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Health-related Disaster Communication and Social Media: Mixed-method Systematic Review

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Abstract

This mixed-method evidence synthesis drew on Cochrane methods and principles to systematically review literature published between 2003 and 2016 on the best social media practices to promote health protection and dispel misinformation during disasters. Seventy-nine studies employing quantitative, qualitative and mixed methods on risk communication during disasters in all UN-languages were reviewed, finding that agencies need to contextualize the use of social media for particular populations and crises. Social media are tools that still have not become routine practices in many governmental agencies regarding public health in the countries studied. Social media, especially Twitter and Facebook (and equivalents in countries such as China), need to be incorporated into daily operations of governmental agencies and implementing partners to build familiarity with them before health-related crises happen. This was especially observed in U.S. agencies, local government, and first responders but also for city governments and school administrations in Europe. For those that do use social media during health-related risk communication, studies find that public relations officers, governmental agencies and the general public have used social media successfully to spread truthful information and to verify information to dispel rumors during disasters. Few studies focused on the recovery and preparation phases and on countries in the Southern hemisphere, except for Australia.

The vast majority of studies did not analyze the demographics of social media users beyond their geographic location, their status of being inside/outside the disaster zone; and their frequency and content of posting. Socio-economic demographics were not collected and/or analyzed to drill deeper into the implications of using social media to reach vulnerable populations. Who exactly is reached via social media campaigns and who needs to be reached with other means has remained an understudied area.

Keywords

Health communication, disaster communication, risk communication, social media, systematic review, Cochrane principles

Introduction

Communication via social media with the public during health-related risk and disaster situations is a complex process involving multiple stakeholders, including public participation and interaction in decision-making. Social media messages between health authorities with the general public, and with specific communities, must be carefully designed to effectively influence health protection behaviors. Emergent health emergency events tend to be both global and local problems; thus, effective health and risk communication about them must also take into account the political and cultural context in which the social media messages will be received and understood. Further, it is crucial to understand which social media platforms different stakeholders in different locations utilize and how those who are not reachable via social media can be communicated with via other channels.

The creation of such social media messages is rather inexpensive in terms of national and international infrastructure; albeit it is time-intensive and demands training those who will take up and consistently use these tools. Although access, use and literacy vary, depending on location and socio-economic background, social media are a relatively accessible communication channel for the public to contact authorities, peers, and other stakeholders directly. Even so, any expenditures on integrating social media into existing health-related communication strategies must compete with equally compelling financial demands for increased medical care and other public health initiatives, particularly at the height of an emergency disaster. Effective health-related disaster communication via social media, thus, must demonstrate effectiveness in promoting individual action in comparison to other potential policy responses. This is best accomplished by guidance from scholarship on the use of social media during disasters.

We located 12 existing relevant reviews (Bean, 2015; Bradley, McFarland & Clarke, 2014; Crowe, 2010; Gesser-Edelsburg et al., 2015; Kraut et al., 2013; Landwehr & Carley, 2014; Lin,

Savoia, Agboola & Viswanath, 2014; Newbold & Campos, 2011; Revere et al., 2011; Ruggiero & Vos, 2013; Simon, Goldberg, & Adini, 2015; Veil, Beuhner, & Palenchar, 2011). Yet, after closer examination[3] we found only one published review directly related to our phenomenon of interest (Newbold & Campos, 2011) and of sufficient quality to take its findings into account (see Table 1 for ratings of all reviews; all tables and figures are presented in the appendix). It reviewed articles published between 2000 and 2011, finding that more research on the efficacy of social media messages as part of public health campaigns is needed and few reports on the integration of social media into regular public health practices are available. Newbold and Campos (2011) called for a universal best practices document for guidance for practitioners and for evaluation of social media campaigns for researchers.

Hence, our objective was to conduct a systematic review of the extant literature on social media use during all phases of a disaster cycle.[1] Specifically, the purpose was to address the following question: What are the best social media channels and practices to promote health protection measures and dispel rumors and misinformation during all phases of disasters with public health implications? We designed this mixed-method review to fill the existing evidence gap to provide a more updated, comprehensive and rigorous review across all UN-languages on scholarship on social media use during disasters and emergencies published between 2003 and 2016. Especially over the past five years studies on social media use during disasters were published demanding a new evaluation of emerging evidence on best practices for governmental agencies, implementing partners and the public.

Method

We adopted a mixed-method design that could incorporate all relevant study types. Our approach to searching for, processing and synthesizing evidence drew on Cochrane methods for processing quantitative, qualitative and mixed-method studies in a rigorous multi-step process following

principles in the Cochrane Handbook and additional supplemental guidance from the Cochrane

Qualitative and Implementation Methods Group (Higgins & Green, 2011).

Literature Search

We adopted a two-phase strategy for literature searching. In the first phase we conducted a

general search that was intentionally broad in scope. In the second phase, a search focused narrowly

on the objective of the present review was conducted. We used a wide range of search terms relevant

to social media and health-related disaster communication (Table 2). Not all terms worked in all

databases; therefore, thesauri were consulted for each database to find synonyms, if they existed, for

each term, or any functionality that allowed the word to be "exploded" or "expanded." Individual

databases searched included: Web of Science; Google Scholar, PubMed/Medline-National Library of

Medicine (NLM); Cumulative Index of Nursing and Allied Health Literature (CINAHL); CINAHL

Complete; Communication and Mass Media Complete (CMMC); PsychInfo; and the website of the

World Health Organization. For foreign languages additional databases and sources were searched by

native speakers.[4]

The following broad inclusion criteria were used in the search for literature: Research related

to the practice of risk communication and the process of disaster management with no preference for

any specific disaster. Research within the viewpoint or scope set by the health-related disaster

communication field including, but not limited to: trust, uncertainty, communities, health,

misinformation, health protection, media (including social media), messages, and stakeholders.

The parameters for searching for studies included a focus on public health implications in high,

low, middle income and fragile states; use of social media by sources such as national governments

and relevant subnational authorities such as local/district health departments; implementing partners,

NGOs, health authorities, celebrities, community leaders; and at-risk communities. In detail this review was concerned with gathering the most recent scholarship on the extent of the reach, the levels of influence, and outcomes of social media use as well as the types of audiences. It thus aimed to gain insights into the impact of social media on public trust in disaster information and on community engagement; the level of information sharing; unanticipated negative consequences; and distortions of public health information during disasters. The time frame was set for 2003 to 2016 to generously cover the past decade of scholarship.

The following exclusion criteria were used in the search for literature: Research in organizational risk communication and disaster management such as technology failures; and research outside of the specified scope of the study, such as laboratory studies and those related to chronic disease, lifestyle, or personal living/ attributes (such as personal health, mental health, etc.)

We additionally utilized reports provided by social media companies. Contacts included Facebook's Head of Global Policy Programs, Google's Social Responsibility Regional Manager, Twitter's Public Policy Lead, and LinkedIn's Head of LinkedIn for Good. Facebook and Twitter contacts responded and each provided several links and leads to promising material, which yielded ten reports. Of these, four were database indexed primary studies, relevant regarding the research topic, and offering the benefit of being very recent publications (Corrigan, 2014; Kryvasheyeu, 2016; Ntalla, 2015; Olteanu, 2015) and were included in the final set for the review. Table 3 provides an overview of the study selection process across all languages.

Individual Article Appraisal

We appraised quantitative control/comparison groups individually using the Effective Practice and Organisation [sic] of Care (EPOC) (2015) Risk of Bias tool. This tool provides nine criteria for assessing randomized control trials, non-randomized control trials, and control before-after studies.

Detailed information on the definitions of levels of risk used in this tool available in section 12.2.2 of the Cochrane Handbook (Higgins & Green, 2011).

We appraised quantitative descriptive survey studies individually using an adapted version of Davids' and Roman's (2014) quality appraisal criteria. This tool assessed on a 0 to 1 scale (0-not reported, 1-reported) the following areas: sampling, response rate, validity and reliability, sources of data, content and focus of study, and relevancy to the corresponding question. We determined final ratings by percentage; weak (0-33.9%), moderate (34-66.9%), and strong (67-100%).

We appraised qualitative studies individually, using the Critical Appraisal Skills Programme (CASP) (2013) checklist, for appropriateness of qualitative methodology, data collection, relationship between research and participants, ethics, rigor of data analysis, clarity of findings, and value of research. Each area in CASP is assessed using "yes," "no," or "can't tell." We gave studies a final rating of "high" (no significant flaws), "moderate" (minor flaws impacting credibility/validity), "low" (some flaws likely to impact credibility/validity), or "very low" (significant flaws impacting credibility/validity).

We appraised mixed method studies using Pluye et al.'s (2011) Methods Appraisal Tool (MMAT) for employed methods and methodological quality (i.e., qualitative, quantitative randomized control trials or non-randomized control trials, quantitative descriptive, and overall implementation of mixed methods). Each area in MMAT is assessed using "yes," "no," or "can't tell." We gave studies ra final rating of "high" (no significant flaws), "moderate" (minor flaws impacting credibility/validity), "low" (some flaws likely to impact credibility/validity), or "very low" (significant flaws impacting credibility/validity).

We appraised the individual media reports that did not report a study for their credibility using the Authority, Accuracy, Coverage, Objectivity, Date, and Significance (AACODS) tool (Tyndall,

2008). Each area in AACODS is assessed using "yes," "no," or "can't tell." Studies received a final rating of "high" (no significant flaws), "moderate" (minor flaws impacting credibility/validity), "low" (some flaws likely to impact credibility/validity), or "very low" (significant flaws impacting credibility/validity). An important factor in weight with AACODS is given to aspects of authority.

Synthesis of findings

We synthesized findings in two stages as presented in the process design in Figure 1. In the first stage, we synthesized findings from individual studies within methodological streams. Then we evaluated these within-method synthesized findings for certainty/ confidence using appropriate tools. In the second stage, we further synthesized the within-method synthesized findings across methodological streams, taking into account the certainty/ confidence evaluations.

In both the within-method and across-method stages, the synthesis of findings included subgroup analyses. These included examination of type of disaster, phase of disaster, country of disaster, and presence of vulnerable populations. The last two subgroups allowed considerations of equity in the synthesized findings.

The lead author of the study conducted the synthesis of findings. The synthesis process and the synthesized findings were discussed with all team members in weekly meetings. One team member closely read the synthesized findings and offered critique. The synthesized findings were modified based on the discussion and critique.

For each methodological stream, the synthesized findings were created by building explanatory and higher level analytical statements supported by quantitative and qualitative evidence from individual studies.

For the two quantitative methodological streams, we again applied principles from Section 11.7.2 of the Cochrane Handbook (Higgins & Green, 2011) dealing with results without meta-analyses and hence following a narrative summary approach to synthesis of findings.

For the qualitative methodological stream, we broadly followed the framework synthesis method (Barnett-Page & Thomas, 2009; Pope, Ziebland, & Mays, 2000). We found this method suited to organize and analyze large amounts of data, which for us was represented by the corpus of findings and supporting evidence. The method is a combination of deductive-inductive processes. We started with a list of a priori framework categories generated from review objectives and phenomena of interest concepts, and modified the list as appropriate based on prior subject matter knowledge and reading of individual studies. Our goal was to synthesize the findings by identifying themes that emerged across the findings from individual studies and fit the framework categories.

For the mixed-method and case study methodological stream, the individual studies typically did not differentiate their overall findings based on type of methodology. For this stream, thus, we looked at the findings holistically and followed a broadly narrative summary approach.

The assessment of certainty/confidence of synthesized findings was done separately for each methodological stream using the following tools.

Quantitative-Comparison Groups and Quantitative-Descriptive Survey findings within methodological stream were assessed for certainty of synthesized findings using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach (GRADE Working Group, 2004; Guyatt et al., 2010; Higgins & Green, 2011). Findings were assessed on allocation sequence and concealment, baseline outcomes and characteristics, protections against contamination(s), presence of selective outcome reporting, and other possible forms of bias. Each category was given a rating of "low risk," "high risk," or "unclear risk." Detailed information on the

definitions of levels of risk used in this tool available in section 12.2.2 of the Cochrane Handbook (Higgins & Green, 2011). Findings received a final rating of "high quality" (meaning that it is highly likely that new research will not modify the finding substantially), "moderate quality" (it is somewhat likely that new research will not modify the finding substantially), "low quality" (it is somewhat likely that new research will modify the finding substantially), or "very low quality" (it is highly likely that new research will modify the finding substantially).

We assessed confidence in qualitative synthesized findings within methodological stream using GRADE-CERQual (Lewin et al., 2015). Findings were assessed on methodological limitations, relevance, coherence, and adequacy of data supporting the finding. Each finding was then given a rating of "high confidence" (it is highly likely that the finding is a representation of the phenomena), "moderate confidence" (it is likely that the finding is a representation of the phenomena "low confidence" (it is possible that the finding is a representation of the phenomena), or "very low confidence" (it was not clear if the finding is a representation of the phenomena).

Mixed method and case study findings were assessed for certainty/confidence of synthesized findings using the same principles of GRADE and GRADE-CERQual approaches.

We synthesized the findings across the four methodological streams to develop an overarching synthesis of findings. The synthesized findings within a methodological stream were compared and contrasted with findings from the other methodological streams. Whenever the findings supported and amplified each other, they were combined into higher order findings that represented synthesis across the method streams. The evaluation of certainty in the within-method synthesized findings was kept in mind during this process.

All methodological streams did not yield the same kind or similar number of synthesized findings. We did not consider this a problematic issue as we were seeking to find the points of

alignment of the findings across the method streams rather than simply merging them together, which would have given some methodological streams more importance than others.

Within-method findings that did not contribute to an across-method higher order finding were analyzed thematically. These thematic analyses were used to uncover a nuance or modification to the across-method findings, which were then either used to create a new higher order across-method finding or incorporated into an existing across-method finding.

A very few synthesized findings within a methodological stream provided evidence that countered the synthesized findings from other methodological streams. Whenever this happened, we strived to retain this finding as a separate finding in the final set of across-method findings or used it to modify an existing across-method finding.

We extracted findings from individual media reports and then synthesized these findings across the individual reports. We used these across-media reports synthesized findings as another input for the final set of synthesized findings

Results

Study Characteristics English-Language Studies

This review included coding a total of 79 studies of which 69 were in English, four in French, three in Arabic, two in Chinese and one in Spanish.[2] It also included grey literature, media reports and articles solicited from social media companies. Of the 69 English language studies examined, 66 were directly relevant and 3 were indirectly relevant; none were partially or unclearly relevant (Table 4). Nearly half of the studies used quantitative methods to investigate questions around social media in health-related disaster communication, two studies conducted research via trials, 29 used other quantitative descriptive methods. The other half was weighted slightly more toward mixed methods and case studies (23 combined) than qualitative methods (15).

Regarding countries, nearly half of all studies were situated in the United States (33), several more studies analyzed crises set in other Western and Eastern developed regions and countries such as Japan (8), China (4) Australia (4), Europe or EU (6) and individual European countries such as Germany, the Netherlands, and the United Kingdom. Other Asian countries in which disasters were studied included the Philippines (3), New Zealand (3) and one study each with data from India, Taiwan, and Thailand. Few studies focused on the Southern hemisphere, almost absent were studies from Latin America (with the exceptions of one study each in Chile and Haiti), the Middle East (with the exception of a study on a refugee camp in Jordan) and Africa (with the exception of Nigeria.)

Regarding the types of disasters, earthquakes (18), typhoon/ hurricane/ cyclone (12), infectious diseases (9), and floods (8) were studied most often. Fewer studies focused on fires (4), storms/tornadoes (3), radiological disasters (3), tsunamis (2), terrorism (2), and food safety (2). Only one study each focused on a drought, a school shooting, a crisis in refugee camp, and a mass panic.

Most studies analyzed the use of social media during the containment phase (29) or the containment phase in combination with preparation or onset or recovery phases. A few studies focused only on the preparation phase (5), recovery phase (4) or all phases (5); no study focused on the onset phase alone.

Regarding vulnerable populations, most studies focused on the general population or health agency officials, only a small minority of studies revealed in sample demographics to be focusing on minority groups, for instance separate studies with participants who identified as Latina/os in Los Angeles, USA; very low to low income people; Nigerians without much internet access; and refugees in a refugee camps in Jordan. It must be noted that many studies that analyzed the use of Twitter did not reveal demographics of the users of Twitter beyond stating the frequency of posts, re-tweets and/or followers and the location within/outside disaster zone or geographical location in general.

Study Characteristics of Other 10 UN-Language-Based Studies

Of the 10 other UN languages (i.e., not English) databased primary studies, there were three Arabic, two Chinese, and four French studies, as well as one Spanish study (Table 5). Seven articles were directly relevant and three were indirectly relevant. Three of the articles used quantitative methods to investigate the questions around social media in health-related disaster communication, two employed qualitative methods, two employed mixed methods, and three employed a case study approach.

Regarding countries, two of the studies focused on Canada, with the remaining articles focusing on an array of regions. These countries include China (2), France (1), Poland/The Czech Republic/Germany/United States/France (1), Saudi Arabia (1), Spain (1), the United Arab Emirates (1) and Yemen (1).

The types of disasters were also varied. The studies focused on avalanches/nuclear disasters (1), the avian influenza (1), floods (1), general influenza/H1N1 (2), terrorism (1), a volcano outbreak (1), and three (3) took a general focused approach on disasters.

Only one study focused on all phases of a disaster cycle. Other studies focused on the preparation (1), containment (1), and evaluation (2) phases. The remainder focused on a combination of phases (5). Regarding vulnerable groups, most of the studies focused on the general populations, with only three examining specific demographic information that identified vulnerable groups. The identified vulnerable groups included pregnant women, adolescents, children, older adults, and people with compromised immune systems/chronic diseases, immigrants, as well as people with disabilities.

Synthesis of Findings Within Methodological Stream and Evaluation of Certainty/Confidence

Different method streams of quantitative (comparison groups and descriptive), qualitative, and mixed methods and case studies, included several studies each (except for trials) did not yield significantly differing findings. Each method stream found different social media, but perhaps first and foremost Twitter, are beneficial during crisis communication for government agencies, implementing partners, first responders and the public to create two-way conversations to exchange information, create situation awareness and facilitate delivery of aid. Each method stream found that use of social media mostly focused on spreading verified information and eliminating rumors via crowd-sourced peer rumor control, sometimes combined with quick and effective myth-busting messages by government officials who had routine and expertise in using social media. Nevertheless, each method stream pointed out that social media can only be one channel during crisis communication and need to be used combined with other channels, especially with messages on traditional news media as they continue to enjoy high credibility and were most often referenced on Twitter and social media to distribute information that the general population deemed credible.

While nearly half of all studies employed quantitative methods, only two studies used trials to assess social media use. Trials may not lend themselves to study disasters for ethical reasons as well as planning reasons especially in the case of unforeseeable or very rapidly developing crises. Yet, across the other three method streams, which were mostly composed of studies individually appraised to be of high or moderate quality, results confirmed each other across a wide range of countries, mostly addressing the containment phase (often combined with one or several other phases), and across a range of disasters. No matter which method stream, few studies paid attention to vulnerable populations, pointing to a vast gap in research on social media during crisis communication.

Synthesis of Findings Across Methodological Streams

Across all methodological streams of quantitative (comparison groups and descriptive survey), qualitative, and mixed methods and case studies, studies of mostly moderate and high quality repeatedly found that social media, especially Twitter and Facebook, should be used by agencies, first responders and the public to monitor public reactions during a crisis, to address the public, create situational awareness, for citizens' peer-to-peer communication and aid, and to solicit responses from the ground; this was especially true of those who are directly affected by a disaster. In tandem, many studies qualified these findings by emphasizing that the use of social media needs to be contextualized for particular populations and disasters. Practitioners need to find out if and how different groups use social media in different crises. Connected to this finding was the important theme that social media, especially Twitter and Facebook, need to be incorporated into daily operations of governmental agencies and implementing partners to build familiarity with them before crises happen. This was especially observed in U.S. agencies, local government and first responders but also for city governments and school administrations in Europe e.g. in Germany and the U.K.

These findings were based on studies conducted in a wide range of countries across the Western and Eastern Northern hemisphere analyzing the use of social media across a wide range of natural disasters such as earthquakes, floods, fires, and infectious diseases as well as typhoons/cyclones/hurricanes which were most commonly studied. Most studies focused on the containment phase, in some cases in combination with preparation, onset and/or recovery phases. Only a few studied addressed vulnerable populations such as refugees in a refugee camp in Jordan; immigrants not literate in the host countries' dominant languages; elderly and disabled people; and very low income people.

Similarly, many studies confirmed across method streams that public relations officers, governmental agencies and the general public could use social media, especially Twitter and Facebook, to spread truthful information and to verify information to dispel rumors. When rumors arose, it was most often found that messages on social media, especially Twitter and Facebook, were verified via self-regulation by users on the platforms as well as by agencies, of which some actively used myth-busting messages. Yet this means, as several of the same studies found that governmental agencies and implementing partners need to train, employ and pay dedicated social media officers to build relationships with stakeholders and to use social media consistently to build trust and credibility before disasters happen.

As nearly half of the studies were placed in a U.S. context or other developed countries in Western Europe and Asia, the use of social media in crisis communication remains little understood in Central and Latin America, the Middle East and Africa as well as the Indian subcontinent and Eastern Europe.

Grey Literature Findings

We treated primary studies based on data in the grey literature (non-academic) similar to the academic primary studies. The literature for the review (only English language noted) contained six reports coded as grey literature; five used case study methodology and one a quantitative descriptive method. Except for one analyzing an earthquake in Haiti, they focused on the USA (one in combination with Germany), and several different disasters, hurricanes, and the H1N1 influenza outbreak.

Two studies looked at social media use during the preparation phase finding that community collaboration with local media and experts are essential for effective response to and recovery from a

disaster; but media partnerships need to be established before a crisis happens to have time to build a

working relationship with local media and to understand their social media use. Social media were

also shown during the preparation phase to be able to trigger people to evacuate when it is in line with

their own motivation.

Similarly, two other studies on the use of social media by local and national government and

agencies found that social media need to be used to complement traditional communication channels

during crises. Further, Facebook was found to be a mostly self-correcting environment needing no

moderating of messages by the governmental agency to verify information to users. The study on

earthquake containment and recovery in Haiti found that the Ushahidi platform, which draws

information from Twitter, Facebook, blogs and SMS, creates crowd-sourced disaster maps to enable

targeted disaster responses; yet a vetting system is needed to rapidly identify misinformation.

Findings in Media Reports

We identified eight media reports for the review objective[5] in the search for English-language

news stories. Of these eight reports, four referred to the use of social media during the preparation,

onset and containment phase of natural disasters in general and in one case specifically to hurricanes.

The other four reported on an earthquake in Japan, the Ebola crisis in Sierra Leone, natural disasters in

Canada and floods in Indonesia. News stories focused on the use of social media by local government

officials, by international news media, the U.S. Federal Emergency Management Agency (FEMA),

and the public. One report described how U.S. cellular service provider AT&T uses mobile towers for

wireless communication during disasters when regular towers may be damaged or out of service.

Findings across the reports suggest that local government officials, disaster aid agencies,

international media and the general public should use social media to send and receive early warning

messages during the preparation phase; share information on the situation on the ground during onset and containment phases; to inform friends, families and communities during the containment phase about aid, food and evacuees. Further, Twitter was suggested as a tool to map in real time the spread of floods and assess damage during a disaster. In the USA, Canada, Indonesia and Japan Twitter and Facebook were specifically mentioned; in Sierra Leone Facebook and WhatsApp were the most popularly used social media during the Ebola crisis. No news story reported on the specific use of social media by or for vulnerable populations.

These findings are in line with the findings of the analyzed studies and grey literature. They confirm that local government officials, aid organizations, news media and the general public should use social media, especially Twitter and Facebook, during the preparation, onset and containment phases of different types of disasters to share information and address misinformation. They also support the findings that news media partnerships are useful to provide credible, verified information and that depending on country different social media may be the most popular and accessible to spread information widely.

Discussion

Social media, especially Twitter and Facebook, should be used by global, regional and local government agencies, first responders, health care practitioners and the public to monitor public reactions during a disaster; to address the public and to provide accurate, timely and transparently source information; to create situational awareness; for citizens' peer-to-peer communication and aid; and to solicit responses from the ground. This was especially true of those who were directly affected by a disaster, especially during preparation, onset and containment phases, and during earthquake and typhoon/ hurricane events.

Yet, studies emphasized that it is important that the use of social media needs to be

contextualized for particular populations and crises. Further, social media, especially Twitter (and the equivalent service of Sina Weibo in China) and Facebook, need to be incorporated into daily operations of governmental agencies and implementing partners *before* disasters strike to build familiarity, routine, and networks. This included that government agencies and health care practitioners needed to find out if, how and which different groups in their area use social media in different crises. This was the case not only regarding socio-economic status, but also in terms of geography as the experiences and affects differed between people who were directly affected by a disaster or in the disaster zone and those not directly affected or farther away. This also means that governmental agencies need to hire, train and consistently and actively support social media officers to build social media networks with the public and other useful entities. Additionally, many studies pointed out that social media should be used in combination with traditional news media for an integrated communication strategy to spread verified information as traditional news media enjoy high credibility and news media reports are often distributed via links on social media during crises.

Social media, especially Twitter and Facebook, can be used to spread truthful information and to verify information to dispel rumors and misinformation during public health crises. This was especially important regarding alternative social media not immediately controlled by the government in countries such as China where people are distrustful of official government messages and campaigns and turn to peers online to find more and accurate information. Studies demonstrated that the vast majority of messages on social media, especially Twitter and Facebook, were verified via self-regulation by users on the platforms as well as by agencies, which actively used myth-busting messages to address rumors and spread truthful information. This means, that while peer monitoring and correcting kept social media messages largely accurate, it was still recommended that governmental agencies and implementing partners train, employ and pay a dedicated social media

officer to build relationships with at-risk communities and stakeholders and to use social media

consistently to build trust and credibility and address rumors and misinformation as soon as they arise.

Studies found hashtags helpful in cases of myth-busting for instance in Australia where social

media accounts by local police were celebrated for their prompt myth-busting and reliability to

provide consistent, timely updates with accurate information during a flood. Governmental agencies

should use hashtags that organically develop, are already used by the public and widely circulated

rather than creating and insisting on others using "their" hashtags for a disaster.

Results Vis a Vis Findings from Existing Reviews

This evidence synthesis of mixed-method studies that addresses best practices and channels to use

social media for health-related disaster communication regarding public health provides the needed

update to previous reviews. In contrast to the existing 12 reviews, of which only one directly focused

on social media use in health messages and noted the dearth of studies on social media in health-

related risk communication, this review was able to draw on 69 English-language studies and 10

studies in other UN languages. The majority of these used large samples of posts from social media by

the public but did not analyze the demographics of the posters beyond such measures as geographic

area (and inside/outside disaster zone), frequency of posting (including re-tweets) and number of

followers. While much has been learned about the great value of information sharing via social media

and the self-regulating practices of social media users to pass on true information and dispel rumors

during times of crises, a gap in research persists as to who these social media users in the respective

countries and regions are to have the advantage to use this social media technology during the

different phases of crises.

In contrast to the previous reviews, in this review most studies on social media in health-

related disaster communication have focused on posts on Twitter (and its equivalent of Sina Weibo in

China) and Facebook by the public and government agencies; a minority of studies focused on other social media sites such as Flickr, SMS, blogs, YouTube and mapping apps such as Ushahidi. Overall, research analyzed in this review pointed to the continued need for government agencies and practitioners to include social media into their communication strategy for a true two-way communication and dialogue with the public during all phases of a crisis. This means agencies need trained staff that knows how to handle social media before disaster strikes and builds networks with the community by consistently providing accurate and timely messages, including those that show empathy and support for sense-making during disasters. Further, social media officers in public health organizations need to consistently respond to inquiries by the public on social media; the key is to develop a conversation rather than only providing a unidirectional flow of instructions. Additionally, in contrast to previous reviews this synthesis found that studies focused more frequently on the relationship between social media use and use of heritage news media. In this regard, this review found that news media remain a crucial part of health-related risk communication as their information was considered to be credible and was most frequently relayed on social media via re-tweets and links to back up messages. Hence, journalism and (local) news media have remained important senders and sources during health-related risk communication with the public and need to remain a part of the communication strategy, especially in collaboration with social media/online journalists.

Weaknesses of the Reviewed Literature

The reviewed articles suggested a heavy bias toward studies based in the United States, Europe, Australia and some Asian countries such as China and Japan, with little attention paid to Central and South America, the Middle East, the Asian subcontinent, Eastern Europe as well as Africa. Accordingly most studies were based on data from high or middle-income countries. Within these countries, studies focused heavily on two social media platforms, Twitter and Facebook. Further,

albeit a few studies specified the user base beyond a geographic area; number of followers and/or tweets; and when users were active, detailed data on gender, ethnicity, nationality, age, socio-economic status, (dis)ability, parental status, animal ownership (pets and for farming) and other dimensions of identity that may be of relevance to identify vulnerable populations were generally not considered and researched in these studies. This might point to a limitation in the discussion of access and literacy issues for people to be able to use social media during disasters; it certainly points to a limitation in research on vulnerable populations and their social media use during crises.

Regarding Twitter, studies were mostly interested in the content of messages, including hashtags, re-tweeted material, sources of the message, and links. These features in turn were often discussed to gauge the credibility and verifiability of social media content, including trust in different types of sources (e.g. government, user-generated or news media). Most studies analyzed natural disasters such as earthquakes, typhoons/hurricanes, fires and floods or infectious disease outbreaks that happen rapidly without or little warning. This may be a reason why most studies analyzed social media use during preparation and containment phases; fewer studies analyzed social use during the recovery phase. It appears that the containment phase, that is to catch social media users in action while the disaster is still ongoing, is considered the most desirable and important phase to study within the subfield of social media study within health-related risk communication. Most studies focused on community and/or affected populations' use of social media and how local governments, NGOs, health organizations and providers use social media to inform and interact with the public. The types of disasters most often studied were seismic events such as earthquakes and tsunamis; weather phenomena such as storms and floods; and emerging infectious diseases, particularly the H1N1 influenza.

Research Gaps in Reviewed Literature

Research gaps appeared regarding the phases of a disaster as few studies on the use of social media focused on the recovery and preparation phases. Geographically, the Southern hemisphere – except for Australia –, that is Africa, Central and South America, South-East Asia, Central Asia, and the Indian Subcontinent as well as Eastern Europe have remained vastly understudied. Within the regions and countries where social media were studied, the vast majority of studies did not analyze the demographics of the social media users beyond their geographic location, their status of being in the disaster zone or outside this zone, and their frequency and content of posting. Socio-economic demographics were not collected and/or analyzed to drill deeper into the implications of using social media to reach vulnerable populations. Who exactly is reached via social media campaigns and who needs to be reached with other means have remained an understudied areas; social media's impact as one part of a multi-modal communication strategy similarly remains understudied. While studies pointed toward information overload and confusion that can arise from social media use during crises it remains little understood how people can effectively balance online and offline information seeking. Few studies used comparative approaches between different countries or regions.

Limitations of the Present Review

The present review has two main limitations. First, the other UN languages articles and reports were not fully translated into English, which may have led to some information to be missed. Second, coding, data extraction and findings synthesis were done only by one person, preventing a calculation of inter-coder reliability as a check for consistency of these data.

Conclusions

Social media are here to stay as another modality of risk and health communication to reach at-risk populations in preparation of and during the different stages of crises, including environmental/natural disasters. Scholars from a range of disciplines have taken up the study of social media in health-related

risk communication providing a range of evidence that social media need to be used to monitor and speak *with*, and not only *to*, the public to promote health measures together, based on credible information. That is, it is crucial that all stakeholders, including the public can participate and interact in environmental decision-making regarding disasters; social media are one mode to create and sustain a two-way conversation between different stakeholders, including potentially vulnerable population. Yet, studies on social media used during health-related disaster communication have thus far only drawn on populations that were privileged enough to have access and literacy to handle social media as a channel of communication. Only a few studies used inquiry into the use of social media to also find out who is not reachable this way to then make the effort to find ways to communicate with non-social media users. One of the most valuable future research goals in this direction would be more fine-grained analyses on who these social media users are in a particular region or country to better understand which (vulnerable) population may not be able to be reached this way but need other forms of communication to prepare for and survive disasters.

Second, social media are still tools that have not become routine practices in many governmental agencies regarding public health in the countries studied. Obstacles still include the reluctance to learn new ways to communicate, the lack of additional staff to handle the increase of information exchange needs via social media, and missing universal guidelines on best practices of social media in daily operations of public health officials and especially during public health crises events. These obstacles need to be overcome to integrate social media into common strategies of health-related risk communication without overemphasizing their use to not neglect those who cannot benefit from their use.

Third, big data analysis of large amounts of posts from social media have become an increasing trend in social media studies within health-related disaster communication. The most

valuable studies combine such data collection with approaches that include interviews, focus groups, and/or discussions with the different stakeholders during an emergency event. Otherwise, a de-humanization of content may risk losing insights into the experiences of disaster-affected populations beyond short snippets of texts and hastily shot images. As studies pointed toward the struggle of information overload, confusion, and exhaustion of handling social media, so must researchers in health-related risk communication balance their fascination with big data dumps and computer-assisted quantitative content analyses of these with continued collection of the holistic experiences of affected audiences to triangulate what Twitter, Facebook, and the next most popular platforms can tell us.

Endnotes

[1] A public health emergency event, such as an emergent infectious disease, earthquake, wildfire or flood, is usually characterized as having four major phases: Preparation; onset; containment, which includes the peak of the emergency event; and recovery. Another characterization, also with four phases, but conceptualized slightly differently, includes: Prevention; readiness/preparedness; response; and recovery. A fifth phase, evaluation, generally follows the recovery phase although it commonly occurs along with the earlier four phases as well.

[2] No relevant studies were found in Russian.

[3] The quality of the reviews was rated using a modified Assessment of Multiple Systematic Reviews (AMSTAR) quality appraisal checklist (Shea et al., 2007). AMSTAR consists of 11 elements that address the reviews' design (i.e., a priori), data extraction, details of the literature search, inclusion of grey literature, characteristics, methods, and scientific quality of included studies, publication bias, and acknowledgement of conflict of interest(s). Each area in AMSTAR is assessed using "yes," "no", "can't answer," or "not applicable." Studies received a final rating of "high" (no significant flaws),

"moderate" (minor flaws impacting credibility/validity), or "low" (some flaws likely to impact credibility/validity). Two coders did the coding independently with high agreement. The final quality assessment was judged after the coders resolved any differences. Reviews that were rated as low quality were "unpacked" for their data-based primary studies, which were added to the literature for the present review. Existing reviews that were appraised as high or moderate quality were read for key relevant findings.

[4] Native readers of Arabic, Chinese, French, Russian, and Spanish who were fluent in English conducted the search. The following information sources were searched. For Arabic, the information sources were: Al-Manhal, Dar-Al-Manduma, Google Scholar, general Google search, university library, and website of the World Health Organization. For Chinese, the information sources were: CNKI (China National Knowledge Infrastructure), Wanfang Patent Database, Google Scholar, general Google search, the university databases and website of the World Health Organization. For French, the information sources were: Archive ouverte UNIGE, Cairn.info, Google Scholar, general Google search, Government of Canada publications, HAL archives ourvertes, JSTOR, La Houille Blanc, Persee.fr, Revues.org, the university databases and website of the World Health Organization. For Russian, the information sources were: Cyberleninka.ru, Google Scholar, general Google search, Mgimo.ru/library/ehd, Msu.ru/info/struct/dep/library, Nbmgu.ru, the university databases and website of the World Health Organization. For Spanish, the information sources were: CONACYT, Cuiden, Elsevier, Google Scholar, general Google search, Public Health institute Mexico, the university databases and website of the World Health Organization.

[5] A modified version of the AACODS tool was used for quality appraisal of the media reports (Shea et al., 2007). Of the eight reports, the quality of one report was high, no report was moderate, five reports was low, and two reports was very low.

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Tables and Figures

Table 1: Existing Reviews Ratings and Relevant Findings

Review Citation and Review Purpose	Modified AMSTAR Quality Rating	Relevancy	Key Relevant Findings
Bean (2015) Mobile public warning messages. What is the state of research regarding terse vs. longer messages and public warning messages via wireless emergency alerts?	Low	---	---
Bradley (2014) Effectiveness of disaster risk communication. What is the state of research regarding interventions during different disaster phases?	High	Indirect	Little evidence on what works in risk communication in response and recovery phases exists as many complex interventions in response to disasters used many methods of communication at once but did not detail how each one was used. High quality trials for health-related disaster communication are absent; randomized trials in risk communication may have become more difficult to conduct in recent years because of likelier information sharing between intervention and control groups. Additionally, differences between the studies did not allow concluding that one method of risk communication is superior to others. Two-way dialogue between the public and professionals happened during preparedness interventions, but was not common during response phase, which mostly followed a unidirectional model of risk communication. Social media offer opportunities for risk communication research to facilitate evaluation of risk communication strategies as people are reachable on mobile devices.
Crowe (2010) Social media manifesto. What is the impact of	Low	---	---

social media on emergency management?			
Gesser-Edelsburg (2015) Emerging infectious disease communication during H1N1. What were risk communication channels, content and strategies used?	Moderate	Indirect	Studies in risk communication have made a turn from predominantly using quantitative methods before 2013 to using more often qualitative methods. Research shows that studies should use triangulation based on input from different stakeholders via interviews and discussions to understand questions and needs of all in the population. Studies conclude that health agencies need to collaborate with media to ensure evidence-based coverage and make key information available. Further studies should address the potential of social media for dialogue with the public.
Kraut (2013) Public response to alerts and warnings using social media. What is the use of and public response to social media for alerts; what are past, current and future research efforts?	Low	---	---
Landwehr (2014) Social media in disaster relief. What are usage patterns, data-mining tools, and current research directions?	Low	---	---
Lin (2014) H1N1 epidemic. What have we learned about communication inequalities during the H1N1 pandemic?	Moderate	Indirect	Trust in public officials, knowing the source of information, worry and knowledge about a disease, routine media exposure and information-seeking behaviors make it likelier that people adopt recommended infection prevention practices. Including these measures into interventions and understanding the socio-economic factors of a population help tailor public health communication messages and channels to the target audience. When addressed in interventions, it can close the gap of communication inequality and increase the effectiveness of the preparedness and

			response to influenza pandemics. It is critical to work with community leaders, physicians, communication specialists and mass media to improve the reach, accuracy, and timeliness of public health messages.

Table 2: Search Terms for Literature Search

Disaster*	Trust	Social media
Disaster plan*	Public health	New media
Communication	Messages	Twitter
Risk communication	Warning messages or warning	Facebook
Emergenc*	Media	(Sina) Weibo
Hazard*	Health campaign	tweet
Risk*	News	SMS
Threat*	Journalism	Text message
Emergency preparedness	Public participation	mobile
Emergency management	Community participation	Cell phone
Cris!s (or other truncation used in a specific database:?,#)	Timing	
Disaster preparedness	Safety	
Hazard communication	Motivat*	
Emergency communication	Governmen* and governance	
Catastrophe communication	Public notice or information	
Health communication	Information dissemination	

Table 3: Study Selection Across UN-Languages

Language	Total number of titles and abstracts scanned:	Total number of full-texts quickly scanned	Total number of full-texts downloaded:	Total number of full-texts read and coded for study characteristics:	Total number of full-texts selected for data extraction (only data-based primary studies):
English	369	163	94	86	69
Arabic	6720	NA	57	3	3
Chinese	800	NA	125	6	2
French	196	NA	78	6	4
Russian	870	NA	639	2	0
Spanish	No accurate data	NA	No accurate data	22	1

Table 4: Characteristics of Studies-English Language

Key

- Total English language data-based primary studies (includes grey literature): 69

- Grey literature studies: 6

- Some categories are not mutually exclusive and so the frequencies will not sum to the total of 69.

- Method: Quantitative-Comparison Groups (QN-CG); Quantitative-Descriptive Survey (QN-DS); Qualitative (QL); Mixed-Method/Case Study (MM,CS)

Relevancy	*Method General*	*Country Focus*	*Disaster/ Emergency Type*	*Disaster/ Emergency Phase*	*At-risk Groups*
Direct: 66 Indirect: 3 Partial: 0 Unclear: 0	Quantitative-CS: 2 Quantitative-DS: 29 Qualitative: 15 Mixed Methods: 6 Case Study: 17	General/Global: 1 Australia: 4 Belgium: 1 China: 4 Chile: 1 Europe/ EU General: 6 India: 1 Japan: 8 Jordan: 1 Haiti: 2 Netherlands: 1 New Zealand: 3 Nigeria: 1 Not specified: 1 Philippines: 3 Thailand: 1 Taiwan: 1 United Kingdom: 3 United States: 32	General/ Multiple: 8 Drought: 1 Earthquake: 18 Flood: 8 Food: 2 Hurricane/ Cyclone/ Typhoon: 12 Infectious Disease: 9 Mass panic: 1 Radiological: 3 Refugee camp crisis: 1 School shooting: 1 Terrorism: 2 Tsunami: 2 Storm/	All Phases: 5 Preparation: 5 Onset: 0 Containment: 29 Recovery: 4 Preparation, Onset & Recovery: 1 Preparation & Onset: 3 Preparation & Containment: 2 Onset, Containment & Recovery: 4 Onset & containment: 11 Containment & Recovery: 4	Yes: 4 (refugees in refugee camp; Latina/os; very low/ low income people; Nigerian low income people)

			Tornado: 3 Wildfire/ Grassfire: 4 Not specified: 2		

Table 5: *Characteristics of Studies-Other UN Languages*

Key

- Total other UN languages data-based primary studies: 10

- Some categories are not mutually exclusive and so the frequencies will not sum to the total of

  10.

- Method: Quantitative-Comparison Groups (QN-CG); Quantitative-Descriptive Survey (QN-

  DS); Qualitative

  (QL); Mixed-Method/Case Study (MM, CS)

Relevancy	*Method General*	*Country Focus*	*Disaster/ Emergency Type*	*Disaster/ Emergency Phase*	*At-risk Groups*
Directly Relevant: 7 Indirectly Relevant: 3	Quantitative-CS: 0 Quantitative-DS: 3 Qualitative: 2 Mixed Methods: 2 Case Study: 3	Canada: 2 China: 2 France: 1 Poland/The Czech Republic/Germany/United States/France: 1 Saudi Arabia: 1 Spain: 1 United Arab Emirates: 1 Yemen: 1	General: 3 Avalanches: 1 Nuclear: 1 Flood: 1 Infectious Disease: 3 Terrorism: 1 Volcano: 1	All Phases: 1 Preparation: 1 Onset: 0 Containment: 1 Recovery: 0 Evaluation: 2 Preparation, Onset & Evaluation: 1 Preparation, Recovery, & Evaluation: 1 Onset & Containment: 3	Yes: 3 (Pregnant women, adolescents, children, older adults, people with compromised immune systems/chronic diseases, immigrants, people with disabilities)

Figure 1: Process Design of Synthesis of Evidence from Data-based Primary Studies