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Review and thematic analysis of guiding principles for effective crisis communication using social media

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Effective crisis communication on social media targets and tailor's crisis information to influence risk perception and ensures messages are accepted. The aim of the current research is to map the research available and summarize key findings of the guiding principles and strategies for social media-based risk and crisis communication during emerging infectious diseases. North American-focused literature assessing risk and crisis communication via social media during emerging infectious diseases between 2009 and 2021 was obtained and examined. From an analysis of 52 sources, we identified five descriptive themes related to the characteristics associated with the receiver of crisis messages, the source of crisis messages, and characteristics associated with increased message acceptance and uptake on social media platforms. The current review builds on prior reviews through the inclusion of additional qualitative studies incorporating public perspectives. The majority of included sources were quantitative U.S. studies focused on COVID-19. We found that social media attributes, features, and analytics can be used to enable interaction, promote amplification of crisis messages, and to better understand the information needs of various subpopulations. Additional research is needed to better understand how to effectively communicate via social media to subpopulations impacted by emerging infectious disease.

Key words: Crisis communication, risk communication, social media, emerging infectious disease, COVID-19, guiding principles.

INTRODUCTION

COVID-19 prompted a rapid, global public health response on a scale not seen in the last century. Once detected and due to its highly infectious nature, it was necessary for many countries to initiate public health communications to prepare for its arrival and impact, and to coordinate their respective responses. Effective crisis

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communication is critical for maintaining public trust and ensuring the public follows recommendations to minimize illness, disability, and death. Naturally, communications were not isolated to public health or governmental bodies, but also involved the public, through which social media played a major role (Tsao et al., 2021). As news of the virus's spread was broadcasted through mainstream news media outlets, and as local and national measures were initiated, social media became an important outlet for the public's concerns, shared experiences, emotional responses, and was an especially important source for information seeking (Amanatidis et al., 2021; Southwick et al., 2021; Xue et al., 2020).

Social media includes platforms such as Facebook, Instagram, Twitter, YouTube, Reddit, and TikTok, and the communications and interactions that occur on each define the social aspect (Auxier and Anderson, 2021). Approximately 70% of all Americans self-report they use at least one social media platform (Auxier and Anderson, 2021) and 73% of Canadian social media users access social media daily (Statista Research Department, 2021). Social media platform preference is highly age dependent, with those under thirty preferring Instagram, TikTok and Snapchat, and those over thirty tending to prefer Facebook and YouTube (Auxier and Anderson, 2021). The majority of Facebook, Snapchat, Instagram and YouTube users report they use the platform daily (Auxier and Anderson, 2021), and many of these users turned to social media for COVID-19-related health information (Neely et al., 2021). Interestingly, social media posts reflected search trends for newly relevant health information preceding official public health or government communications (Mangono et al., 2021).

Numerous communication challenges have been associated with COVID-19, including the epidemiological issues associated with the novelty and uncertainty surrounding COVID-19's characteristics. At the same time, a globalized world of online communication contributed to the mass spread of mis/disinformation from unreliable sources, leading the public to a state of confusion and contributing to distrust in health officials and institutions (Banks, 2020; Pazzanese, 2020). Such mis/disinformation threatens the public's confidence in government and health officials to successfully manage the risk and may also result in public noncompliance with recommended behaviors (Liu et al., 2020; WHO, 2018). In a situation of high uncertainty, rapidly evolving conditions, and an excess of mis/disinformation (Banks, 2020), the COVID-19 pandemic has emphasized the need for reliable and effective information and guidance from public health authorities.

In the early 2000s, the Centre for Disease Control (CDC) in the US recognized that crises, such as outbreaks and epidemics, require an ongoing communications approach, and sought to transform and integrate crisis communications with combined elements of risk communication, health communication, emergency management, and public relations (Seeger, 2006). With this integrated approach becoming the new gold standard, communications tended to be focused on the core elements of building trust, message timing, and message development to communicate effectively with those of different health literacy levels, as well as creating a "triangle of trust" amongst decision-makers, communicators, and public health experts (WHO Expert Consultation on Outbreak Communications and World Health Organization Communicable Diseases, 2005). This "triangle of trust" somewhat alienated the public's role in crisis communications, as there was disagreement over the role of the public and media as communication partners and the view that they would instead skew, misinterpret or decontextualize key crisis messaging (WHO, 2005). With social media amplifying the public's ability to connect with, and create and amplify crisis messaging, social media has become a new key area of interest for public health crisis communications and has warranted a paradigm shift of how and where crisis communications should be designed and delivered.

Crisis communication is complex and should not just be a one-way dissemination of information, but rather, an interactive and ongoing process among individuals, communities, and organizations. Communication during emerging infectious diseases involves the discussion of the nature of risks, opinions regarding crisis messages, and the risk management process itself (Hyland-Wood et al., 2021). Crisis communication serves to inform, build trust, and encourage public cooperation with public health guidelines (Hyland-Wood et al., 2021). Thus, there are multiple actors that must continually engage in the risk management and communication process, which involves translating and transferring scientific knowledge as it evolves, as well as fostering trust. Crisis communication must be tailored to the needs and wants of individuals as their engagement with, and response to, messages is influenced by many factors including age, sex, health literacy level, culture, and other determinants (Hyland-Wood et al., 2021).

Amidst copious amounts of messages rapidly circulating through social networks, there are inaccuracies and inconsistencies, making it challenging for the public to assess what information, along with its source, is trustworthy (Wendling et al., 2013; Xiang et al., 2017). This is especially true for the COVID-19 pandemic, or the current COVID-19 "infodemic" (World Health Organization, 2020). A Canadian study found approximately 38% of its respondents thought the government was withholding information concerning the pandemic, and only 53% of respondents recognized their exposure to mis/disinformation (Université de Sherbrooke, 2020). These findings, coupled with the fact that COVID-19 is the largest pandemic of the social media age, make it critical to understand how to effectively communicate crisis information via social media.

Social media has successfully been used to predict and track disease outbreaks (Aiello et al., 2020; Samaras et al., 2020), to understand how the public perceives social media crisis communication and their corresponding behaviours (Kim, 2016; London and Matthews, 2021), and to examine how news media and public health communicators are employing crisis communication principles and how they can improve doing so Li et. al., 2021; Malecki et al., 2021). Further, similar research has sought to evaluate whether public health crisis communications has made full use of the best practices that have been developed in recent years during outbreak scenarios (Jong, 2020), as well as characterizing organizational social media use, public opinion, and information accuracy during emerging infectious disease outbreaks (Tang et al., 2018). Other research has focused on public sentiment analysis during outbreaks (Boon-Itt and Skunkan, 2020), and on message persuasiveness (Ghio et al., 2020). However, less has been done to determine the optimal combinations of message content, message timing, message spokespersons, and audience segmentation for trust-building, knowledge transfer and translation and optimal public cooperation. It is essential to determine best practices in social media crisis communications to prepare for, and to create better public health responses to future infectious disease events.

Our aim with this paper is to map the research available and summarize key findings using thematic analysis of the literature describing guiding principles and strategies for social media-based risk and crisis communication during emerging infectious disease events. Specifically, we sought to map the range of literature available, synthesize key research findings, and identify gaps in the literature where evidence is lacking or little research has been undertaken (Arksey and O'Malley, 2005). The objectives of this scoping review were to: 1) review the literature to identify studies on the use of social media for crisis communication during emerging infectious disease events; 2) describe guiding principles, strategies, and best practices for social media crisis communication during emerging infectious disease; and 3) identify gaps in research and evidence to inform the use of social media for crisis communication during the COVID-19 pandemic and future infectious disease outbreaks.

MATERIALS AND METHODS

Review approach and team

This scoping review was guided by the methodology outlined in Arksey and O'Malley (2003) and enhanced by Levac et al. (2010). The review team consisted of four researchers with expertise in health communication, policy, and knowledge synthesis. A librarian with research synthesis expertise in public health was consulted to provide input on the review scope and search strategy. All search, screening, and data extraction activities were conducted by two members of the research team. This scoping review is reported in accordance with the PRISMA statement for scoping reviews (Tricco et al., 2018).

Review scope

All literature was included in this review including qualitative, quantitative, and mixed methods research published in English as peer-reviewed journal articles, dissertations, and grey literature. The study population or study authors (for relevant infodemiology studies where data were not geocoded) or publishing organizations were from North America. Literature was selected where the results were generalizable to the community or country levels as social media is widely available and accessed by a large majority of the population (Auxier and Anderson, 2021), especially during the COVID-19 pandemic (Cinelli et al., 2020). Literature published between 2009 and 2021 inclusive were included in the review to isolate the research conducted following the 2009 H1N1 pandemic and include the emerging social media era. The intervention of interest included literature measuring or evaluating crisis communication via social media for respiratory-borne emerging infectious diseases. Exclusion criteria were: studies that focused solely on vaccination; vector-borne, foodborne, and chronic diseases; sexually transmitted infections and HIV/AIDs; and bioterrorism. These types of studies were excluded because communication during emerging infectious disease is based within the high uncertainty that exists and is different from other types of health communication. The combination of inclusion and exclusion criteria, applied to title and abstract, as well as full text screening stages, narrowed the scope of results to ensure the relevance to emerging infectious diseases and social media crisis communication during pandemics in countries with similar health care systems, similar socio-economic status, similar rates of use of social media, and similarities in terms of population language use, cultures, and social determinants of health to Canada. Specifically, the focus on North America was chosen to further narrow the scope of relevant results to provide adequate depth to the thematic analysis to inform public health practice.

Search strategy

The search strategy was developed in collaboration by a specialist librarian by scanning the literature for relevant articles and reviewing the keywords and controlled vocabulary used, as well as common terminology used in the titles, abstracts, and bodies of the articles. Several preliminary search algorithms were pretested in Ovid MEDLINE and results were reviewed to ensure focus, relevancy, and inclusion of key articles identified in the initial literature scan. The final search algorithm comprised of three key concepts: emerging infectious disease, health communication, and social media. The final database search was conducted on March 5th, 2021 on the following electronic databases: Ovid MEDLINE (Table 1), CAB Direct, Web of Science, PsycINFO, and Communication and Mass Media Complete. Additionally, the following pre-print servers were searched on March 9, 2021: SSRN, PsyArXiv, and medRvix.

The search strategy was verified by hand-searching seven relevant review articles for references not captured by the database searches. The following seven journals were also searched for additional references (2009 – present): Journal of Medical Internet Research, Journal of Health Communication, Journal of Applied Communication Research, Health Communication Journal, Public Relations Review, and International Journal of Public Health. These journals were selected as they were the most cited journals in articles extracted from the database searches. Additionally, the reference lists of relevant review articles were hand searched on

Table 1. Search Algorithm as Implemented in Ovid MEDLINE.

Category*	Key terms
Health communication	Health or illness or diseases or risk or crisis) adj15 (communication or campaign or promotion or media or message$ or announcement or appeals or warnings or advertise or "persuasive communication" or "social marketing" or "behavioural science")).af.
	(Health Communication or Communication).sh.
Emerging infectious disease	Pandemics or emerging infectious diseases or infectious diseases or disease outbreaks or epidemics or communicable disease$ or outbreaks or influenza or COVID-19 or SARS-CoV-2 or H1N1 or H7N9 or Ebola or SARS-CoV).af.
	Pandemics or Communicable Diseases or Disease Outbreaks or Epidemics or Communicable Diseases, Emerging or Communicable Diseases, Imported).sh.
Social media	Social media or social networking sites or SNS or Facebook or Twitter or YouTube or Instagram or LinkedIn or TikTok or blogs or "web 2.0" or Snapchat or Vimeo or Flickr or Pinterest or forums or Reddit or Quora or Digg).af.
	Social Media.sh.

*Keywords and medical subject headings for each category were combined with the OR operator, then overall concepts were combined with the AND operator.

March 11, 2021 for potential missing articles. Finally, grey literature was identified through Google searches using search strings focused on the key concepts (e.g., crisis communication + emerging infectious disease + social media).

Relevance screening

Search results were imported into DistillerSR systematic review software (Evidence Partners, Ottawa, ON, Canada), which automates each stage of the review and allows for multiple reviewers to access it simultaneously while keeping track of every step. DistillerSR was used to conduct both title and abstract and full text screenings. Deduplication was conducted prior to screening using the automated deduplication tool in DistillerSR. Each unique reference was independently screened for relevance by reviewing the title and abstract. If reviewers were unsure of the relevance at the title and abstract stage, the reference was included in the full text screening. A screening form was used to assess whether the title and abstracts of included references had potential relevance to the review.

The eligibility form for full text screening was pre-tested and revisions were made to ensure the form was clear and complete. For each potentially relevant reference identified during title and abstract screening, full text documents were retrieved and reviewed independently by the same two investigators. Each article's eligibility was determined using an eligibility form with 10 questions that assessed the following criteria: publication year, publication type, language, location, population, relation to crisis communication and social media, and topic investigated related to emerging infectious diseases. After completing full text screening, the Kappa score generated by DistillerSR for inclusion and exclusion agreement was 0.82 indicating strong agreement between the researchers (McHugh, 2012). Conflicts between reviewers at both screening levels were discussed following completion of screening at each level and resolved to the point of reaching agreement on inclusion or exclusion.

Article characterization/ review management and analysis

The included articles were divided where one of two investigators was the primary data extractor on one half of the articles and

secondary extractor on the other half. Key information was extracted to pre-specified criteria in a data table using Microsoft Excel (Microsoft Corporation, 2018). The following criteria were extracted from each article: title, authors, year of publication, publication type, country of origin, study design, aims/purpose/research question(s), study population/sample size, context/ emerging infectious disease focus, methodology, theories/frameworks, type of social media included in literature, biases identified, key findings, gaps/limitations, and future areas of study.

Data extraction results were thematically analyzed following the methodology outlined by Thomas and Harden (2008). Using an inductive approach, the researchers developed descriptive themes from the data and assigned data to themes. Thematic analysis was used to produce a descriptive summary of themes but was not used to generate new ideas or analytical themes for the purposes of this scoping review. Criteria and themes were iteratively developed, and revisions were made as appropriate. Results of the data extraction were reviewed and coded into subthemes by two researchers independently. One researcher then developed an initial thematic framework, which was then reviewed by two other researchers to provide perspective and analytical triangulation. Three researchers discussed, refined, and finalized the thematic framework.

RESULTS

Search and selection of articles

A PRISMA flow diagram of the article identification and inclusion process is found in Figure 1. Following deduplication, 4915 citations were screened at the title and abstract level for potential relevance to study criteria. Next, 277 full text articles were obtained and reviewed for relevance, with 52 included in the final scoping review.

Characterization of included articles

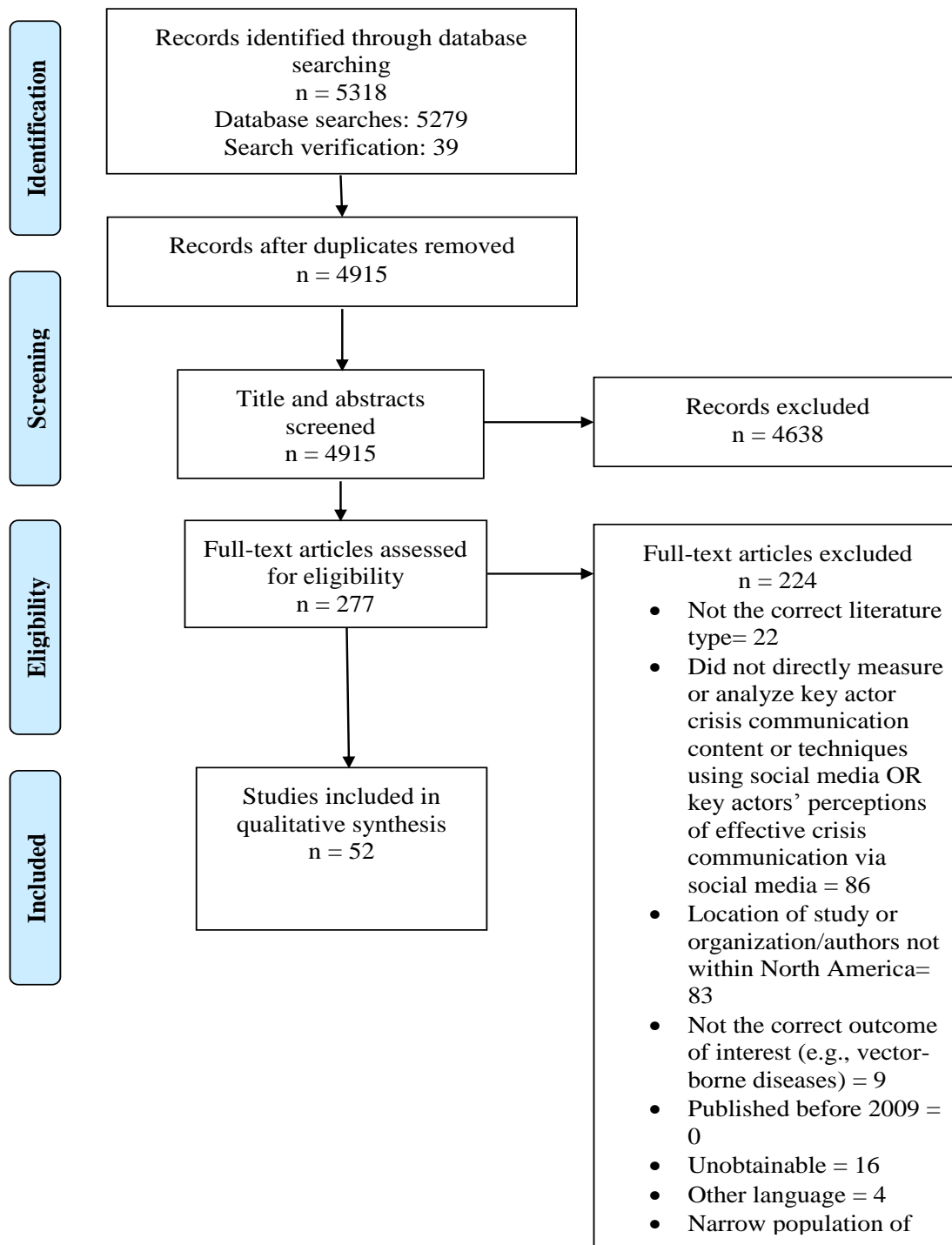Literature was categorized according to document type,

Figure 1. PRISMA flow diagram of scoping review study selection process.

study location, study design, data collection method, study population, study context, and underlying theories/ frameworks (Table 2). All articles included in this review were published between January 1, 2009 and March 5, 2021 (median year 2016). Most included articles were journal articles (96%) with a focus on the U.S.A. (83%).

The most frequently used study design was quantitative methods (48%), followed by mixed methods (29%). COVID-19 (73%) was the emerging infectious disease most articles focused on, followed by H1N1 (15%), and Influenza (8%). Finally, the main social media platforms of focus in the included articles were Twitter (58%),

Table 2. Summary characteristics of the 51 included studies in the review.

Characteristic	N	%
Document type		
Journal article	49	96
Book chapter	1	2
Grey literature	1	2
Study country focus		
U.S.A	42	82
North America	5	10
Canada	4	8
Study design		
Quantitative	25	49
Mixed Methods	15	29
Qualitative	9	18
Other: Book Chapter	1	2
Other: Grey Literature	1	2
Emerging infectious disease focus[1]		
COVID-19	38	73
H1N1	8	15
Influenza	4	8
Not specified- emerging infectious disease in general	3	6
Measles	2	4
SARS	2	4
Ebola	1	2
Type of social media included in study[1]		
Twitter	30	58
Facebook	18	35
Social media in general	12	23
Instagram	7	13
YouTube	6	12
Snapchat	3	6
TikTok	2	4
WhatsApp	1	2
Reddit	1	2
Delicious	1	2
LinkedIn	1	2
Pinterest	1	2
Theories or frameworks used[1]		
Health belief model	3	6
Crisis and emergency risk communication framework	3	6
Risk amplification through media spread framework	2	4
Situational crisis communication theory	2	4
Uncertainty reduction theory	2	4
Extended parallel process model	2	4
Social cognitive theory	1	2
Risk communication on social media	1	2
Protection motivation theory	1	2
Uses and gratifications theory	1	2

Table 2. Contd.

Exemplification theory	1	2
Primacy and recency effect	1	2
Risk perception attitude framework	1	2
Conformity effect	1	2
Study includes specific ethnic groups		
Yes	5	10
No	46	90

[1]Multiple categories were possible, therefore answers exceed 100%. This table was developed by the authors, based on the data from included studies. A summary of the data from the included studies can be found within the supplementary data.

Facebook (35%), and social media in general (23%).

Thematic analysis

To start, five preliminary themes based on key findings were developed to guide the data extraction including: monitoring, responding and engaging; combatting the infodemic, effective spokespersons and partnerships; content/message development; and overcoming vaccine hesitancy. The data extracted within these preliminary themes can be found in the supplementary file. Next, data in each of the five areas were tagged for more specific themes by two independent researchers. The keyword tagging was discussed and agreed upon by the two researchers. Based on the keyword tagging, one researcher organized into five descriptive themes that describe best practices in social media crisis communication related to the characteristics associated with the receiver of crisis messages, the source of crisis messages, and characteristics associated with social media platforms that can increase message acceptance and uptake. The themes were verified by two other researchers and are described in detail below.

Audience segmentation should be used to reflect a deeper understanding of the needs and wants of the public, and to create culturally appropriate messaging.

Audience segmentation is an important aspect of health communication as it provides information about health behaviours and opinions of an audience that can guide efforts (Myrick and Willoughby, 2021). The communities that public health serves are highly segmented, and communications must have a multifunctional approach to address this (Jin et al., 2019). Audience segmentation should be used to shape crisis messages across multiple platforms, where messages should be frequent, and responses monitored by public health (Ali et al., 2020; Warren and Wen, 2017). Social media provides a good

channel through which to share information quickly with a larger audience including information to raise awareness and prevention efforts during emerging infectious disease (Jin et al., 2019; Keene woods et al., 2021; Khan et al., 2019; Khokhar et al., 2021), and empower the public to participate in the crisis response (Ding and Zhang, 2010). Subpopulations and hard-to-reach groups can be accessed with appropriate targeting and tailoring of messages and social media channels (Jardine et al., 2015; Jin et al., 2019; Khan et al., 2019; Tangcharoensathien et al., 2020). Audience use patterns should guide the selection of social media platforms and message development should be accessible and based on audience needs (Chesser et al., 2020; Jardine et al., 2015; Khan et al., 2019; Southwell et al., 2013; Tangcharoensathien et al., 2020).

Audience needs, including literacy, language, and cultural aspects must be understood and applied to information, recommendations, and resources, as well as social media channel selection (Jin et al., 2019; Keene Woods et al., 2021; Tangcharoensathien et al., 2020). During COVID-19, messages that focused on protecting yourself were much more successful at eliciting click-throughs to further public health messaging compared to pro-social messages focused on protecting your community (Banker and Park, 2020). In addition, messages that focused on fear appeals must contain both threat information (e.g., information about disease severity and susceptibility) and efficacy information (e.g., information about how to successfully engage in public health measures) to impact risk protective behaviours (Nazione et al., 2021). Focusing on personal experience during emerging infectious disease does not immediately influence risk perception as individuals may not have had experience with a newer disease and interpersonal communication via social media can help individuals understand the threat both to self and other (Han et al., 2014).

Additionally, leveraging existing infrastructure can help support the development of culturally relevant resources

targeted towards those disproportionately harmed by COVID-19 and other public health emergencies (Brewer et al., 2020; Chandler et al., 2021). For example, a faith-based crisis communication campaign during COVID-19, FAITH!, provided evidence-based information that church leaders disseminated to church members during the pandemic, resulting in overall positive perceptions and trust within a marginalized community (Brewer et al., 2020). Additionally, vlogs with Chinese diaspora have shared stories with a transnational perspective relevant to those who are Chinese and migrant (Zhang and Zhao, 2020). The vloggers reinterpreted and re-contextualized public health information and partnerships should be explored to better mobilize diaspora influencers and reach diaspora communities (Zhang and Zhao, 2020). Vloggers have created a supported space that can help maintain mental health of marginalized, immigrant, and migrant populations (Zhang and Zhao, 2020). Twitter chats were used successfully to engage with American Latinos via a weekly series that engaged followers in discussing COVID-19 solutions (Despres et al., 2020). Finally, hashtags used by priority populations can help engage individuals and involve them in the risk management process (Sutton et al., 2020b).

Campaigns in partnership with an influencer "can have the look, feel, and sound that will capture an audience's attention" (Bonnevie et al., 2020). This approach may help reach, engage, and inform those groups, such as African Americans and Hispanics, that are disproportionately impacted by COVID-19 and less likely to get the flu vaccine (Bonnevie et al., 2020). Targeted messaging about flu vaccination in English and Spanish was found to be effectively disseminated by influencers and can help cut through mis- and disinformation that is easily spread regarding flu vaccines (Bonnevie et al., 2020). A higher rate of engagement was found within the Spanish-speaking followers, which may have been due to the targeting and tailoring of information in a culturally relevant manner in their first language (Bonnevie et al., 2020).

Partnerships between public health, government, and other key actors should be developed to effectively combat mis/disinformation

Partnerships across sectors, including public, social media, and technology sectors, should be developed to strengthen social media monitoring capabilities and information amplification and impact (Hwang, 2020; Niburski and Niburski, 2020; Tangcharoensathien et al., 2020). Strategic partnerships can boost credibility, increase the reach of crisis messages, aid in fact-checking information, analyze the infodemic, and the impact of messages and interventions within the population (Ranjit et al., 2021; Tangcharoensathien et al., 2020; Vraga and Bode, 2021). An analysis of three agency Twitter accounts found that while most agencies were sharing information about pandemic response, few

were sharing information about resources that can help individuals cope with the COVID-19 pandemic (Zeemering, 2021). Social media mangers in government agencies can work together to decrease fragmentation and improve the public's understanding of government through strategically mentioning resources, sharing information, and mentioning and retweeting other agencies (Zeemering, 2021).

The infodemic should be considered an integral aspect of public health during emerging infectious disease and analysis of conversations across the communication ecosystem should be applied to policy decisions (Niburski and Niburski, 2020; Tangcharoensathien et al., 2020). Many actors have a key role to play in addressing the infodemic, for example, clear language summaries of research related to the emerging infectious disease could be produced that can be used by journalists and other actors (Tangcharoensathien et al., 2020), and medical professionals can effectively address mis/disinformation about vaccines (Hwang, 2020). A recent modeling study showed that addressing the infodemic is as important as providing crisis information, given that reducing harmful information by 10% significantly minimized risk-taking behaviours (Ranjit et al., 2021). Social media experts must be employed by government agencies to build relationships with other actors and coordinate accurate and factual crisis information to build trust and credibility during public health emergencies (World Health Organization, 2017).

Spokesperson(s) that reflect the public's preferences must be used for consistent and effective crisis communication to create buy-in, cooperation, shared understanding, and trust.

The public should be encouraged to obtain COVID-19 and other public health emergency information from multiple sources and channels, allowing individuals to access more accurate information and positively impact coping appraisal (Al-Hasan et al., 2020). Coproduction of information between crisis actors and the public on social media are an important aspect of being proactive and creating public buy-in early in the process (Warren and Wen, 2017; World Health Organization, 2017). Public health should identify other actors that are actively disseminating factually correct crisis information and build relationships across various levels of health agencies and other sectors (Fridman et al., 2020; Hwang, 2020; Kim et al., 2020; Rufai and Bunce, 2020). Partnering with credible organizations, such as the World Health Organization and social media platforms, can boost the credibility of the message and reduce misperceptions and mis/disinformation as well as create consistency in messaging (Hwang, 2020; Vraga and Bode, 2021). Both instructing information and adjusting information such as empathy and risk protective actions were found to be important aspects of social media crisis communication during H1N1 and COVID-19 for both education and

reputation management purposes (Kim and Liu, 2012; Rufai and Bunce, 2020). Specific to social media, public health should hold a central social network position by strategically mentioning, retweeting, or quoting influential actors to receive higher public engagement regardless of number of followers, tweets sent, and use of interactive strategies (Kim et al., 2021).

Effective spokespersons are critical for crisis communication, as trust levels vary across sources and channels. Several studies examined various spokespersons during COVID-19, including spokespersons' impact on message passing and credibility. Viral messages become part of the social conversations around emerging infectious diseases, which can shape risk perception and behaviours (Vijaykumar et al., 2015). Physicians sharing tweets and other social media messages about COVID-19 were more likely to be shared and had a significant impact on the perception of message and attitude effectiveness (Hwang, 2020; Solnick et al., 2021). Similarly, state accounts sharing COVID-19 messages were very influential (Hwang, 2020; Kamiński et al., 2021) and retransmitted more than public health accounts, but local and state emergency accounts were retransmitted less (Sutton et al., 2020a). Celebrities served as key amplifiers of COVID-19 information such as flattening the curve and following public health guidelines including self-isolation (Kamiński et al., 2021; Mututwa and Matsilele, 2020). Celebrities that shared their lived experience with COVID-19 influenced risk perception, spread awareness, destigmatized the disease, and reinforced public health recommendations (Mututwa and Matsilele, 2020). The media also plays a central role in shaping and driving public attention and risk perception during pandemics, where media coverage was a primary driver of public attention rather than the progression of the pandemic itself (Gozzi et al., 2020). Coordinated and strategic crisis communication by official actors can increase crisis message amplification (Abu-Akel et al., 2021; Sutton et al., 2020b), including the coordinated use of specific hashtags by many actors (Sutton et al., 2020b), and influence risk perception and adherence to public health measures (Abu-Akel et al., 2021; Gozzi et al., 2020; Kamiński et al., 2021; Mututwa and Matsilele, 2020; Wang et al., 2020).

Crowdsourcing and other novel approaches should be considered, such as encouraging influencers and individuals to create social media posts about adhering to public health measures and using them strategically (Fridman et al., 2020). Influencers on social media are creating their own messaging and influence with regards to emerging infectious disease (Freberg et al., 2013) and engagement can be leveraged to increase message virality and impact risk perception (Vijaykumar et al., 2015). Influencers include people like celebrities, brand influencers, politicians, and even others in the public eye such as leaders within communities. Social media influencers generated high levels of engagement in posts about influenza and are an effective way to reach large numbers, including Spanish speaking individuals, with limited resources (Bonnevie et al., 2020). Various spokespersons were found to have significant differences in their effectiveness as advocates for social distancing during COVID-19 (Abu-Akel et al., 2021). The public had the highest intention to share posts by Dr. Fauci, Chief Medical Advisor to the U.S. President and director of the National Institute of Allergy and Infectious Diseases, about social distancing, followed by national-level elected officials, celebrity actor Tom Hanks, with celebrity Kim Kardashian, who is a U.S. media personality, socialite, and businesswoman, the least effective (Abu-Akel et al., 2021). This effect was found to be consistent despite cultural and national boundaries (Abu-Akel et al., 2021). Partnering with influencers who are viewed favourably by the public is important so that accurate information regarding risk protective measures is shared among those with large followings (Abu-Akel et al., 2021), and could help drive followers to public health and government accounts by promoting those accounts with their followers (Kamiński et al., 2021).

Social media attributes should be leveraged to enable engagement and to create feedback systems which in turn create more effective messaging.

Social media platforms have functions that allow for information sharing and interaction between virtual communities. Social media should be used to engage the public, facilitate discussion among the public, create situational awareness, and respond to mis/disinformation, reactions, and concerns by public health during public health emergencies (World Health Organization, 2017). However, information sharing, or the passive one-way dissemination of information, was recognized as the default use of social media by public health (Khan et al., 2019). During COVID-19, the number of comments on official CDC Facebook posts increased steadily over the pandemic (Raamkumar et al., 2020). The CDC did not engage with their followers directly, such as addressing mis/disinformation within comments, which was a missed opportunity to engage with the public and provide targeted information given the large number of followers on their Facebook page (Raamkumar et al., 2020). A study focused on measles outbreaks in the US found that despite a majority of state public health departments using social media, most demonstrated limited interactions between the departments and their followers (Warren and Wen, 2017). The bi-directional approach where public health engages with the public to answer questions and ask for feedback over social media is an important contribution to effective crisis communication (Khan et al., 2019) and an important aspect of being proactive (Warren and Wen, 2017). Public health should engage and respond to questions and concerns left on

social media platforms in order to expand the reach of messages and access to priority populations (Khan et al., 2019; Warren and Wen, 2017).

In addition to engaging with the public, social media attributes can be leveraged to increase the reach of messages. Accounts with a greater number of followers receive greater immediate exposure and more retweets due to the effects of network diffusion (Sutton et al., 2020a). During H1N1, the CDC used buttons, badges, and widgets to allow partners to post information on their own websites and enabled RSS to allow individuals to subscribe to the information about H1N1 (Vijaykumar et al., 2015). Message features including videos and the ability to quote other tweets on Twitter during COVID-19 were found to positively impact message retransmission (Guidry et al., 2020; Renshaw et al., 2021). Images that included text about COVID-19 symptoms, resilience, and closures and openings were also found to strongly influence message retransmission (Guidry et al., 2020; Renshaw et al., 2021; Sutton et al., 2020a). One study found the use of most hashtags and replies on Twitter had a negative impact on message retransmission (Renshaw et al., 2021). However, when hashtags are used in conjunction with videos and photos in Twitter messages, they result in significantly more message transmission during COVID-19 (Rufai and Bunce, 2020; Sutton et al., 2020a, b). TikTok videos using trending hashtags were also found to garner more views (Basch et al., 2021). The trending videos used dance, music, and humour and were far more likely to attract viewers (Basch et al., 2021). Hashtags used in conjunction with videos and images can be used to help individuals feel part of a larger community and participate in information sharing about their local context (Sutton et al., 2020b; World Health Organization, 2017).

Moreover, fact-checking and bots that correct mis/disinformation can improve the quality of information surrounding COVID-19 (Fridman et al., 2020). In addition to the previously mentioned, accuracy reminders that encourage individuals to fact-check information can all help reduce participants intention to share mis/disinformation with their social media followers (Fridman et al., 2020; Pennycook et al., 2020). Self-regulation was found to be used by the majority of Twitter and Facebook users to verify the accuracy of messages (World Health Organization, 2017); however, those that reported relying on intuition or who had lower basic scientific knowledge were less able to discern between true and false information (Pennycook et al., 2020). Technology, including prompts for accuracy and fact-checking bots, can be used to encourage followers to verify crisis message accuracy and decrease intention to share information that has not been vetted (Pennycook et al., 2020).

Social media features should be used to continually assess effectiveness and to inform subsequent messaging.

Social media platform analytics, such as views, shares, click-throughs, and comments provide high-quality large datasets that can be used to understand public discussion about emerging infectious diseases and should be used to improve the effectiveness of official crisis messages (Jong, 2020; Khan et al., 2019; Lyu and Luli, 2021). These can also be used to help analysts track the spread and impact of emerging infectious disease (Campos-Castillo and Laestadius, 2020). Social media monitoring should be used to increase the reach and effectiveness of messages and resources, identify information gaps, identify platforms used by subpopulations, as well as improve the timeliness of official messages (Ding and Zhang, 2010; Jong, 2020; Khan et al., 2019; Sutton et al., 2020a, b). Processing, perception, and the resulting overall public perception of the official messaging is influenced by the motivation behind individual use of social media platforms (Kim et al., 2020). This knowledge can help actors understand what messaging works during particular conditions and allows them to revaluate and alter messages that are not received positively (Sutton et al., 2020a).

Information such as social media reach and questions from the public can help public health understand the information needs of the community and what the gaps are (Jin et al., 2019). Trending social media posts, such as TikTok videos, can be analyzed to understand the type of information circulating regarding emerging infectious diseases and adherence of messages to public health measures (Basch et al., 2021). Topics related to COVID-19 found through social media monitoring on Reddit included health, data, and interventions to decrease the spread, which reflected topics first published in mainstream media (Gozzi et al., 2020). Further, a study analyzing COVID-19 social media data found that members of racial and ethnic minority groups were more likely to post COVID-19 content on social media (Campos-Castillo and Laestadius, 2020). The representativeness in the data is an important consideration within social media monitoring (Campos-Castillo and Laestadius, 2020).

Additionally, individuals experience a range of emotions during emerging infectious disease outbreaks that change depending on the stage of the crisis (Meadows et al., 2019). Emotional responses to official social media messages should be monitored through sentiment analysis and used to develop effective messages that consider the emotional needs of the public (Meadows et al., 2019). During emerging infectious diseases, such as COVID-19, YouTube comments provided a useful source of information regarding public opinion and information needs (Zheng et al., 2021). Anger and negative comments received more replies compared to nontoxic comments on CDC's Facebook posts related to COVID-19 (Raamkumar et al., 2020). Exposure to comments

about vaccines on Facebook can lead to changes in an individual's attitudes and vaccine behaviours (Kim et al., 2021). Comments on social media can serve as useful exemplars for public health professionals to understand public opinion and vaccine-related issues (Kim et al., 2021). Individuals who perceive flu vaccines as highly effective are more likely to analyze information and are less susceptible to the impact of exemplars (Kim et al., 2021). Individuals use comments as exemplars to assess public opinion and may then alter their own attitudes to fit public opinion (Kim et al., 2021).

DISCUSSION

This scoping review identified 52 articles related to best practices in social media crisis communication during emerging infectious disease outbreaks. The majority of the studies were quantitative peer-reviewed journal articles that focused on COVID-19 in the United States, which is consistent with the findings of a systematic review of crisis communication on social media (Eriksson, 2018). Many of the quantitative and mixed methods studies were infodemiological studies where social media data was collected and analyzed, often using automated thematic analysis to identify themes discussed regarding public attitudes and opinions about emerging infectious disease. Five themes were identified based on our search strategy including audience segmentation and culturally appropriate messaging, partnerships, effective and trusted spokespersons, social media attributes that can increase message effectiveness and transmission, and social media analysis to understand how the public is interacting with and accepting messages. This review builds on previous research that has systematically assessed the literature associated with effective social media crisis communication during emerging infectious disease (Eriksson, 2018; Tang et al., 2018; Veil et al., 2011a). Tang et al. (2018) identified the need for studies that assess the effectiveness of official actor, such as public health, communication by examining public response. The current research extends the prior reviews through the inclusion of several studies that incorporate public perspectives, including sentiment analysis, opinion mining, and qualitative data in large part coming from recent COVID-19 literature.

Social media has become a vital communication tool for crisis actors such as public health, government, and politicians and can be used to share accurate information quickly (Jin et al., 2019; Khan et al., 2019). The need for segmenting audiences through what is known about their culture, literacy, and language (Jin et al., 2019; Tangcharoensathien et al., 2020), as well as their social media preferences was found (Chesser et al., 2020; Khan et al., 2019; Southwell et al., 2013; Tangcharoensathien et al., 2020). Social media channels can be used to reach subpopulations through leveraging existing infrastructure and identifying those of influence

with populations of interest (Bonnevie et al., 2020; Brewer et al., 2020; Veil et al., 2011a; Zhang and Zhao, 2020). Culture is a connecting space where communication can be improved through focusing on lived experience and overcoming barriers to adhering to public health recommendations (Airhihenbuwa, 2020). Partnerships between community leaders in culturally and linguistically diverse groups and community leaders, communities, and government results effective communication that is culturally relevant (Wild et al., 2021). Targeted and tailored messages with the needs of the diverse cultural and linguistic groups in communities must be at the centre of crisis communication strategy (Wild et al., 2021). Further, culturally relevant influencers are effective at communicating influenza vaccination information to at-risk groups including African American and Hispanic people (Bonnevie et al., 2021). Influencers can be used to create highly targeted content for subpopulations that results in positive intentions and sentiment towards flu vaccination messages (Bonnevie et al., 2021). Purposeful segmentation to understand audience needs, partnerships with leaders and influencers that are trusted by subpopulations, and co-production of crisis communication strategies and messages can help ensure social media crisis communication meets the needs of the public.

Partnerships with influential actors, including those in social media and the technological sectors, can have an influence on crisis message reach and the ability to address the infodemic (Ranjit et al., 2021; Tangcharoensathien et al., 2020; Vraga and Bode, 2021). In Europe, public health has partnered with US-based social media platforms (Facebook and WhatsApp) and other technology organizations to further research and public health interventions during COVID-19. Geolocation data from smartphones was collected within a public-private partnership to model COVID-19 disease (Storeng and de Bengy Puyvallée, 2021). Reviews during the COVID-19 pandemic have suggested that despite downfalls of public-private partnerships, the means to facilitate planning, modelling, contract tracing, and infodemic management have made those countries which employed them more successful (Storeng and de Bengy Puyvallée, 2021). Social media experts within public health, government, and other key actor organizations should be employed to effectively coordinate partnerships and consistent and accurate crisis communication across sectors (World Health Organization, 2017). Larger, more robust health communication teams are needed within public health with specialized training in risk and crisis communication, as well as the effective use of social media.

Moreover, choosing effective spokespersons who can build trusted relationships with actors and shape risk perception and behaviours is vital during emerging infectious disease (Al-Hasan et al., 2020; Fridman et al., 2020; Vijaykumar et al., 2015). New Zealand Prime Minster Jacinda Ardern has demonstrated the value in

two-way communication; live announcements, live Facebook question and answer sessions with the public to address key issues, and daily television updates have earned her almost perfect ratings for her risk communication during COVID-19 (McGuire et al., 2020). Prime Minister Ardern's crisis communication was found to be consistent and framed as positive, inspiring confidence and shared meaning around COVID-19 (McGuire et al., 2020). Government spokespersons were found to have a significant impact on social distancing behaviour during COVID-19, likely due to the need for reassurance from government by the public (Abu-Akel et al., 2021). Physicians (Solnick et al., 2021), celebrities (Kamiński et al., 2021), politicians (Renshaw et al., 2021), news media (Gozzi et al., 2020), and public health authorities (Kamiński et al., 2021; Vraga and Bode, 2021) were found to shared more crisis information on social media, which can impact risk perception and behaviours (Vijaykumar et al., 2015). Influencers on social media have also been found to be effective at increasing message virality, generating high levels of engagement with their followers, and influencing risk perception (Bonnevie et al., 2021; Vijaykumar et al., 2015). For example, public health successfully partnered with a social media influencer in the Netherlands to develop an evidence-based COVID-19 campaign, including videos and infographics and was associated with proper handwashing, awareness of face touching, and physical distancing (Yousuf et al., 2020).

The various attributes social media platforms have that enable interaction should be used to facilitate discussion, raise awareness, combat the infodemic, and identify reactions and concerns of the public (World Health Organization, 2017). Despite this, passive information dissemination remains the main use of social media by public health (Khan et al., 2019; Warren and Wen, 2017). A study that examined dialogic engagement by public health agencies in Italy, UK, and New Zealand found that COVID-19 represents a missed opportunity for public health to engage in dialogue with the public (Landi et al., 2021). The authors discuss that organizational resources and competencies, as well as fear of being held accountable for answers within an uncertain environment likely resulted in lack of engagement (Landi et al., 2021). Effective dialogue should be used to listen to impacted individuals and priority groups and engage them in the crisis response (Eriksson, 2018; Veil et al., 2011b). Further, increased public health competencies within risk communication is necessary to ensure the workforce have the skills needed to communicate uncertain and developing science in the highly connected information age (Public Health Agency of Canada, 2021).

In addition to two-way communication, message features like hashtags, videos and images, replies, and quoting tweets can impact message retransmission (Basch et al., 2021; Guidry et al., 2020; Renshaw et al., 2021; Sutton et al., 2020a). Photos that had information

regarding disease symptoms and other related information (Guidry et al., 2020; Renshaw et al., 2021; Sutton et al., 2020a), and videos that used hashtags, dance, music, and humor (Basch et al., 2021), attracted more views and positively influenced message retransmission. Bots and fact-checking prompts have also been used to improve the accuracy of crisis information surrounding COVID-19 (Fridman et al., 2020). An experiment using prompts that identify potential bot accounts and mis/disinformation on Twitter during COVID-19 decreased the participant's willingness to engage with the tweet and lowered their opinion on the accuracy, relevance, and trustworthiness of the tweet (Lanius et al., 2021). The platform WhatsApp also partnered with a technology company to develop a fact-checking bot that provides answers on over 4,000 COVID-19 myths and conspiracy theories (Hutchinson, 2020). Using the tools available on social media platforms, such as including images and videos, as well as prompts for accuracy can help reduce mis/disinformation and maintain trust in official crisis actors.

Finally, social media analytics can be used to better understand the effectiveness of crisis messages, platforms used by subpopulations, and how the public are reacting to messages (Ding and Zhang, 2010; Eriksson, 2018; Jong, 2020; Khan et al., 2019; Lyu and Luli, 2021; Renshaw et al., 2021; Tang et al., 2018; Veil et al., 2011b). Analytics regarding message reach (Jin et al., 2019), trending topics discussed by the public (Basch et al., 2021; Gozzi et al., 2020), and subpopulations using various platforms (Campos-Castillo and Laestadius, 2020), can be analyzed to understand the information needs of the public and what the gaps are (Jin et al., 2019). Sentiment analysis, or the emotional response of the public to crisis messages, should be monitored and used to develop effective crisis messages that account for the emotional needs of the public (Meadows et al., 2019; Tang et al., 2018; Tangcharoensathien et al., 2020). Negative comments can influence individuals to negatively assess the crisis message and adjust their own attitudes to align with what they believe is public opinion (Kim et al., 2020; Raamkumar et al., 2020; Zheng et al., 2021). A study examining the effects of comments made by the public on Facebook news pages found that negative comments were highly persuasive and impacted individuals attitudes (Winter et al., 2015). Further, a systematic review found that sentiment analysis can be used during emerging infectious diseases to monitor and contain disease spread and track and avoid public concerns and panic (Alamoodi et al., 2021).

LIMITATIONS

The results of this study are limited in part by the search strategy. The inclusion of literature focused on North

America limits the diversity of participants and study generalizability, however, was necessary to ensure depth in the thematic analysis that could be applied to public health practice. Our research includes studies from 2009 to 2021 to capture emerging infectious disease within the social media age. Within that time, social media has significantly changed and grown. Not only have the number of users dramatically increased, the access to social media platforms and sheer volume of information on the various platforms has enabled people to communicate and share information in an unprecedented way. As such, research from the early social media age may not represent best practices for current social media platforms.

Our review specifically focused on emerging infectious disease due to the high level of uncertainty that underscores the communication process, making it different from other public health crises. Additionally, studies consisting of user-generated social media data were excluded from this review when it did not directly measure or evaluate the crisis communication.

GAPS AND FUTURE RESEARCH DIRECTIONS

Of the research that included participants, many studies included representative population samples, but few were found to include priority populations. Future research should examine how to effectively communicate with subpopulations disproportionately impacted by emerging infectious disease. While much of the research that included participants was qualitative, additional qualitative research could help to understand participant's perceptions and behaviour in relation to crisis messages. Additionally, the current research focuses on the more popular and established social media platforms including Facebook, Twitter, and Instagram. The effectiveness of crisis messages on newer social media platforms such as TikTok or understudied platforms such as Reddit, should also be explored. Additional research should also explore the feasibility and success of public health and other key actors' use of fact checking and accuracy checks and bots to decrease the spread of mis/disinformation. Finally, although influencers were widely discussed, more research is needed to examine how public health and government can effectively partner to deliver accurate, timely, and targeted crisis communication via social media.

Conclusion

The current review identified various emerging infectious diseases, themes, and methods in research and grey literature examining crisis communication via social media. Among the included studies Twitter was the platform most examined, followed by Facebook. Additionally, COVID-19 was the emerging infectious disease of focus in many of the studies, followed by H1N1. Five themes were identified based on our search strategy including audience segmentation and culturally appropriate messaging, partnerships, effective and trusted spokespersons, social media attributes that can increase message effectiveness and transmission, and social media analysis to understand how the public is interacting with and accepting messages. Targeting and tailoring platform selection and crisis messages to various subpopulations using social media attributes, features, and analytics is crucial. Partnerships with trusted spokespersons, including social media influencers, can aid in targeting and tailoring messages, influencing risk perception and the uptake of recommended behaviours.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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REFERENCES

Abu-Akel A, Spitz A, West R (2021). Who Is Listening? Spokesperson Effect on Communicating Social and Physical Distancing Measures During the COVID-19 Pandemic. Frontiers in Psychology 11:3845.

Aiello AE, Renson A, Zivich PN (2020). Social Media– and Internet-Based Disease Surveillance for Public Health. Annual Review of Public Health 41(1):101-118.

Airhihenbuwa CO (2020). Culture Matters in Communicating the Global Response to COVID-19. Preventing Chronic Disease 17. https://doi.org/10.5888/pcd17.200245

Alamoodi A H, Zaidan BB, Zaidan AA, Albahri OS, Mohammed KI, Malik RQ, Almahdi EM, Chyad MA, Tareq Z, Albahri AS, Hameed H, Alaa, M (2021). Sentiment analysis and its applications in fighting COVID-19 and infectious diseases: A systematic review. Expert Systems with Applications 167. https://doi.org/10.1016/j.eswa.2020.114155

Al-Hasan A, Khuntia J, Yim D (2020). Threat, Coping, and Social Distance Adherence During COVID-19: Cross-Continental Comparison Using an Online Cross-Sectional Survey. Journal of Medical Internet Research 22(11):e23019. https://doi.org/10.2196/23019

Ali SH, Foreman J, Tozan Y, Capasso A, Jones AM, DiClemente, RJ (2020). Trends and Predictors of COVID-19 Information Sources and Their Relationship With Knowledge and Beliefs Related to the Pandemic: Nationwide Cross-Sectional Study. JMIR Public Health and Surveillance 6(4):e21071. https://doi.org/10.2196/21071

Amanatidis D, Mylona I, Kamenidou I, Mamalis S, Stavrianea A (2021). Mining Textual and Imagery Instagram Data during the COVID-19 Pandemic. Applied Sciences 11(9):4281. Available at: https://doi.org/10.3390/app11094281

Arksey H, O'Malley L (2005). Scoping studies: Towards a methodological framework. International Journal of Social Research Methodology 8(1):19-32. https://doi.org/10.1080/1364557032000119616

Auxier B, Anderson M (2021, April 7). Social Media Use in 2021. Pew Research Center: Internet, Science & Tech. Available at:

https://www.pewresearch.org/internet/2021/04/07/social-media-use-in-2021/

Banker S, Park J (2020). Evaluating prosocial COVID-19 messaging frames: Evidence from a field study on Facebook. Judgement and Decision Making 15(6):1037-1043

Banks K (2020, July 29). In the midst of the pandemic, academics are fighting a rising 'infodemic.' University Affairs. Available at: https://www.universityaffairs.ca/features/feature-article/in-the-midst-of-the-pandemic-academics-are-fighting-a-rising-infodemic/

Basch CH, Fera J, Pierce I, Basch CE (2021). Promoting Mask Use on TikTok: Descriptive, Cross-sectional Study. JMIR Public Health and Surveillance 7(2):e26392. https://doi.org/10.2196/26392

Bonnevie E, Rosenberg SD, Kummeth C, Goldbarg J, Wartella E, Smyser J (2020). Using social media influencers to increase knowledge and positive attitudes toward the flu vaccine. PLOS ONE 15(10):e0240828. https://doi.org/10.1371/journal.pone.0240828

Bonnevie E, Smith SM, Kummeth C, Goldbarg J, Smyser J (2021). Social media influencers can be used to deliver positive information about the flu vaccine: Findings from a multi-year study. Health Education Research 36(3):286-294. https://doi.org/10.1093/her/cyab018

Boon-Itt S, Skunkan Y (2020). Public Perception of the COVID-19 Pandemic on Twitter: Sentiment Analysis and Topic Modeling Study. JMIR Public Health and Surveillance 6(4):e21978. https://doi.org/10.2196/21978

Brewer LC, Asiedu GB, Jones C, Richard M, Erickson J, Weis J, Abbenyi A, Brockman TA, Sia IG, Wieland ML, White RO, Doubeni CA (2020). Emergency Preparedness and Risk Communication Among African American Churches: Leveraging a Community-Based Participatory Research Partnership COVID-19 Initiative. Preventing Chronic Disease, 17: E158. https://doi.org/10.5888/pcd17.200408

Campos-Castillo C, Laestadius LI (2020). Racial and Ethnic Digital Divides in Posting COVID-19 Content on Social Media Among US Adults: Secondary Survey Analysis. Journal of Medical Internet Research 22(7):e20472. https://doi.org/10.2196/20472

Chandler R, Guillaume D, Parker AG, Mack A, Hamilton J, Dorsey J, Hernandez ND (2021). The impact of COVID-19 among Black women: Evaluating perspectives and sources of information. Ethnicity and Health 26(1):80-93. https://doi.org/10.1080/13557858.2020.1841120

Chesser A, Drassen Ham A, Keene Woods N (2020). Assessment of COVID-19 Knowledge Among University Students: Implications for Future Risk Communication Strategies. Health Education and Behaviour 47(4):540-543. https://doi.org/10.1177/1090198120931420

Cinelli M, Quattrociocchi W, Galeazzi A, Valensise CM, Brugnoli E, Schmidt AL, Zola P, Zollo F, Scala A (2020). The COVID-19 social media infodemic. Scientific Reports 10(1):16598. https://doi.org/10.1038/s41598-020-73510-5

Despres C, Aguilar R, McAlister A, Ramirez AG (2020). Communication for Awareness and Action on Inequitable Impacts of COVID-19 on Latinos. Health Promotion Practice 21(6):859-861. https://doi.org/10.1177/1524839920950278

Ding H, Zhang J (2010). Social media and participatory risk communication during the H1N1 flu epidemic: A comparative study. China Media Research 6(4):80-91.

Eriksson M (2018). Lessons for Crisis Communication on Social Media: A Systematic Review of What Research Tells the Practice. International Journal of Strategic Communication 12(5):526-551. https://doi.org/10.1080/1553118X.2018.1510405

Freberg K, Palenchar MJ, Veil SR (2013). Managing and sharing H1N1 crisis information using social media bookmarking services. Public Relations Review 39(3):178-184. https://doi.org/10.1016/j.pubrev.2013.02.007

Fridman I, Lucas N, Henke D, Zigler CK (2020). Association Between Public Knowledge About COVID-19, Trust in Information Sources, and Adherence to Social Distancing: Cross-Sectional Survey. JMIR Public Health and Surveillance 6(3):e22060. https://doi.org/10.2196/22060

Ghio D, Lawes-Wickwar S, Tang MY, Epton T, Howlett N, Jenkinson E, Stanescu S, Westbrook J, Kassianos A, Watson D, Sutherland L, Stanulewicz N, Guest E, Scanlan D, Carr N, Chater A, Hotham S, Thorneloe R, Armitage C, Keyworth C (2020). What influences people's responses to public health messages for managing risks and preventing infectious diseases? A rapid systematic review of the evidence and recommendations. BMJ Open 11(11):e048750. https://doi.org/10.31234/osf.io/nz7tr

Gozzi N, Tizzani M, Starnini M, Ciulla F, Paolotti D, Panisson A, Perra N (2020). Collective Response to Media Coverage of the COVID-19 Pandemic on Reddit and Wikipedia: Mixed-Methods Analysis. Journal of Medical Internet Research 22(10):e21597. https://doi.org/10.2196/21597

Guidry J, Austin L, O'Donnell N, Coman I, Lovari A, Messner M (2020). Tweeting the #flushot: Beliefs, Barriers, and Threats During Different Periods of the 2018 to 2019 Flu Season. Journal of Primary Care and Community Health 11(4):1-10.

Han G, Zhang J, Chu K, Shen G (2014). Self–Other Differences in H1N1 Flu Risk Perception in a Global Context: A Comparative Study Between the United States and China. Health Communication 29(2):109-123. https://doi.org/10.1080/10410236.2012.723267

Hutchinson A (2020, May 4). WhatsApp Launches New COVID-19 Fact-Checker Bot to Help Reduce the Spread of Misinformation. Social Media Today. Available at: https://www.socialmediatoday.com/news/whatsapp-launches-new-covid-19-fact-checker-bot-to-help-reduce-the-spread-o/577332/

Hwang J (2020). Health Information Sources and the Influenza Vaccination: The Mediating Roles of Perceived Vaccine Efficacy and Safety. Journal of Health Communication 25(9):727-735. https://doi.org/10.1080/10810730.2020.1840675

Hyland-Wood B, Gardner J, Leask J, Ecker UKH (2021). Toward effective government communication strategies in the era of COVID-19. Humanities and Social Sciences Communications 8(1):1-11. https://doi.org/10.1057/s41599-020-00701-w

Jardine CG, Boerner FU, Boyd AD, Driedger SM (2015). The More the Better? A Comparison of the Information Sources Used by the Public during Two Infectious Disease Outbreaks. PLOS One 10(10):e0140028. https://doi.org/10.1371/journal.pone.0140028

Jin Y, Austin L, Vijaykumar S, Jun H, Nowak G (2019). Communicating about infectious disease threats: Insights from public health information officers. Public Relations Review 45(1):167-177. https://doi.org/10.1016/j.pubrev.2018.12.003

Jong W (2020). Evaluating Crisis Communication. A 30-item Checklist for Assessing Performance during COVID-19 and Other Pandemics. Journal of Health Communication 25(12):962-970. https://doi.org/10.1080/10810730.2021.1871791

Kamiński M, Szymańska C, Nowak JK (2021). Whose Tweets on COVID-19 Gain the Most Attention: Celebrities, Political, or Scientific Authorities? Cyberpsychology, Behavior and Social Networking 24(2):123-128. https://doi.org/10.1089/cyber.2020.0336

Keene Woods N, Vargas I, McCray-Miller M, Drassen Ham A, Chesser AK (2021). SARS-CoV2, the COVID-19 Pandemic and Community Perceptions. Journal of Primary Care and Community Health 12:215013272199545. https://doi.org/10.1177/2150132721995451

Khan Y, Tracey S, O'Sullivan T, Gournis E, Johnson I (2019). Retiring the Flip Phones: Exploring Social Media Use for Managing Public Health Incidents. Disaster Medicine and Public Health Preparedness 13(5-6):859-867. https://doi.org/10.1017/dmp.2018.147

Khokhar A, Spaulding A, Niazi Z, Ailawadhi S, Manochakian R, Chanan-khan A, Niazi S, Sher T (2021). A Panel Evaluation of the Changes in the General Public's Social-Media-Following of United States' Public Health Departments during COVID-19 Pandemic. Journal of Primary Care and Community Health 12:215013272199545. Available at: https://doi.org/10.1177/2150132721995450

Kim H, Han JY, Seo Y (2020). Effects of Facebook Comments on Attitude Toward Vaccines: The Roles of Perceived Distributions of Public Opinion and Perceived Vaccine Efficacy. Journal of Health Communication 25(2):159-169. https://doi.org/10.1080/10810730.2020.1723039

Kim HM, Saffer AJ, Liu W, Sun J, Li Y, Zhen L, Yang A (2021). How Public Health Agencies Break through COVID-19 Conversations: A Strategic Network Approach to Public Engagement. Health Communication pp. 1-9. https://doi.org/10.1080/10410236.2021.1886393

Kim S, Liu BF (2012). Are All Crises Opportunities? A Comparison of How Corporate and Government Organizations Responded to the

2009 Flu Pandemic. Journal of Public Relations Research 24(1):69-85. https://doi.org/10.1080/1062726X.2012.626136

Kim Y (2016). Understanding publics' perception and behaviors in crisis communication: Effects of crisis news framing and publics' acquisition, selection, and transmission of information in crisis situations. Journal of Public Relations Research 28(1):35-50. https://doi.org/10.1080/1062726X.2015.1131697

Landi S, Costantini A, Fasan M, Bonazzi M (2021). Public engagement and dialogic accounting through social media during COVID-19 crisis: A missed opportunity? Accounting, Auditing and Accountability Journal 35(1). https://doi.org/10.1108/AAAJ-08-2020-4884

Lanius C, Weber R, MacKenzie WI (2021). Use of bot and content flags to limit the spread of misinformation among social networks: A behavior and attitude survey. Social Network Analysis and Mining 11(1):32. https://doi.org/10.1007/s13278-021-00739-x

Levac D, Colquhoun H, O'Brien KK (2010a). Scoping studies: Advancing the methodology. Implementation Science 5(1):69. https://doi.org/10.1186/1748-5908-5-69

Li Y, Guan M, Hammond P, Berrey LE (2021). Communicating COVID-19 information on TikTok: a content analysis of TikTok videos from official accounts featured in the COVID-19 information hub, Health Education Research 36(3):261-271. https://doi.org/10.1093/her/cyab010

Liu BF, Austin L, Lee YI, Jin Y, Kim S (2020). Telling the tale: The role of narratives in helping people respond to crises. Journal of Applied Communication Research 48(3):328-349. https://doi.org/10.1080/00909882.2020.1756377

London J, Matthews K (2021). Crisis communication on social media—Lessons from Covid-19. Journal of Decision Systems 31(1-2):150-170. https://doi.org/10.1080/12460125.2021.1926612

Lyu JC, Luli GK (2021). Understanding the Public Discussion About the Centers for Disease Control and Prevention During the COVID-19 Pandemic Using Twitter Data: Text Mining Analysis Study. Journal of Medical Internet Research 23(2):e25108. https://doi.org/10.2196/25108

MacKay M, Colangeli T, Gillis D, McWhirter J, Papadopoulos A (2021). Examining Social Media Crisis Communication during Early COVID-19 from Public Health and News Media for Quality, Content, and Corresponding Public Sentiment. International Journal of Environmental Research and Public Health 18(15):7986. https://doi.org/10.3390/ijerph18157986

MacKay M, Colangeli T, Thaivalappil A, Del Bianco A, McWhirter JE, Papadopoulos A (2021). A Review and Analysis of the Literature on Public Health Emergency Communication Practices. Journal of Community Health pp. 1-13. https://doi.org/10.1007/s10900-021-01032-w

Malecki KMC, Keating JA, Safdar N (2021). Crisis Communication and Public Perception of COVID-19 Risk in the Era of Social Media. Clinical Infectious Diseases 72(4):697-702. https://doi.org/10.1093/cid/ciaa758

Mangono T, Smittenaar P, Caplan Y, Huang VS, Sutermaster S, Kemp H, Sgaier SK (2021). Information-Seeking Patterns During the COVID-19 Pandemic Across the United States: Longitudinal Analysis of Google Trends Data. Journal of Medical Internet Research 23(5):e22933. https://doi.org/10.2196/22933

McGuire D, Cunningham JEA, Reynolds K, Matthews-Smith G (2020). Beating the virus: An examination of the crisis communication approach taken by New Zealand Prime Minister Jacinda Ardern during the Covid-19 pandemic. Human Resource Development International 23(4):361-379. https://doi.org/10.1080/13678868.2020.1779543

McHugh ML (2012). Interrater reliability: The kappa statistic. Biochemia Medica 22(3):276-282.

Meadows CZ, Tang L, Liu W (2019). Twitter message types, health beliefs, and vaccine attitudes during the 2015 measles outbreak in California. American Journal of Infection Control 47(11):1314-1318. https://doi.org/10.1016/j.ajic.2019.05.007

Microsoft Corporation (2018). Microsoft Excel. Available at: https://office.microsoft.com/excel

Mututwa W, Matsilele T (2020). COVID-19 infections on international celebrities: Self presentation and tweeting down pandemic awareness. Journal of Science Communication 19(5):A09.

https://doi.org/10.22323/2.19050209

Myrick JG, Willoughby JF (2021). A Mixed Methods Inquiry into the Role of Tom Hanks' COVID-19 Social Media Disclosure in Shaping Willingness to Engage in Prevention Behaviours. Health Communication, pp. 1-9. https://doi.org/10.1080/10410236.2020.1871169

Nazione S, Perrault E, Pace K (2021). Impact of Information Exposure on Perceived Risk, Efficacy, and Preventative Behaviors at the Beginning of the COVID-19 Pandemic in the United States. Health Communication 36(1):23-31. https://doi.org/10.1080/10410236.2020.1847446

Neely S, Eldredge C, Sanders R (2021). Health Information Seeking Behaviors on Social Media During the COVID-19 Pandemic Among American Social Networking Site Users: Survey Study. Journal of Medical Internet Research 23(6):e29802. https://doi.org/10.2196/29802

Niburski K, Niburski O (2020). Impact of Trump's Promotion of Unproven COVID-19 Treatments on Social Media and Subsequent Internet Trends: Observational Study. Journal of Medical Internet Research 22(11):e20044. https://doi.org/10.2196/20044

Pazzanese C (2020, May 8). Social media used to spread, create COVID-19 falsehoods. Harvard Gazette. Available at: https://news.harvard.edu/gazette/story/2020/05/social-media-used-to-spread-create-covid-19-falsehoods/

Pennycook G, McPhetres J, Zhang Y, Lu JG, Rand DG (2020). Fighting COVID-19 Misinformation on Social Media: Experimental Evidence for a Scalable Accuracy-Nudge Intervention. Psychological Science 31(7):770-780. https://doi.org/10.1177/0956797620939054

Public Health Agency of Canada (2021, December 13). A Vision to Transform Canada's Public Health System: Chief Public Health Officer's Report on the State of Public Health in Canada 2021. Available at: https://www.canada.ca/en/public-health/corporate/publications/chief-public-health-officer-reports-state-public-health-canada/state-public-health-canada-2021.html

Raamkumar AS, Tan SG, Wee HL (2020). Measuring the Outreach Efforts of Public Health Authorities and the Public Response on Facebook During the COVID-19 Pandemic in Early 2020: Cross-Country Comparison. Journal of Medical Internet Research 22(5):e19334. https://doi.org/10.2196/19334

Ranjit YS, Shin H, First JM, Houston JB (2021). COVID-19 protective model: The role of threat perceptions and informational cues in influencing behavior. Journal of Risk Research 24(3-4):449-465. https://doi.org/10.1080/13669877.2021.1887328

Renshaw SL, Mai S, Dubois E, Sutton J, Butts CT (2021). Cutting Through the Noise: Predictors of Successful Online Message Retransmission in the First 8 Months of the COVID-19 Pandemic. Health Security 19(1):31-43. https://doi.org/10.1089/hs.2020.0200

Rufai SR, 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

Samaras L, García-Barriocanal E, Sicilia MA (2020). Comparing Social media and Google to detect and predict severe epidemics. Scientific Reports 10(1):4747. https://doi.org/10.1038/s41598-020-61686-9

Seeger MW (2006). Best practices in crisis communication: an expert panel process. Journal of Applied Communication Research 34(3):232e244. http://dx.doi.org/10.1080/00909880600769944

Solnick RE, Chao G, Ross RD, Kraft-Todd GT, Kocher KE (2021). Emergency Physicians and Personal Narratives Improve the Perceived Effectiveness of COVID-19 Public Health Recommendations on Social Media: A Randomized Experiment. Academic Emergency Medicine 28(2):172-183. https://doi.org/10.1111/acem.14188

Southwell BG, Reynolds BJ, Fowlie K (2013). Communication in infectious disease surveillance: PART 1: Communication, mass media relations, and infectious disease surveillance. In: NM M'ikanatha, R Lynfield, CA Van Beneden, & H de Valk (Eds.), Infectious Disease Surveillance (pp. 607-617). John Wiley & Sons Ltd. https://doi.org/10.1002/9781118543504.ch49

Southwick L, Guntuku SC, Klinger EV, Seltzer E, McCalpin HJ, Merchant, RM (2021). Characterizing COVID-19 Content Posted to TikTok: Public Sentiment and Response During the First Phase of the COVID-19 Pandemic. Journal of Adolescent Health 69(2):234-241.

https://doi.org/10.1016/j.jadohealth.2021.05.010

Statista Research Department. (2021, August 25). Social media usage in Canada. Statista. Available at: https://www.statista.com/topics/2729/social-networking-in-canada/

Storeng KT, de Bengy Puyvallée A (2021). The Smartphone Pandemic: How Big Tech and public health authorities partner in the digital response to Covid-19. Global Public Health 16(8-9):1482-1498. https://doi.org/10.1080/17441692.2021.1882530

Sutton J, Renshaw SL, Butts CT (2020a). COVID-19: Retransmission of official communications in an emerging pandemic. PLOS ONE 15(9):e0238491. https://doi.org/10.1371/journal.pone.0238491

Sutton J, Renshaw SL, Butts CT (2020b). The First 60 Days: American Public Health Agencies' Social Media Strategies in the Emerging COVID-19 Pandemic. Health Security 18(6):454-460. https://doi.org/10.1089/hs.2020.0105

Tang L, Bie B, Park SE, Zhi D (2018). Social media and outbreaks of emerging infectious diseases: A systematic review of literature. American Journal of Infection Control 46(9):962-972. https://doi.org/10.1016/j.ajic.2018.02.010

Tangcharoensathien V, Calleja N, Nguyen T, Purnat T, D'Agostino M, Garcia-Saiso S, Landry M, Rashidian A, Hamilton C, AbdAllah A, Ghiga I, Hill A, Hougendobler D, Andel J van, Nunn M, Brooks I, Sacco PL, Domenico MD, Mai P, Briand S (2020). Framework for Managing the COVID-19 Infodemic: Methods and Results of an Online, Crowdsourced WHO Technical Consultation. Journal of Medical Internet Research 22(6):e19659. https://doi.org/10.2196/19659

Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, Moher D, Peters MDJ, Horsley T, Weeks L, Hempel S, Akl EA, Chang C, McGowan J, Stewart L, Hartling L, Aldcroft A, Wilson MG, Garritty C, Straus SE (2018). PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Annals of Internal Medicine 169(7):467-473. https://doi.org/10.7326/M18-0850

Tsao SF, Chen H, Tisseverasinghe T, Yang Y, Li L, Butt ZA (2021). What social media told us in the time of COVID-19: A scoping review. The Lancet Digital Health 3(3):e175-e194. https://doi.org/10.1016/S2589-7500(20)30315-0

Veil SR, Buehner T, Palenchar MJ (2011a). A Work-In-Process Literature Review: Incorporating Social Media in Risk and Crisis Communication. Journal of Contingencies and Crisis Management 19(2):110-122. https://doi.org/10.1111/j.1468-5973.2011.00639.x

Vijaykumar S, Jin Y, Nowak G (2015). Social Media and the Virality of Risk: The Risk Amplification through Media Spread (RAMS) Model. Journal of Homeland Security and Emergency Management 12(3):653-677. https://doi.org/10.1515/jhsem-2014-0072

Vraga EK, Bode L (2021). Addressing COVID-19 Misinformation on Social Media Preemptively and Responsively. Emerging Infectious Diseases 27(2):396. https://doi.org/10.3201/eid2702.203139

Wang H, Cleary PD, Little J, Auffray C (2020). Communicating in a public health crisis. The Lancet Digital Health 2(10):e503. https://doi.org/10.1016/S2589-7500(20)30197-7

Warren KE, Wen LS (2017). Measles, social media and surveillance in Baltimore City. Journal of Public Health (Oxford, England) 39(3):e73-e78. https://doi.org/10.1093/pubmed/fdw076

Wendling C, Radisch J, Jacobzone S (2013). The Use of Social Media in Risk and Crisis Communication. https://doi.org/10.1787/5k3v01fskp9s-en

Wild A, Kunstler B, Goodwin D, Onyala S, Zhang L, Kufi M, Salim W, Musse F, Mohideen M, Asthana M, Al-Khafaji M, Geronimo MA, Coase D, Chew E, Micallef E, Skouteris H (2021). Communicating COVID-19 health information to culturally and linguistically diverse communities: Insights from a participatory research collaboration. Public Health Research and Practice 31(1):3112105. https://doi.org/10.17061/phrp3112105

Winter S, Brückner C, Krämer NC (2015). They Came, They Liked, They Commented: Social Influence on Facebook News Channels. Cyberpsychology, Behavior and Social Networking 18(8):431-436. https://doi.org/10.1089/cyber.2015.0005

World Health Organization (2017). Communicating risk in public health emergencies: A WHO guideline for emergency risk communication (ERC) policy and practice. In Communicating risk in public health emergencies: A WHO guideline for emergency risk communication (ERC) policy and practice [Internet]. World Health Organization. https://www.ncbi.nlm.nih.gov/books/NBK540733/

World Health Organization (2018, January 10). Communicating risk in public health emergencies. https://www.who.int/publications-detail-redirect/9789241550208

World Health Organization (2020). Novel Coronavirus(2019-nCoV) Situation Report—13. World Health Organization. Available at: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200202-sitrep-13-ncov-v3.pdf?sfvrsn=195f4010_6

World Health Organization Expert Consultation on Outbreak Communications, World Health Organization Communicable Diseases (2005). Outbreak communication: Best practices for communicating with the public during an outbreak : report of the WHO Expert Consultation on Outbreak Communications held in Singapore, 21-23 September 2004 (WHO/CDS/2005.32). World Health Organization. Available at: https://apps.who.int/iris/handle/10665/69138

Xiang D, Kontos C, Veloudaki A, Baka A, Karnaki P, Linos A (2017). Risk Communication in times of an epidemic or pandemic (Asset Paper Series P 14). Available at: http://www.asset-scienceinsociety.eu/sites/default/files/paper_series_5_-_risk_communication_in_time_of_an_epidemic_or_pandemic.pdf

Xue J, Chen J, Chen C, Zheng C, Li S, & Zhu T (2020). Public discourse and sentiment during the COVID 19 pandemic: Using Latent Dirichlet Allocation for topic modeling on Twitter. PLOS One 15(9):e0239441. https://doi.org/10.1371/journal.pone.0239441

Yousuf H, Corbin J, Sweep G, Hofstra M, Scherder E, van Gorp E, Zwetsloot PP, Zhao J, van Rossum B, Jiang T, Lindemans JW, Narula J, Hofstra L (2020). Association of a Public Health Campaign About Coronavirus Disease 2019 Promoted by News Media and a Social Influencer With Self-reported Personal Hygiene and Physical Distancing in the Netherlands. JAMA Network Open 3(7):e2014323. https://doi.org/10.1001/jamanetworkopen.2020.14323

Zeemering ES (2021). Functional fragmentation in city hall and Twitter communication during the COVID-19 Pandemic: Evidence from Atlanta, San Francisco, and Washington, DC. Government Information Quarterly 38(1):101539. https://doi.org/10.1016/j.giq.2020.101539

Zhang LT, Zhao S (2020). Diaspora micro-influencers and COVID-19 communication on social media: The case of Chinese-speaking YouTube vloggers. Multilingua 39(5):553-563. https://doi.org/10.1515/multi-2020-0099

Zheng C, Xue J, Sun Y, Zhu T (2021). Public Opinions and Concerns Regarding the Canadian Prime Minister's Daily COVID-19 Briefing: Longitudinal Study of YouTube Comments Using Machine Learning Techniques. Journal of Medical Internet Research 23(2):e23957. https://doi.org/10.2196/23957