of the pandemic: economic and environmental |
| Collective action |
| Governmental legislation |
| Connection and socialisation |

> and create litter. Peel them off so that they turn inside out and put them in a bin or take them with you and bin them safely at home. #SpiritOfSalford.'

Local authorities connected with citizens, provided customer services by replying and advising, and disseminated governmental support and information to individuals and families during the pandemic. Fedorova et al. (2023) investigated the sentiments reflected in tweets concerning governmental anti-pandemic policies. They found that positive tweets reflected satisfaction with governments' policies. Rufai and Bunce (2020) investigated the Group of Seven world leaders' use of X in responding to the COVID-19 pandemic. They found that most of the shared content was informative, along with web links to official government-based sources. Githaiga and Shifare (2024) investigated government use of X during the pandemic and examined the involvement of Kenya's Ministry of Health; they identified six communication clusters as follows: disseminating public health information, government plans and measures, correcting and combating misinformation, pandemic updates, humanitarian and community aid, and pandemic surveillance.

### Individuals

Individuals participated in #covid19, to be involved in the global conversation on the pandemic situation, promote achievements, share information and views, support each other, and take action. Charquero-Ballester et al. (2024) found that individuals involved in social networking for information and emotional exchange during the pandemic used crisis-specific hashtags. The following is an example of an individual voicing expectations of the medical profession to play a role:

> '#DrFauci #Covid19 WHY isn't he on TV urging protestors to go home, or at least to social distance? Is the #pandemic over? Or are we going to see an explosion of cases in two weeks?'

Individuals were negatively affected by fake and misleading news regarding the pandemic. Therefore, Chiu et al. (2024) investigated the attributes of users and posts (tweets) to identify the truthfulness of content and distinguish between true and false COVID-19 news.

### Professionals

Professionals involved in #covid19, in an effort to encourage the sharing of trusted sources to obtain information and to share their knowledge and useful resources with the public, connected with professional bodies and other professionals and shed light on important scientific events. Biermann and Taddicken (2025) investigated the role of virologists on X during the pandemic in Germany. They found that virologists engaged in sharing scientific evidence and prevention measures at the individual level, and participated in reflecting on political measures and media coverage. Rao et al. (2025) investigated the behaviours of public health experts versus pseudo-experts on X. They found that experts were more focused on sharing content on masking, healthcare, education, and vaccines, while pseudo-experts were more concerned about therapeutics and lockdowns.

### Organisations

X was used as a news channel and platform. News agencies disseminated news and directed individuals to their websites. Businesses and other organisations exploited the situation created by the pandemic and started promoting and marketing their products and services by sharing links to their websites, keeping their followers updated, and sharing their contribution to society. The COVID-19 crisis negatively affected the global economy and business profitability, but many organisations exploited the opportunity to utilise digital transformation and social media platforms for survival (Rojas-García et al. 2024). Furthermore, the pandemic impacted organisational sales and communication strategies, forcing many organisations to adapt to change and turn to virtual point-of-sales and virtual communications (Giovannetti et al. 2024).

### Non-profit organisations

Non-profit organisations involved in #covid19, to offer support to those affected by the pandemic, shared achievements and involvement, promoted social support and recruited participants. They also used social platforms to redirect people to their websites by sharing links and photos. Duffett and Thomas (2024) investigated the use of social media networking during the pandemic by South African health non-profit organisations. It was determined that social networking sites' communication facilities were used for communication and as part of a marketing strategy to increase donations, awareness and virtual presence and to promote services, events and memberships.

## Conclusion

X was used as a social platform during the COVID-19 pandemic to share information and resources, connect and participate in global conversations on social and political issues. The hashtag feature facilitated connectivity and convergence. Contributions for #covid19 were identified from countries all over the world, including France, Canada and Nigeria, despite the variations in culture and language. Messages were written for and targeted at the public. In this study, the social conversation was traced and an analysis of keywords, hashtags, and mentions was conducted through topic modelling, using R. Based on the analysis of the dataset, five clusters of players were identified: governments, individuals, professionals, organisations and non-profit organisations. They shared the same interest in #covid19, although with diverse stakes. Involvement and communication took the form of 'one conversation, yet globally'. Future studies could investigate the motives of each cluster, the interactions among them and the degree of involvement and influence.

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The author declares that no financial or personal relationships inappropriately influenced the writing of this article.

## Author's contributions

A.A. declares that she is the sole author of this article.

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## Data availability

Data sharing does not apply to this article as no new data were created or analysed in this study.

## Disclaimer

The views and opinions expressed in this article are those of the author and are the product of professional research. They do not necessarily reflect the official policy or position of any affiliated institution, funder, agency or the publisher. The author is responsible for this article's results, findings and content.

# References


Alotaibi, S., Mehmood, R., Katib, I., Rana, O. & Albeshri, A., 2020, 'Sehaa: A big data analytics tool for healthcare symptoms and diseases detection using Twitter, Apache Spark, and machine learning', *Applied Sciences* 10(4), 1398. https://doi.org/10.3390/app10041398

Ashtari, S., Taylor, J. & Lai, G., 2020, 'Systematic review of social networking support groups for genetic-disorders pain management', in *Proceedings of the 53rd Hawaii international conference on system sciences*, Maui, HI, January 07–10, 2020.

Biermann, K. & Taddicken, M., 2025, Visible scientists in digital communication environments: An analysis of their role performance as public experts on Twitter/X during the Covid-19 pandemic', *Public Understanding of Science* 34(1), 38–58. https://doi.org/10.1177/09636625241249389

Bryan, M.A., Evans, Y., Morishita, C., Midamba, N. & Moreno, M., 2020, 'Parental perceptions of the internet and social media as a source of pediatric health information', *Academic Pediatrics* 20(1), 31–38. https://doi.org/10.1016/j.acap.2019.09.009

Byrd, K., Mansurov, A. & Baysal, O., 2016, 'Mining Twitter data for influenza detection and surveillance', In *Proceedings of the international workshop on software engineering in healthcare systems,* Austin, Texas, May 14-15, 2016, pp. 43–49.

Carroll, C.L., Kaul, V., Sala, K.A. & Dangayach, N.S., 2020, 'Describing the digital footprints or "sociomes" of asthma for stakeholder groups on Twitter', *ATS Scholar* 1(1), 1–12. https://doi.org/10.34197/ats-scholar.2019-0014OC

Charquero-Ballester, M., Walter, J.G., Rybner, A.S., Nissen, I.A., Enevoldsen, K.C. & Bechmann, A., 2024, 'Emotions on Twitter as crisis imprint in high-trust societies: Do ambient affiliations affect emotional expression during the pandemic?', *PLoS One* 19(3), e0296801. https://doi.org/10.1371/journal.pone.0296801

Chiu, M.M., Morakhovski, A., Ebert, D., Reinert, A. & Snyder, L.S., 2024, Detecting COVID-19 fake news on Twitter: Followers, emotions, relationships, and uncertainty', *American Behavioral Scientist* 68(10), 1269–1289. https://doi.org/10.1177/00027642231174329

Culotta, A., 2010, 'Towards detecting influenza epidemics by analyzing Twitter messages', In *SOMA'10: Proceedings of the first workshop on social media analytics,* Washington, D.C., July 25, 2010, pp. 115-122, Association for Computing Machinery, New York, United States.

De Gagne, J.C., Hall, K., Conklin, J.L., Yamane, S.S., Roth, N.W., Chang, J. et al., 2019, 'Uncovering cyberincivility among nurses and nursing students on Twitter: A data mining study', *International Journal of Nursing Studies* 89, 24–31. https://doi.org/10.1016/j.ijnurstu.2018.09.009

Duffett, R.G. & Thomas, S., 2024, Health nonprofit organizations use of social media communication and marketing during COVID-19: A qualitative technology acceptance model viewpoint', *Social Sciences & Humanities Open* 10, 101042. https://doi.org/10.1016/j.ssaho.2024.101042

Fedorova, E., Ledyaeva, S., Kulikova, O. & Nevredinov, A., 2023, 'Governmental anti-pandemic policies, vaccination, population mobility, Twitter narratives, and the spread of COVID-19: Evidence from the European Union countries', *Risk Analysis* 43(10), 1975–2003. https://doi.org/10.1111/risa.14088

Giovannetti, M., Sharma, A., Rangarajan, D., Cardinali, S. & Cedrola, E., 2024, 'Understanding the enduring shifts in sales strategy and processes caused by the COVID-19 pandemic', *Journal of Business & Industrial Marketing* 39(4), 735–756. https://doi.org/10.1108/JBIM-12-2022-0570

Githaiga, N. & Shifare, H., 2024, 'The opportunities and challenges of social media use by government in crisis management: A case of Ministry of Health and Twitter usage in Kenya during Covid-19', *American Journal of Industrial and Business Management* 14(12), 1658–1677. https://doi.org/10.4236/ajibm.2024.1412083

Greaves, F., Ramirez-Cano, D., Millett, C., Darzi, A. & Donaldson, L., 2013, 'Harnessing the cloud of patient experience: Using social media to detect poor quality healthcare', *BMJ Quality & Safety* 22(3), 251–255. https://doi.org/10.1136/bmjqs-2012-001527

Hopkins, S.W., Stark, A.M., Zinoviev, D., Tousignant, O.H. & Fireman, G.D., 2024, 'College student expression on Twitter during the COVID-19 pandemic', *Journal of American College Health* 72(3), 722–730. https://doi.org/10.1080/07448481.2022.2055434

Ji, X., Chun, S.A. & Geller, J., 2013, 'Monitoring public health concerns using Twitter sentiment classifications', in *2013 IEEE international conference on healthcare informatics*, Philadelphia, PA, September 09–11, pp. 335–344.

Lee, K., Agrawal, A. & Choudhary, A., 2013, 'Real-time digital flu surveillance using twitter data', In *The 2nd workshop on data mining for medicine and healthcare*, Austin, Texas, May 4, 2013.

Leek, S., Canning, L. & Houghton, D., 2016, 'Revisiting the task media fit model in the era of web 2.0: Twitter use and interaction in the healthcare sector', *Industrial Marketing Management* 54, 25–32. https://doi.org/10.1016/j.indmarman.2015.12.007

Mandrola, J. & Futyma, P., 2020, 'The role of social media in cardiology', *Trends in Cardiovascular Medicine* 30(1), 32–35. https://doi.org/10.1016/j.tcm.2019.01.009

Merolli, M., Busuttil, M.L., Wåhlin, C. & Green, A., 2019, Global communication practices of physiotherapists on Twitter', *European Journal of Physiotherapy* 21(1), 20–26. https://doi.org/10.1080/21679169.2018.1464061

Michela, E., Rosenberg, J.M., Kimmons, R., Sultana, O., Burchfield, M.A. & Thomas, T., 2022, '"We are trying to communicate the best we can": Understanding districts' communication on Twitter during the COVID-19 pandemic', *AERA Open* 8, 23328584221078542.

Nakhasi, A., Bell, S.G., Passarella, R.J., Paul, M.J., Dredze, M. & Pronovost, P.J., 2019, 'The potential of Twitter as a data source for patient safety', *Journal of Patient Safety* 15(4), e32–e35. https://doi.org/10.1097/PTS.0000000000000253

Oehler, R.L., 2020, 'On measles, vaccination, social media activism, and how to win back our role as our patients' best advocates', *Clinical Infectious Diseases* 70(2), 338–340. https://doi.org/10.1093/cid/ciz656

Park, H., Reber, B.H. & Chon, M.G., 2016, 'Tweeting as health communication: Health organizations' use of Twitter for health promotion and public engagement', *Journal of Health Communication* 21(2), 188–198. https://doi.org/10.1080/10810730.2015.1058435

Patrick, P.A., Obermeyer, I., Xenakis, J., Crocitto, D. & O'Hara, D.M., 2020, Technology and social media use by adult patients with intellectual and/or developmental disabilities', *Disability and Health Journal* 13(1), 100840. https://doi.org/10.1016/j.dhjo.2019.100840

Paul, M.J. & Dredze, M., 2011, 'You are what you tweet: Analyzing Twitter for public health', *Proceedings of the International AAAI Conference on Web and Social Media* 5(1), 265–272. https://doi.org/10.1609/icwsm.v5i1.14137

Pershad, Y., Hangge, P.T., Albadawi, H. & Oklu, R., 2018, 'Social medicine: Twitter in healthcare', *Journal of Clinical Medicine* 7(6), 121. https://doi.org/10.3390/jcm7060121

Rao, A., Sabri, N., Guo, S., Raschid, L. & Lerman, K., 2025, 'Public health messaging on Twitter during the COVID-19 pandemic: Observational study', *Journal of Medical Internet Research* 27, e63910. https://doi.org/10.2196/63910

Rojas-García, J.A., Elias-Giordano, C., Quiroz-Flores, J.C. & Nallusamy, S., 2024, 'Profitability enhancement by digital transformation and canvas digital model on strategic processes in post-Covid-19 in logistics SMEs', *Social Sciences & Humanities Open* 9, 100777. https://doi.org/10.1016/j.ssaho.2023.100777

Rose, R. & Bock, B.C., 2019, 'Current Issues in Social Media and Healthcare Technology', In *Proceedings of the 52nd Hawaii International AAAI Conference on System Sciences,* Hawaii, USA, January 8–11, 2019, pp. 4317–4318, Kozminski University, Poland, viewed 01 November 2024, from https://dn.kozminski.edu.pl/info/book/ALK904ff4674b3e46bebaf184b4853029c7/.

Rufai, S.R. & Bunce, C., 2020, 'World leaders' usage of Twitter in response to the COVID-19 pandemic: A content analysis', *Journal of Public Health* 42(3), 510–516. https://doi.org/10.1093/pubmed/fdaa049

Storey, V.C. & O'Leary, D.E., 2024, 'Text analysis of evolving emotions and sentiments in COVID-19 Twitter communication', *Cognitive Computation* 16(4), 1834–1857. https://doi.org/10.1007/s12559-022-10025-3

Thelwall, M., 2017, *Web indicators for research evaluation: A practical guide*, Morgan & Claypool, San Rafael, CA.

Thompson, M.A., Majhail, N.S., Wood, W.A., Perales, M.A. & Chaboissier, M., 2015, 'Social media and the practicing hematologist: Twitter 101 for the busy healthcare provider', *Current Hematologic Malignancy Reports* 10(4), 405–412. https://doi.org/10.1007/s11899-015-0286-x

Wicke, P. & Bolognesi, M.M., 2024, 'Framing COVID-19: How we conceptualize and discuss the pandemic on Twitter', *PLoS One* 19(7), e0306644. https://doi.org/10.1371/journal.pone.0306644


Appendices starts on the next page →

# Appendix 1

**TABLE 1-A1:** Topic modelling for March 2020.

| Identified topic | Topic description |
|---|---|
| Help | Providing and sharing health information, tips, and advice in order to: |
| | Help manage the spread of the pandemic and connect people |
| | Help ask for funds and for volunteering |
| | Help promote services and products |
| | Help exchange information to manage and survive in the situation |
| Test | Tests and testing, and the number of positive cases |
| Precautionary measures | Staying home and maintaining physical distance |
| Global conversation | Involving countries: Italy, China, India |
| Economic impact | Working, closing, jobs |
| Nitrogen dioxide pollution | Decrease in the levels of nitrogen dioxide pollution in Italy |
| Vaccine | Update on vaccine development |
| Government | Government behaviours and attitudes to tackle the pandemic |

**TABLE 2-A1:** Topic modelling for April 2020.

| Identified topic | Topic description |
|---|---|
| Lockdown | Sharing advice and tips during lockdown period |
| | Promoting services during lockdown and connecting for action |
| Fight pandemic | Support and funding to fight the pandemic and its consequences |
| | Sharing information and tips to eliminate the outbreak |
| | Supporting those affected by the consequences of the pandemic |
| Spread | Sharing information and updates |
| | Connecting with news agencies and official bodies |
| | Sharing and discussing government actions and plans |
| Medical care | Supporting and donating to hospitals |
| | Supporting individuals and healthcare workers |

**TABLE 3-A1:** Topic modelling for May 2020.

| Identified topic | Topic description |
|---|---|
| Help | Distributing survey links regarding the impact of the pandemic |
| | Donating plasma to treat critically ill patients |
| | Disseminating proactive measures of social distancing and wearing masks |
| | Sharing achievements and social contributions |
| | Connecting with others and getting involved with society |
| | Disseminating official regulations and procedures |

**TABLE 4-A1:** Topic modelling for June 2020.

| Identified topic | Topic description |
|---|---|
| Cases | Updates on new cases, status, and numbers |
| Protestors | Involvement in social and political issues |
| Back | Back to school |
| | Back to work |
| | Back to reopening of the economy |
| Thank | Socialising and connecting |
| Hospital | Hospital system |
| Support | Sharing social involvement and support |
| | Transparency regarding information and achievements |
| Applaud | Applauding solidarity |
| | Applauding healthcare workers |
| | Applauding achievements |

**TABLE 5-A1:** Topic modelling for July 2020.

| Identified topic | Topic description |
|---|---|
| Gavinnewsom | Involvement and connecting with decision makers |
| Laurie | Involvement and connecting with professionals |
| Breaking | Following breaking news |
| Economic | Discussing and getting involved in economic conversations |
| | Economic impact of COVID-19 |
| Physical | Maintaining physical distance |

COVID-19, coronavirus disease 2019.

**TABLE 6-A1:** Topic modelling for August 2020.

| Identified topic | Topic description |
|---|---|
| DrEricDing | Involvement and connecting with professionals |
| Masks | Mask procedures and instructions |
| Vaccine | Updates on vaccine development |
| Plasma blood | Sharing knowledge and information |
| | Connecting and getting involved |
| Data | Sharing data related to the pandemic |
| | Sharing research data |

**TABLE 7-A1:** Topic modelling for September 2020.

| Identified topic | Topic description |
|---|---|
| Thank | Thanking medical staff |
| | Thanking researchers |
| | Thanking participants of vaccine research |
| | Thanking staff, teachers, students |
| Economy | COVID-19's impact on economy |
| Students | Back to school |
| | COVID-19 cases among students |
| DrTedros | Involvement and connecting with profession |
| Mask home absolutely | Staying home |
| | Home isolation |
| | Working from home |
| | Increase in home buying |
| Immunity | Herd immunity strategy |

COVID-19, coronavirus disease 2019.