

Research Paper

A Systematic Review of the Use of Social Media for Food Safety Risk Communication

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ABSTRACT

This article covers the current published literature related to the use of social media in food safety and infectious disease communication. The aim was to analyze literature recommendations and draw conclusions about how best to utilize social media for food safety risk communication going forward. A systematic literature review was conducted, and 24 articles were included for analysis. The inclusion criteria were (i) original peer-reviewed articles and (ii) primary focus on communication through social media about food safety and/or infectious diseases. Studies were coded for themes about social media applications, benefits, limitations, and best practices. Trust and personal beliefs were important drivers of social media use. The wide reach, immediacy, and information gathering capacities of social media were frequently cited benefits. Suggestions for social media best practices were inconsistent among studies, and study designs were highly variable. More evidence-based suggestions are needed to better establish guidelines for social media use in food safety and infectious disease risk communication. The information gleaned from this review can be used to create effective messages for shaping food safety behaviors.

Key words: Foodborne illness; Food safety; Infectious disease; Social media

Every year in the United States an estimated 48 million people are sickened by foodborne illness, 125,000 are hospitalized, and 3,000 die. The estimated cost of these illnesses in the United States is \$7.7 billion annually (52). Globally, foodborne agents cause more than an estimated 600 million illnesses and 420,000 deaths, approximately 40% of which affect children younger than 5 years (15). The burden of foodborne illness cannot be addressed by scientific advancements alone—behavior change at the individual level plays a crucial role, because unsafe practices by individual food handlers significantly contribute to foodborne illness (31, 44, 46, 47, 57, 66). Previous communication campaigns across numerous scientific disciplines historically have relied on a deficit approach—assuming that consumers are merely lacking “correct” information, and if consumers could be provided this information, they would make “correct” decisions. It has widely been accepted that this method is not effective (7, 23, 59). Current literature indicates that risk communication is a two-way process and that a participatory model of communication is necessary (1, 20, 23).

One method for two-way engagement with individuals is social media, which allow users to interact with message producers and each other (65). The number of people using

social media sites in the United States continues to grow—73% of online American adults use social networks, and a majority of Internet users seek out health information online (13, 16). These findings indicate a potential means for communication and changing behavior; an increasing number of people are expected to turn to the Internet for food safety information (26). Previous work has demonstrated that social media can be used to communicate public health messages, but this approach is relatively unstudied especially in relation to food safety behavior (5, 8). Practical, research-based advice for utilizing social media in food safety and infectious disease communication is also needed to guide professionals.

To most effectively utilize social media as a risk communication tool for food safety, it is important to understand current research on how social media are currently used, especially for food safety risk communication. This information and identification of currently recommended best practices will allow for better utilization of social media. However, the dearth of food safety–specific risk communication research necessitates the use of research from other areas of study to inform communication practices. Research on communication related to non–sexually transmitted infectious diseases, for example influenza, can be applicable to food safety topics. The principles of risk communication span disciplines, and the inclusion of research on non–sexually transmitted infectious diseases strengthens the conclusions that can be drawn and applied to food safety risk communication (19, 25, 48).

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Many current food safety communication studies do not provide empirical evidence of the effect of various approaches, and even fewer focus on social media's role in food safety communication (14, 34, 55). Previous literature reviews related to this topic are either not food safety specific (34) or not social media focused (55) or focus broadly on use of the Internet in health communications (43, 64).

The objective of this study was to collate and analyze the body of knowledge on current applications, benefits, limitations, and best practices for social media use in communication about food safety and non-sexually transmitted infectious disease. The following questions were addressed:

Research question 1. What is the current state of literature examining social media use for food safety and infectious disease communication, including study types, focus, and main conclusions?

Research question 2. What conclusions are provided by these studies concerning how social media are used in food safety and infectious disease risk communication, and what recommendations for using social media can be distilled from this research?

MATERIALS AND METHODS

Article selection. A systematic literature search was conducted to investigate findings of studies concerning use of social media for food safety and infectious disease risk communication; this approach allowed rigorous review of research and aggregation of results. Information on non-sexually transmitted infectious diseases was included because the communication techniques used could be applicable to foodborne illness and research on infectious disease communication can provide relevant conclusions for food safety-related communication. There is precedence for grouping these two topics together; previous literature has focused on broad health risk communication, including recommendations for both foodborne and other infectious diseases (19, 48). Both food safety and infectious disease control measures rely heavily on managing risks at the individual level and on shaping individual perceptions (38, 58). Because of these similarities, methods for managing infectious disease and food safety risks are analogous. The inclusion of infectious disease communication literature also resulted in a more robust sample size. This review was limited to articles published in English between 2010 and 2015; in a recent review of social media for health communication, the majority of articles were published in 2010 and later (35).

Databases searched were Academic Search Complete, Web of Science, and PubMed. Search terms were ("social media" OR Facebook OR Twitter OR blog OR microblog OR "web 2.0") AND ("food safety" OR "food-borne" OR foodborne OR foodbourne OR "food-bourne" OR "food handling" OR "food preparation" OR "food poisoning" OR "food hygiene" OR "safe food" OR "infectious disease" OR "flu" OR "H1N1") NOT (surveillance OR monitoring OR tracking). Because social media use in food safety is still a growing area, a supplementary search was conducted on Google Scholar using the search terms "social media" AND ("food safety" OR "infectious disease")—"surveillance." These terms were purposely narrower, because Google Scholar yields a much wider base of articles and cannot handle complex Boolean operators; however, research indicates that

Google Scholar can serve as a complement to more traditional database searches (32). This search yielded 8,780 citations. Searches from the databases were first screened for title or abstract relevance, and then relevant full-text articles were screened for inclusion in the study (Fig. 1). The bibliographies of relevant reviews and meta-analyses (28, 35, 43, 50, 55, 64) were examined for pertinent studies, yielding four additional articles. One of us (K.N.O.) conducted and screened the searches.

Article inclusion criteria were (i) primary focus on communication through social media about food safety and/or infectious diseases, (ii) original peer-reviewed research studies, and (iii) all study designs. Exclusion criteria were (i) studies not in English, (ii) literature reviews, review papers, dissertations, theses, reports, conference papers or abstracts, letters to the editor, and feature articles, (iii) studies on data mining or disease tracking or surveillance, and (iv) studies with a primary marketing or advertising focus. This yielded 24 articles for analysis; a summary of included studies is provided in Table 1.

Study design and article content. Articles were coded through an iterative approach using thematic analysis, and a list of themes was established before final coding. The thematic analysis used in this study was a semantic, theoretical approach. A semantic approach focuses on what is explicitly stated and does not involve interpretation of latent meaning behind statements, whereas a theoretical approach is grounded in the research question (6). The use of the theoretical approach drove the researchers to identify themes related to conclusions drawn by authors about how social media were used and the recommendations provided in each article.

One coder began by coding results and conclusions made by the authors of each study utilizing NVivo 11 Qualitative Data Analysis Software (QSR International, Melbourne, New South Wales, Australia). After coding a quarter of the articles, codes were reviewed by a second coder for relevance and clarity. These initial codes were analyzed for patterns and ultimately aggregated into four final coding themes: benefits, challenges, applications, and suggestions (Table 2). An article was coded for a theme when the authors reported it in their results or mentioned it in their discussion. Coded themes did not have to be explicitly measured by authors because the intent was to capture research-based recommendations about how social media are used. The general purpose of the social media activity in each study was classified in one of three categories: (i) content, where a study was focused on the themes, purpose, or content of a body of social media (i.e., tweets related to a specific subject such as the H1N1 outbreak), (ii) intervention, where a study was focused on an intervention or campaign delivered through social media with the intent to obtain a desired behavior change, and (iii) opinions and motivation, which were studies focused on why certain groups used social media or on a group's opinions of social media.

Quality appraisal. The methodological quality of each study was assessed using a modified form of the mixed methods appraisal tool (MMAT) (42). This tool is a validated instrument used to assess the methodological quality of qualitative, quantitative, and mixed methods studies, making it an ideal choice for this review (39). The tool consists of three sets of questions: qualitative, quantitative, and mixed methods. For purely quantitative and qualitative studies, only those sections are utilized, whereas all three sections are used for mixed methods studies. Quantitative standards are further subdivided into three categories of participant-based studies: randomized control trials, nonrandomized studies, and descriptive studies. The MMAT tool was adapted to

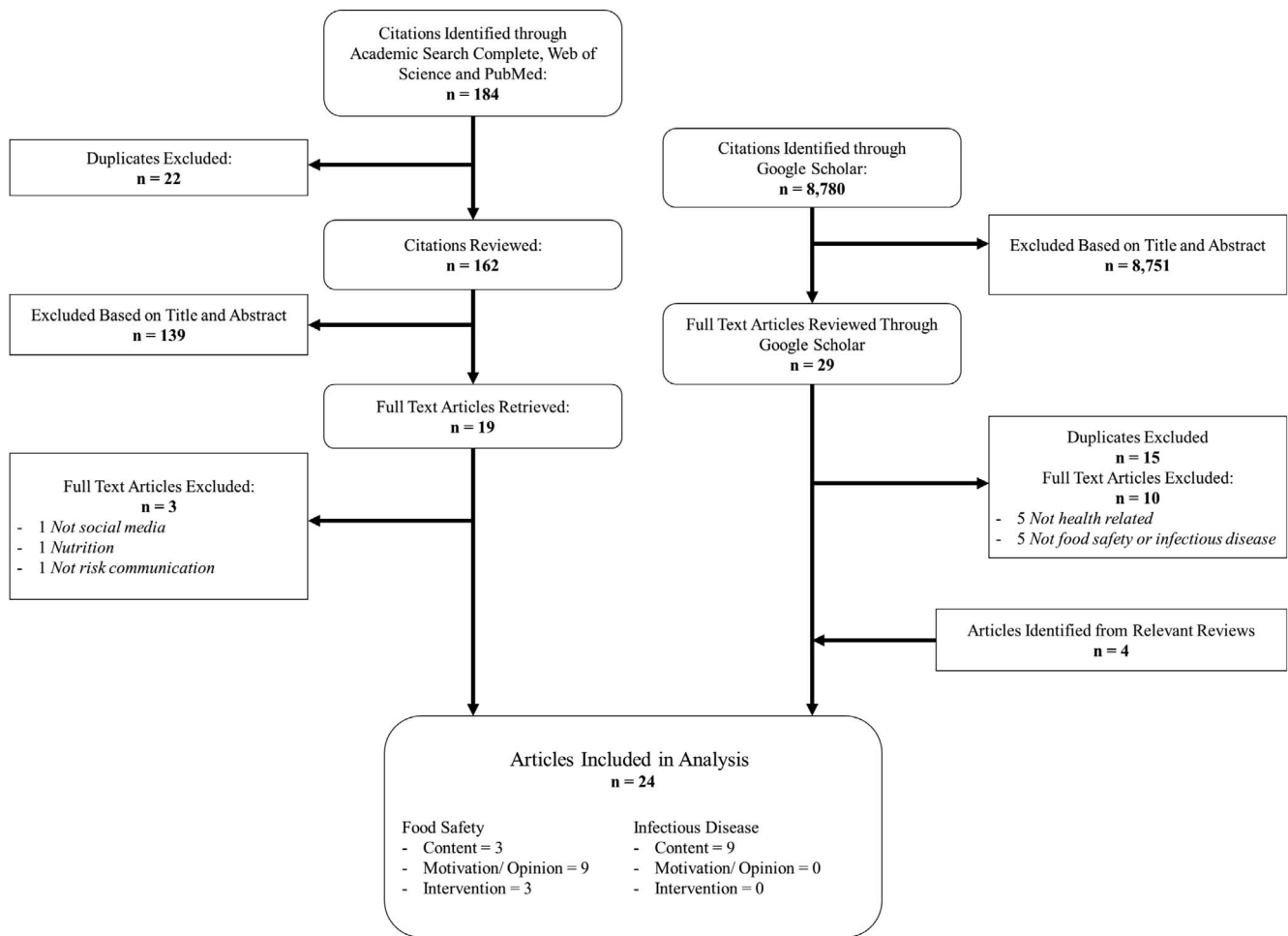


FIGURE 1. Flow chart for systematic literature review of studies using social media for food safety and infectious disease risk communication.

accommodate the large number of quantitative content analyses in this review. A content analysis category was added to the quantitative component, using seven steps of content analyses outlined by Hsieh and Shannon (24) to develop quality criteria. These added questions focused on how sources were obtained, the development of coding themes, description of the coding method, and the methods employed to ensure trustworthy coding.

The fully amended MMAT criteria used in this study can be found in Table 3. For the quantitative and qualitative sections, each article received a score of 0 to 4, whereas mixed methods scores ranged from 0 to 3. The final assigned score was the lowest of the three categories. However, in previous literature researchers have cautioned against reporting scores and instead have suggested using the tool to provide an overall picture of methodological quality and to identify main areas of weakness (42).

RESULTS

General characteristics of studies included for review. To address research question 1, characteristics of the identified articles were compared. Of the 24 articles, 16 dealt with food safety communications; the other 8 articles dealt with communications related to infectious diseases. Of those focused on infectious diseases, seven dealt specifically with a strain of influenza and one dealt with a range of infectious diseases. The studies were conducted in various

geographic locations: eight in Europe, seven in the United States, four in Asia, one in both the United States and Asia, and four that focused on all English language social media content.

Eleven articles sampled online content (i.e., tweets and blogs), 11 sampled participants via a survey or interview, and 2 focused on single case studies. For articles on online content, sample size ranged from 224 to over 1,000,000 artifacts, and participant numbers ranged from 12 to 1,400. Qualitative methods were used in 3 research studies, quantitative methods were used in 5, and a mixed methods approach was used in the other 16. A range of social medium types were represented, with most studies focusing on all or general social media (seven articles). Six of the articles were focused solely on microblog content (including Twitter), four were focused solely on Facebook, two were focused on blog content, one was focused on forums, one was focused on a phone app, and one was focused on the use of bookmarking sites. In one study, both Facebook and Twitter were examined; in another, Facebook, Twitter, and blogs were examined.

The aims of the included studies differed, which was intentional in our study design because we wanted to capture research on social media use across the literature. The design

TABLE 1. Characteristics and key findings of studies included in this review of social media use in food safety and infectious disease risk communication

Author(s)	Topic, purpose ^a	Location	Social media type	Sample	Data collection	Key findings
Albrecht et al. 2012 (3)	FS, intervention	United States	Phone app	NA ^b	Case study	Use of mobile smartphone technology can offer consumers immediate access to food safety information.
Chew and Eysenbach 2010 (9)	ID, content	English language content	Twitter	Online content (n = 5,395)	Content analysis	H1N1 tweets were primarily used to disseminate information but also included opinions and experiences. Tweets can be used for real-time information gathering to allow timely response to public concerns.
Cortley et al. 2010 (10)	ID, content	English language content	Blogs	Online content (n = 158,497,700)	Text mining	Text and structural data mining can be used to identify online "flu" topic health information communities for targeting health campaigns.
Ding and Zhang 2010 (12)	ID, content	United States and China	All	Online content (n = 540)	Content analysis	During the H1N1 pandemic, governments used social media in one-way or limited two-way transmission, but the public circumvented institutional response through participatory communications.
Freberg 2012 (17)	FS, motivation and opinion	United States	All	Public (n = 400)	Survey	Stronger intent to comply with organizational food recall messages compared with user-generated content was noted, but no effect was observed with message reliability. Strong age cohort effects were seen in response to message source.
Freberg et al. 2013 (18)	ID, content	English language content	Bookmark	Online content (n = 244)	Content analysis	From social bookmarks related to H1N1, the Centers for Disease Control and Prevention was the most popular reference, individuals were strongly present, blogs were the most popular type of documents, and Twitter was the most popular source being referenced.
Hale et al. 2014 (22)	ID, content	United States	Facebook	Online content (n = 953)	Content analysis	Health-related Facebook content is frequently irrelevant, and stigma attached to certain diseases may inhibit how users interact on social media.
James et al. 2013 (27)	FS, intervention	United States	Facebook, Twitter	Intervention users (n = 600)	Survey	Use of interventions delivered through both traditional and social media increased awareness and intention to change health behaviors related to handling of leftovers.
Kuttschreuter et al. 2014 (29)	FS, motivation and opinion	Europe	All	Public (n = 1,264)	Survey	Four consumer types were identified based on inclination to seek information about food-related risks; individuals most inclined to use social media considered it more important to be well informed, were more motivated to find information, and had a high perceived risk of a food incident.

TABLE 1. Continued

Author(s)	Topic, purpose ^a	Location	Social media type	Sample	Data collection	Key findings
Mayer and Harrison 2012 (33)	FS, intervention	United States	Facebook	Intervention users (<i>n</i> = 710)	Survey	Participation in the “Safe Eats” Facebook intervention leads to improvements in food safety attitudes, practices, and knowledge. The combination of lecture and Facebook resulted in higher knowledge scores than did use of Facebook alone, and participants who spent more time on the Facebook page had greater improvements in food safety attitudes and practices.
Mou 2014 (36)	FS, content	China	Microblog	Online content (<i>n</i> = 6,186)	Content analysis	Type of social media user (i.e., public versus news) impacts what content that a user posts to microblogs. Compared with other users, the general public seems to use microblogging to express opinions, particularly negative ones, during a food safety crisis.
Mou and Lin 2014 (37)	FS, motivation and opinion	China	Microblog (Weibo)	Public (<i>n</i> = 1,400)	Survey	Emotional response to food safety incidents was a stronger predictor of risk perception and preventative action than was awareness of food safety incidents and knowledge.
Panagiotopoulos et al. 2013 (40)	FS, motivation and opinion	United Kingdom	All	NA	Case study	Governments using social media should manage the public’s expectations for responsiveness, be aware of their audience, use proactive monitoring, and utilize social media for promotion of behavior change.
Peng et al. 2015 (41)	FS, content	China	Microblog	Trend in online content	Content analysis	Individual “opinion leaders” play a large role in the dissemination of food safety information on social media and can greatly alter public opinion. Social media information about food safety can affect consumer purchasing behavior.
Prades et al. 2014 (45)	FS, motivation and opinion	Spain	Blogs	Public (<i>n</i> = 12)	Interview	Social media are reshaping online roles related to food content, and both professionals and the public have roles in online food communication. In social media food-related content, there is a need for more official sources, information overload is a big drawback, and creativity is paramount.
Rutsaert et al. 2013 (50)	FS, motivation and opinion	Belgium	All	Public (<i>n</i> = 497)	Survey	Social media can play a role in food risk-benefit communication. Identified strengths include speed, accessibility, and interaction; weaknesses include lack of filter, low trust, information overload, and preference for traditional media.

TABLE 1. Continued

Author(s)	Topic, purpose ^a	Location	Social media type	Sample	Data collection	Key findings
Rutsaert et al. 2014 (51)	FS, motivation and opinion	Europe	All	Public (n = 71)	Interview	Groups with higher interest in social media as an information source were more familiar with and appreciative of the opportunities of social media. Wikipedia was perceived by all groups as the most useful and credible online source. Speed and accessibility were the main motives for using social media, and lack of trustworthiness was the main barrier.
Seo et al. 2015 (53)	FS, motivation and opinion	United States	Facebook comments	Public (n = 252)	Survey	Credibility of the source and the content of comments on a Facebook post have a significant impact on consumer perception of the post. Negative comments induce negative responses regardless of whether the source is credible.
Shan et al. 2014 (54)	FS, content	Ireland	Blogs, forums, Twitter	Online content (n = 316)	Content analysis	Social media posts related to the Irish dioxin crisis responded to and diminished faster than did the response of traditional media, and news messages were used as the primary sources. No significant difference in negative tone was found between traditional and social media.
Signorini et al. 2011 (55)	ID, content	United States	Twitter	Online content (n = 1,000,000)	Text mining	Twitter can be used as a measure of public interest or concern about health-related events in order to target messages.
Tirkkonen and Vilma 2011 (60)	ID, content	Finland	Forum	Online content (n = 2,264)	Content analysis	Trust of authorities may not necessarily extend to the online environment, particularly when interventions are carried out too late and with too little resources. More proactive authority communication is needed to establish a dialogue with citizens before a crisis.
Van Velsen et al. 2012 (61)	FS, content	Germany	All	Public (n = 18)	Content analysis	Survey participants believed that during an infectious disease outbreak social media was not a suitable or reliable source for communicating information, whereas Wikis did fill several information needs. Source credibility was cited as an important aspect of useful information.
Vos and Buckner 2015 (63)	ID, content	English language content	Twitter	Online content (n = 25,598)	Content analysis	A large proportion of Twitter messages related to H7N9 (bird flu) contained information that was understandable, but few messages contained information that would help individuals respond.
Wu 2015 (67)	FS, motivation and opinion	Taiwan	Facebook	Public (n = 652)	Survey	High risk perception, social trust, support and positive emotions are key determinants of Facebook use for finding food-safety information.

^a FS, food safety; ID, infectious disease^b NA, not applicable; studies without sample size were single case studies.

TABLE 2. Main coding themes used in the evaluation of studies in which social media were used for food safety and infectious disease risk communication

Category	Description	Examples
Benefits	Article addresses the benefits of using social media, including any measured positive impacts	Ability to conveniently update content (3); data suggest that the campaign impacted food safety behaviors (27)
Challenges	Article addresses the drawbacks of using social media, including challenges in providing content, negative outcomes, and barriers to access and use by the public	Negative image of social media (49); most frequently identified barrier to accessing food safety information through social media was a lack of time (34)
Applications	Article covers a topic related to the current usage of social media, including most common content, nature of engagement, and variables that impact how the public uses social media	90.2% of tweets provided references to information in the tweet (10); social media used to establish a virtual community (19); perceived severity and intense news coverage likely dictate tweet posting activity (10)
Suggestions	Article provides suggestions for the best ways to utilize social media or for future research on social media	Campaigns should utilize an appropriate mix of traditional media and social media (27); social media is in its infancy, and more research is needed to evaluate its educational use (27)

of the majority of articles was content analysis (12 articles), which involved examining content already present in social media for trends. In nine articles, the analysis focused on opinions and motivations that drive users to use certain types of social media or respond in a certain way to social media messages. Only three studies were conducted to look at specific interventions, and of those only two included a controlled study of intervention impacts with an experimental design in which one group received the intervention and the other did not (27, 33).

To address research question 2, the information obtained from the results and discussion sections of each study were collated into the main themes of benefits, challenges, applications, and recommendations. Benefits were defined as items that article authors highlighted as an advantage that social media provides in communication. Challenges were characteristics of social media that authors saw as drawbacks or issues that needed to be addressed when using social media. Applications included both discussions of the main content of social media and factors that authors indicated were important for widespread dissemination of messages. Suggestions were those provided by authors for better utilization of social media.

Quality appraisal of studies. Of the 24 studies reviewed here, 3 were purely qualitative, 3 were purely quantitative, and 18 were mixed methods. For the articles that contained a quantitative component, 2 were randomized control trials, 1 was nonrandomized, 7 were descriptive, and 11 were content analyses. Nine of the analyzed articles received a score of ≤ 2 on at least one component of the MMAT. Eight of these articles received the lowest score for the quantitative section.

For the quantitative criteria, six of the seven descriptive studies did not provide evidence that their sample was representative of their target population (Table 3, question 4.2) nor did they have an acceptable response rate (Table 3, question 4.4). Four of these articles reported no response rate at all. Of the 11 content analyses, 3 did not detail a systematic and logical coding process (Table 3, question

5.3) and 4 did not provide methods for determining the trustworthiness of the coding (Table 3, question 5.4).

The most commonly missing qualitative methodological quality criteria were appropriate consideration given to how findings relate to the data collection setting (Table 3, question 1.3) and appropriate consideration given to how findings relate to researchers' influence (Table 3, question 1.4); 33 and 19% of articles did not meet these criteria, respectively. This issue most commonly manifested as authors not appropriately discussing how using social media-based data sources could skew results and not addressing potential ascertainment bias. All of the mixed methods studies analyzed met all three methodological quality criteria for that section.

Benefits. A majority (83%) of the 24 analyzed articles included information about the benefits of social media for food or infectious disease-related communication (Table 4). Six articles included the ways in which social media can impact public knowledge and behaviors. Three provided data on the impact of social media or a social media-based intervention on (i) increased self-reported food safety behaviors (27), (ii) increased food safety knowledge and more appropriate attitudes (33), and (iii) increased food safety preventive actions (37). The other articles cited the ability of social media to shape public opinion (9), their role in influencing health behaviors (60), and their utility for providing information to help the public understand health concerns (63).

In two studies, controlled trials were conducted to determine the impact of food safety interventions delivered through social media. In one study, a campaign using both social and traditional media aimed at impacting food leftover practices of families with young children was evaluated (27). In this study, the intervention resulted in higher scores for knowledge of proper handling and self-reported proper handling. The second study concerned the impacts of a lecture-based course in conjunction with a Facebook-based intervention on college students' knowledge, attitudes, and self-reported practices (33). Participation in a Facebook-driven intervention alone led to significant improvements in

TABLE 3. Amended mixed methods appraisal tool used to evaluate methodological quality of studies included in a review of social media use in food safety and infectious disease risk communication

Study component	Methodological quality criteria
Screening questions	<ol style="list-style-type: none"> 1. Are there clear qualitative and quantitative research questions (or objectives) or a clear mixed methods question (or objective)? 2. Do the collected data address the research question (objective), e.g., consider whether the follow-up period is long enough for the outcome to occur (for longitudinal studies or study components)?
1. Qualitative	<ol style="list-style-type: none"> 1.1. Are the sources of qualitative data (archives, documents, informants, observations) relevant to address the research question (objective)? 1.2. Is the process for analyzing qualitative data relevant to address the research question (objective)? 1.3. Is appropriate consideration given to how findings relate to the context, e.g., the setting, in which the data were collected? 1.4. Is appropriate consideration given to how findings relate to researchers' influence, e.g., through their interactions with participants?
2. Quantitative randomized control trial	<ol style="list-style-type: none"> 2.1. Is there a clear description of the randomization (or an appropriate sequence generation)? 2.2. Is there a clear description of the allocation concealment (or blinding when applicable)? 2.3. Are there complete outcome data (80% or above)? 2.4. Is there a low withdrawal or drop-out rate (below 20%)?
3. Quantitative nonrandomized	<ol style="list-style-type: none"> 3.1. Are participants (organizations) recruited in a way that minimizes selection bias? 3.2. Are measurements appropriate (clear origin, validity known, or standard instrument; absence of contamination between groups when appropriate) regarding the exposure or intervention and outcomes? 3.3. In the groups being compared (exposed vs nonexposed, with intervention vs without, cases vs controls), are the participants comparable, or do researchers take into account (control for) the difference between these groups? 3.4. Are there complete outcome data (80% or above) and, when applicable, an acceptable response rate (60% or above) or an acceptable follow-up rate for cohort studies (depending on the duration of follow-up)?
4. Quantitative descriptive	<ol style="list-style-type: none"> 4.1. Is the sampling strategy relevant to address the quantitative research question (quantitative aspect of the mixed methods question)? 4.2. Is the sample representative of the population under study? 4.3. Are measurements appropriate (clear origin, validity known, or standard instrument)? 4.4. Is there an acceptable response rate (60% or above)?
5. Quantitative content analysis	<ol style="list-style-type: none"> 5.1. Is the sample selected appropriate for the quantitative research question? 5.2. Are the coding categories and a rationale for their development provided? 5.3. Is the coding process described systematic and logical, and if applicable, are coding training methods included? 5.4. Is a method for determining trustworthiness of coding utilized?
6. Mixed methods	<ol style="list-style-type: none"> 6.1. Is the mixed methods research design relevant to address the qualitative and quantitative research questions (or objectives) or the qualitative and quantitative aspects of the mixed methods question (or objective)? 6.2. Is the integration of qualitative and quantitative data (or results) relevant to address the research question (objective)? 6.3. Is appropriate consideration given to the limitations associated with this integration, e.g., the divergence of qualitative and quantitative data (or results) in a triangulation design?

food safety knowledge, attitudes, and perceptions. Knowledge improvements were even greater when the Facebook intervention was administered in conjunction with the lecture, and a longer time spent on the associated Facebook page led to more significant improvements in attitudes and practices.

Challenges. Fifty percent of the 24 articles mentioned challenges in using social media. Eight of these articles explicitly addressed barriers that prevent the use of social

media. Challenges found in these studies are summarized in Table 5.

Applications. All articles except one (3) included information about how social media are used or what factors impact their use by the public. In 12 studies, the content of social media posts was analyzed. In five of these studies, the most common content types on social media were informative resources (9); news updates, including spread of disease and government actions (12, 54, 63); and posts of

TABLE 4. *Benefits associated with social media use for risk reduction identified in literature examining social media use in food safety and infectious disease risk communication*

Benefit	Description	Reference(s)
Reach	Social media provide the ability to reach a diversity of people	9, 10, 12, 18, 27, 29, 33, 41, 45, 50, 51
Information gathering	Social media can be used to gather information and target specific populations	10, 17, 18, 27, 33, 40, 45, 51, 55
Immediate	Social media provide the ability to react immediately to situations and provide timely information	3, 9, 12, 27, 29, 50, 51, 54
Interaction	Social media provide opportunities to engage with the audience	51
Public opinions	Social media can allow users to access unbiased public opinions that can help improve communication efforts	10, 51
Cost	Social media use has a low cost and resource input	10

Wikipedia information (22). In one of the articles, content types were distinguished based on user profile information; the general public appeared to express opinions, particularly negative ones, more than did other social media users such as government institutions, food producers, media institutions, journalists, and food safety experts (36). In another article, the authors specifically pointed out the dearth of efficacious information found on Twitter (63). Personal experiences, opinions, and reactions were also relatively common in analyzed social media (9, 36, 54), as were links (9, 36, 54, 63). A conflict was observed between findings on misinformation: authors of a few articles maintained that misinformation is prevalent on social media (17, 36, 41, 63), whereas Chew and Eysenbach (9) found that only about 4.5% of tweets dealing with the 2009 influenza H1N1 outbreak actually contained misinformation ($n = 5,395$).

Twelve articles concerned utilizing the engagement capacity of social media, and the authors of six of these pointed out engagement as a unique or positive aspect of social media. One concept that came up frequently ($n = 7$) was individual influencers, i.e., people in the public who possess influence as risk communicators on social media. Although most studies focused on individuals as content creators, two indicated the potential for these individuals to

widely disseminate content created by health authorities (10, 50).

Factors impacting message engagement and reach.

Nine studies provided explanations for why users may be more engaged with food safety or infectious disease information on social media. Authors of one article suggested that the public may be growing more interested in food issues in general (45). Seven articles pointed to controversial issues and high-profile stories, such as a celebrity becoming ill (9, 10), as a contributing factor in increased sharing and engagement. Authors of two studies indicated that more social media activity was likely to occur during crisis or outbreak situations (40), possibly because of media preference for those stories (45).

Authors of 23 of the 24 articles discussed variables that impacted dissemination and reception of social media content. The most common variable was content source, with many authors noting that trust in the producer of social media content was paramount in users' minds ($n = 10$). However, in one study the authors suggested that when comments on a social media post are overwhelmingly negative, a credible source will not counteract users' negative opinions of that content (53). A few articles

TABLE 5. *Challenges associated with using social media for risk reduction identified in literature examining social media use in food safety and infectious disease risk communication*

Challenge	Description	Reference(s)
Drawbacks		
Complicated	Numerous platforms can be difficult to manage, and the ease of information access allows more complex questions to be asked.	17, 36, 40
Hard to measure	It is difficult to measure if and how social media are impacting behavior.	27, 40
Resources	It takes a lot of time to manage a social media account, and an investment is needed to ensure an effective presence.	51, 60
Control	It can be difficult to control the messages on social media, and there is a concern that hysteria could ensue.	51
Barriers		
Age	Different age groups use social media, and some are generally more comfortable with these media.	
Anonymity and stigma	Some users may be concerned about privacy or about discussing health concerns that carry a stigma (i.e., diarrhea associated with foodborne illness).	17, 29, 51
Information overload	Users may be overwhelmed by the amount of information on social media and either reject the whole experience or not know how to identify credible information.	22, 60

TABLE 6. Recommendations for using social media for risk communication identified in the literature examining social media use in food safety and infectious disease risk communication

Recommendation	Description	Reference(s)
Complement	Recommend that social media be treated as a complement to traditional media sources	9, 18, 27, 29, 37, 40, 41, 45, 54, 55, 61
Proactive	Emphasize the importance of proactively monitoring social media and building relationships before crises	29, 40, 60, 63
Demographic specific	Suggest that social media are more appropriate for certain demographics and use should be tailored to different groups	17, 22, 29, 40, 51
Links	Provide advice on the use of links in social media content	63
Consistency	Emphasize the need for consistent messages between different groups	61
Conclusions	Consumers want communications about the conclusions of outbreaks or crises situations	61

indicated that consumers were not likely to trust information originating from platforms such as Facebook or Twitter, but many users placed a high amount of trust in wiki-based sites (50, 61), and wiki-based sites were a common source of information for acute conditions (i.e., flu symptoms and diarrhea) on Facebook pages (22). In one study, no difference was found in public reception between confirmed and unconfirmed messages (17), whereas in another the authors noted that the public appeared to believe food safety crisis messages on social media even when the information was unconfirmed (41).

Many studies indicated that consumer interest in food safety was an important contributing factor in how likely individuals were to use social media as an information source ($n = 7$). Consumers' perceived risk about foodborne illness also was cited as an important predicting factor in use of social media for food safety information (27, 37, 67). In one study, the most common reason that students did not seeking out food safety information on social media was a belief that they already possessed the knowledge, followed by a lack of interest, and a belief that they were not susceptible to foodborne illness (33).

Recommendations for social media use. Seventy-five percent of articles ($n = 18$) offered recommendations for practitioners using social media to communicate about food safety or infectious disease (Table 6). Only one article touched on the impact of including links in social media content and provided evidence that inclusion of such links may actually prevent the widespread dissemination of content (63).

Although all studies provided suggestions for future directions, authors of 11 studies explicitly stated a need for more research on the applicability of social media to food safety and infectious disease communication. Research needs included (i) better tools to measure behavior change in social media interventions (27), (ii) an understanding of why certain strategies motivate behavior change (18), (iii) how to distinguish between the general public and experts in an online environment (54), and (iv) pragmatic guidelines for best practices in encouraging behavior change through social media (22, 51, 63).

DISCUSSION

The ever-growing body of literature examining the use of social media in health applications indicates that use of social media is in its infancy with respect to food safety communication. The literature on this topic includes a range of studies looking at both social media content and public reactions to and use of social media. This present review covers the current knowledge about social media as it relates to food safety and infectious disease communications and highlights strengths and weaknesses in this body of literature. The aim is to aid researchers both in their use of social media for food safety purposes and in their design of new studies on this topic.

The first aim of this review was to survey the research on the use of social media for food safety and infectious disease risk communication. The study types examined in this review were diverse, but all fell into two general groups: those analyzing already published social media content ($n = 14$) and those analyzing public perceptions or impacts of social media ($n = 10$). These types of articles serve two different functions, but findings complement each other in providing a complete picture of the state of knowledge on social media use in food safety and infectious disease communication. Content analyses provide insight into most shared messages, public knowledge, and conversations about food safety issues online, whereas survey and interview-based research provides insight into why certain messages may work and can provide a clearer picture of impacts. Only two studies provided any type of control group in their analysis of social media impacts (27, 33). The absence of controlled studies makes eliminating confounding variables and providing a strong conclusion about social media's efficacy difficult, as has been pointed out in other reviews (62).

The observed methodological quality scores from the MMAT tool indicate areas for improvement in future investigations. Quality will improve by acknowledgement and control of biases introduced when using social media-based populations as surrogates for the general population regarding beliefs and behaviors. An additional improvement will be to ensure the populations recruited for surveys and interviews are representative of the desired target group and that response rates are appropriate. The absence of response

rates in four of the seven descriptive studies is an important area for improvement. The absence of methods for ensuring the trustworthiness of coding in content analyses also was noted. Standardization of methods and reporting for mixed methods studies, particularly those containing a content analysis, could help address these concerns.

The second aim was to utilize the literature base to determine how social media are currently used for food safety and infectious disease communication and to synthesize research-based suggestions for utilizing social media. Based on the studies analyzed, social media provide many opportunities for food safety communications, including the ability to respond quickly and to reach a wide variety of people with tailored messages. However, exclusive reliance on social media can lead to neglect of some demographic groups (17). The most common factors that motivated users to seek and utilize food safety information on social media were trust and individual interests and beliefs. Trust in the source and in the online community was repeatedly emphasized as paramount to users' positive perceptions of social media messages and inclinations to follow the messages recommendations. In numerous studies, authors also mentioned the importance of traditional media for shaping social media content and the function of traditional media as complements to social media. A majority of consumers still choose traditional media over social media as news sources, and much of the content on social media originates from traditional news sites.

The concept that personal interests and beliefs drive responses to food safety content on social media is consistent with previous research on social media marketing and behavior change (2, 21). Some studies have revealed that those individuals who (i) believe they are not susceptible to foodborne illness (27), (ii) believe they already possess correct knowledge (33), or (iii) just have no interest in or knowledge of food safety information (37) are less likely to seek out and use social media-based food safety information. However, these studies did not provide further research on how these initial beliefs are formed and how to potentially change them and encourage utilization of food safety resources. The role of emotion in social media behavior also requires further research; emotional responses can influence whether an individual takes preventive actions (37, 49). However, extreme emotional responses are potentially dangerous in a social media setting because they can escalate a crisis (51).

The idea of individual influencers also merits further investigation; numerous studies referenced the concept but did not provide much information. The concept of a few individuals who have the ability to impact a large group of people online is still relatively unexplored. If these individuals were to provide incorrect information, this information could pose a significant threat to public health. A recent example is the public outcry that resulted after a well-known celebrity chef condemned lean finely textured beef, also referred to as "pink slime." His television segment on the process used to make lean finely textured beef was viewed by over 5.4 million viewers and led to a flurry of online activity demanding companies cease using the product (8, 11). More work is needed to assess individual

influence over social media and to create strategies for working with these individuals to provide accurate information. Individual influencers have a combination of knowledge, ability, motivation to lead others, and social capital in the form of a wide reach, and further research on how these factors influence public opinion could allow for the development of more persuasive and scientifically accurate materials (30). Direct cooperation with an individual is ideal for improving communication; however, an organization may be able to utilize lessons learned from successful individual influencers, which could include displaying competence in their respective fields and providing value to users (4).

More research on the role of social media in food safety communication is needed. Very few articles on this topic were identified, necessitating the inclusion of articles on infectious diseases to provide a more robust sample size. Although these infectious disease studies offered insight into communications similar to those related to foodborne illness, a wider body of food-specific knowledge would be better for drawing appropriate conclusions. A main limitation of this review is the small sample size. Many of the studies in this review focused on different topics, utilized different methods, and provided a range of conclusions. The inclusion of a range of studies allowed for the analysis of recommendations across the literature but for only general comparisons of conclusions across studies. To build a credible body of evidence concerning the role of social media in food safety communication and to establish best practices, more standardization of studies may be necessary. As the body of literature increases, reviews focusing on specific study types could provide more insight into social media uses and recommendations and could better highlight methods gaps.

The first aim of this research was to survey the current state of the literature on social media use in food safety and infectious disease communication. A dearth of research in this field was identified, and very few articles provided experimental evidence related to the impacts of social media. The majority of research in this area is focused on content of social media postings and on using surveys to determine what drives users to use social media. However, an understanding of the capacity of social media messages to actually change behavior is crucial and is an important gap identified in this work. The second aim was to collate current research-based benefits, challenges, applications, and suggestions for social media use in food safety and infectious disease communication. Studies differed and often used different metrics, which is an important area to address in the future, but this research still yielded valuable insights into social media use. Trust and personal beliefs appear to be crucial motivators in how the public utilizes social media for food safety information, but more research is needed on using these factors to create effective messages about food safety risks and preventive actions. The role of individual influencers in affecting opinions online appears to be clear, but it is still unknown what about these individuals specifically inspires their widespread following.

The included studies highlighted the importance of preconceived ideas for shaping users' responses to social

media, but the literature is still lacking information on how these ideas are formed and how to structure social media messages based on this information. It is clear from analyzed literature that it is important not to undervalue the role of traditional media in social media communication and to ensure that social media campaigns are executed in conjunction with traditional media campaigns. For example, messages could be coordinated between traditional news articles and content posted on social media, and readers of a news article could be encouraged to interact via social media with questions and comments. These practical conclusions can be used by professionals working in the fields of food safety and infectious disease to guide how they utilize social media for risk communication and to identify gaps to inform future research. Best practices for social media use are still not well established, and more evidenced-based guidelines and controlled studies of impacts are needed.

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