The use of social media in environmental health research and communication: an evidence

review

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Environmental Public Health

March 9, 2014

Introduction

The rise in popularity of social media presents new sources of scientific data and new ways to enhance communication and citizen engagement within the field of environmental health [1–3]. Social media is defined as "a group of Internet-based online and mobile applications…that allow the creation and exchange of user-generated content and data" [4]. Common categories of social media applications include: forums, message boards, social networking sites (e.g. Facebook), blogs, microblogs (e.g. Twitter) and media sharing sites (e.g. YouTube) [5]. A Statistics Canada report on Internet use found that in 2012, 83% of Canadians 16 and over use the Internet [6]. Among Canadians that use the Internet, 67% visit social networking websites, a 9% increase since 2010 [6]. A recent survey by Media Technology Monitor found that nearly one third of Internet users actively use the social networking site Facebook, and nearly one fifth Internet users are on the microblogging platform Twitter [7]. As social media has become such a prominent communication tool within popular culture, businesses, researchers, and experts from a variety of diverse disciplines have been investigating ways to leverage social media for communication, marketing, public relations and research activities [8–11]. The purpose of this report is to conduct a review of the literature to examine the potential uses and effectiveness of social media technologies in the field of environmental health.

Methods

A review of the literature in English, peer-reviewed journals pertaining to social media and environmental health was conducted. The literature review was conducted using the databases PubMed, Scholar's Portal, BioMed Central and Primo (University of Guelph). The search was conducted using the search string ("environmental health" OR "environmental public

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health" or "environment and health") AND ("social media" OR Twitter OR Facebook OR blog). Articles were included if they discussed applications of social media related to environmental health as a whole, or to various subfields within environmental health (e.g. food, water and air quality, surveillance, emergency management). Sixteen articles were found to be relevant. Information such as author, year of publication, study design and key points were extracted from each article and summarized in the appendix.

Use and effectiveness of social media in environmental health: evidence review

In the evidence review the following four categories of uses of social media pertaining environmental health were identified;

- information dissemination
- engaging the public, stakeholders and/or policy makers in conversation about environmental health issues
- surveillance and outbreak investigation
- crowdsourcing for data collection.

Information dissemination

Thackeray and colleagues (2012) conducted a cross-sectional study to determine the extent of social media use in public health departments in the United States [5]. The researchers found that 60% of health departments used social media [5]. The most common social media website used by the health departments was Twitter (~86.7%) [5]. On average, health departments had 483 Twitter followers, 789 Facebook Friends and 40 YouTube subscribers [5]. The researchers found that health departments were primarily using social media to disseminate information, of which approximately 8% of messages were related to environmental health [5].

The authors recommend that health departments incorporate social media into their overall communications strategy to maximize the potential benefit of social media as an information dissemination tool [5].

Social media also has the potential for use in environmental health promotion and education campaigns [12]. After conducting a survey that found that university students have limited food safety knowledge, Mayer and Harrison (2012) developed a tailored food safety education program on Facebook [12]. The program utilized recommendations made by students during focus group discussions, such as the use of short videos and recipe demonstrations incorporating safe food handling practices [12]. The researchers found that students preferred the Facebook program over a traditional food safety class lecture [12]. Ninety-seven percent of students reported that they would change their food handling practices after participating in the program [12]. The success of this program demonstrates that social media can be used as a platform for learning about food safety, and may lead to behavior changes that ultimately decrease the risk of foodborne illness in young adults [12].

Lastly, several articles highlighted the value of social media as a low cost tool to rapidly disseminate information to a large group of people [2, 5, 13–15]. This ability of social media can be especially valuable for risk communicators and other health professionals in times of crisis, such as during natural disasters and epidemics [2, 13]. Freberg and colleagues (2013) sought to determine where people received their information from during the 2009 H1N1 pandemic using a social media bookmarking tool [14]. The researchers found that the Center for Disease Control and Prevention (CDC) was one of the most frequently bookmarked sources of information, demonstrating that people rely on reputable government sources for information during a crisis [14]. The CDC frequently updated their Facebook page during the H1N1 crisis with information

about the disease and importance of vaccination [15]. Social media applications also allowed the CDC to immediately respond to questions and address any rumors or misinformation [15]. Freberg et al. (2013) emphasize the need for health organizations utilize social media, as seen with the CDC in the H1N1 crisis, to address public concerns and exert control over the messages presented in social media in order to influence and manage public perceptions in times of crisis [14].

Gaspar and colleagues (2014) note that in addition to being a useful tool to disseminate information during a health crisis, social media can be used to inform researchers and health professionals of how the public is coping with a crisis [13]. The researchers conducted a psychosocial analysis of Twitter messages during an E. coli outbreak in Europe [13]. The researchers found that evidence of coping strategies could be observed on Twitter, and suggested that this information can be used to help health professionals shape their communications messages to address specific public concerns and provide necessary information to help the public respond to the crisis [13]. For example, the researchers found that more people expressed avoidance in terms of purchasing and consuming various products like vegetables when the source of the outbreak was uncertain compared to later in the investigation when the source was identified [13]. The researchers suggested that having this information about public concerns could allow health professionals to implement problem solving strategies, such as disseminating information regarding proper washing of products [13].

As these articles demonstrate, social media can be a valuable tool for disseminating information in a rapid, low cost manner to address public concerns and needs in times of environmental health emergencies. In addition, social media can also provide a platform for

environmental health promotion and education campaigns tailored to the specific needs of the desired target audience.

Engaging the public, stakeholders and/or policy makers in conversations about environmental health issues

In the article by Thackeray and colleagues (2012) examining use of social media by health departments, they found that most health units were using social media for one way communication rather than to interact and engage with the public [5]. In addition to information dissemination, environmental health professionals can leverage social media to engage in two-way communication with the public, policy makers and other stakeholders [1, 3, 5, 14, 16, 17].

Martinello and Donelle (2012) conducted a content analysis of discussion postings in Ontario university Facebook groups related to the environment and determinants of health and found that health issues related to the built environment, air and water quality as well as recycling were very important to these university students [3]. They also found that students used Facebook to communicate their concerns to decision makers [3]. These researchers suggest that Facebook can be a useful tool for facilitating communication between the public and decision makers, as well as to foster community activism and civil participation related to environmental health issues [3].

Williams and colleagues (2008) also identified blogs as a useful tool for encouraging discourse about environmental health issues through the Sustainable Table project [16]. The Sustainable Table project is an initiative of the non-profit organization GRACE Communications Foundation with the goal of raising awareness of food-related issues such as antibiotic resistance and pesticide use [16]. Through a survey and the evaluation of a blog developed as part of the

Sustainable Table project, the researchers found that users enjoy blog postings about action oriented topics such as buying local and food-related health issues [16]. Blog users also used the comment section of the blog to discuss action steps that could be taken to address food-related health issues [16].

Social media has also been found to be an effective platform for knowledge exchange between environmental health researchers and policy makers [1]. Grossberndt et al. (2010) provide an overview of the European Union Health and Environment Network (HEVINET) project – an interactive network that allows researchers and other stakeholders to interact with policy makers through discussion boards, groups, newsletters, profile pages and other tools [1]. The HEVINET project involved 350 members from 46 countries around the world [1]. Nearly all participants surveyed at the end of the project indicated that they would be interested in continuing to invest in the portal [1]. Many individuals surveyed noted that they perceived uncertainty regarding information about environmental health issues to be an issue for policy makers, and therefore believe that cooperation and communication between scientists, policy makers and stakeholders is essential in environmental health decision-making [1]. The HEVINET social media portal addresses this issue by facilitating evidence informed policy through collaboration and networking between researchers and policy makers [1]. The case of the HEVINET project, the Sustainable Table blog and Facebook among university students demonstrates social media can be a valuable tool for two-way communication between environmental health professionals, researchers, the public and/or decision makers [1].

Surveillance and outbreak investigations

Over half of the articles analyzed in this literature review indicated that social media can play an important role in disease surveillance and outbreak investigation activities [2, 4, 15, 17–22]. According to Kass-Hout and Alhinnawa (2013), the highly networked and contextualized nature of social media can be used to better understand clustering of health issues within a population [15]. Abdullah and Wu (2011) demonstrate that the lifecycle of Twitter tends can be modeled in the same way as infectious diseases, and suggest that Twitter trends can be used to help identify outbreaks and predict outbreak dynamics [20]. In their scoping review of social media for disease surveillance, Bernardo and colleagues (2013) note that 66% of the articles reviewed found a good correlation between social media based surveillance and traditional surveillance systems [4]. For example, studies have analyzed the content of Twitter messages for key terms related to influenza and have shown that trends in Twitter discussion of influenza can accurately model influenza rates [4]. Schmidt (2012) notes that Twitter has been found to predict influenza outbreaks 1-2 weeks ahead of the traditional CDC influenza surveillance system [17].

One field within environmental health that could benefit from the incorporation of social media based surveillance is food safety [18, 22]. Foodborne illness surveillance is limited by underreporting [22]. A number of high profile foodborne illness outbreaks in recent years highlights the need for improved surveillance systems [22]. Social media websites and messages can be mined for indicators of an outbreak, can be used to distribute questionnaires during an investigation, and can facilitate the ability of groups to self-identify foodborne illness and common exposures [22]. For example, Kemble and colleagues (2013) present a case study of an foodborne illness outbreak involving Group A *Streptococcus* [18]. Health officials were first notified of the outbreak after students who attended the same banquet started discussing having a

sore throat on Facebook [18]. The number of cases identified in the subsequent epidemiological investigation corresponded well to the potential cases identified through Facebook [18]. Researchers note that social media played a critical role in bringing the outbreak to the attention of public health officials, and recommend the use of social media in the future as a tool for informing outbreak investigations [18].

Social media has the potential to enhance disease surveillance and outbreak response because of the ability to mine social media data to identify trends and reduce the time required to identify an outbreak [19]. Other benefits of using social media for surveillance and outbreak investigation is that it is low cost and freely accessible [15]. Social media can provide real-time information on outbreaks which can guide public and environmental health decision making [19]. The biggest challenges of using social media for outbreak investigations include information overload and low sensitivity and specificity, which can lead to false positives and false negatives [2, 4, 19, 22]. Bias as well as privacy concerns related to transmission of personal health information are other challenges that must be considered when using social media as a source of information for surveillance and epidemiological investigations [22]. Researchers emphasize that social media based surveillance cannot replace current systems, and should be cross-referenced with other sources to increase validity [4, 15, 19, 22]. Future research is needed to investigate methods to improve sensitivity and specificity of social media based surveillance techniques [4].

Crowdsourcing for data collection

Social media also presents new opportunities for environmental health research through the use of crowdsourcing [15, 21, 23]. Kass-Hout and Alhinnawa (2013) define crowdsourcing

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as "the act of taking tasks by a group (crowd) of people or community in the form of an open call" [15]. User-driven, mass citizen participation is a revolutionary new way to collect data within environmental health. Such forms of citizen engagement can allow for information on almost anything, anywhere to be collected and analyzed in real time [2]. In the review article by Boulos and colleagues (2011), the authors discuss a GPS integrated smart phone application that uses street level audio recording to produce a map of citywide noise pollution as one example of an environmental health application of crowdsourcing [2].

Another example of a crowdsourcing environmental health initiative is the Sri Lankan based application called "Mo-Buzz" [21]. Lwin et al. (2014) provide an overview of this social media application, which was designed to predict dengue fever outbreaks, engage the public in surveillance efforts, and communicate health risks to the public [21]. The program uses algorithms to predict dengue fever outbreaks based on weather, vector and human patterns, and disseminates this information to the public [21]. Members of the public can also use the "Mo-Buzz" application to report mosquito breeding sites, as well as signs and symptoms of dengue fever to local health authorities [21].

The use of crowdsourcing for environmental health research and surveillance has similar limitations to data-mining of social media for surveillance, including information overload, validity, bias and misinformation [21, 23]. Lwin and colleagues (2014) also note that encouraging collaboration among stakeholders from a variety of different disciplines when developing and implementing social media applications involving crowdsourcing can be challenging [21]. Despite these challenges, Boulos and colleagues (2011) note that the power and uniqueness of crowdsourcing via social media lies in the ability for intelligent humans to actively participate in an assigned task, and predict that this new method of data collection will become

increasingly common as mobile devices like tablets and smartphones continue to grow in popularity [2].

Limitations

There are several limitations present in this evidence review. First, the results of the literature review may have been limited by the search terms. By expanding the search terms to include key words from a variety of fields within environmental health it may have produced a greater quantity of articles and revealed additional uses for social media in environmental health.

Several of the articles in the literature review provided an overview of possible applications of social media in environmental health, but did not provide a detailed evaluation of the effectiveness of these various applications. In addition, use of social media applications varies across demographic groups such as age and ethnicity [24], therefore applications of social media that were found to be successful in the literature review may not be as effective when implemented in different demographic groups or geographical locations.

Conclusion

In conclusion, social media presents new opportunities for enhanced communication surveillance and community engagement activities in environmental health. Social media is a rapid, low cost tool that can be used to disseminate information in a timely manner during outbreaks, natural disasters and other crisis situations. The real-time nature of social media can be used to inform decision-making in emergency situations. Social media also presents new opportunities for education and two-way communication about environmental health issues at the environmental health research-policy interface.

Opportunities also exist for incorporating data mined from social media into surveillance systems that have the ability to rapidly identify trends, reduce the amount of time to identify an outbreak, and inform public and environmental health decision making. Crowdsourcing and active citizen engagement via social media can present new sources of data for environmental health research.

Future users of social media in environmental health must be cautious of the challenges and limitations this new technology presents, including; biased information, information overload, poor sensitivity and specificity, and the need for coordination of multidisciplinary and multijurisdictional teams. Future research is needed to investigate ways to improve sensitivity and specificity of crowdsourced data and data mined from social media sites. Future research is also needed to examine the success of social media based communication in eliciting behavior change and the overall effectiveness of various social media applications within the environmental health field.

References

1. Grossberndt S, van den Hazel P, Bartonova A: **Application of social media in the environment and health professional community**. *Environ Health* 2012, **11**(Suppl 1):S16.

2. Kamel Boulos MN, Resch B, Crowley DN, Breslin JG, Sohn G, Burtner R, Pike W a, Jezierski E, Chuang K-YS: **Crowdsourcing, citizen sensing and sensor web technologies for public and environmental health surveillance and crisis management: trends, OGC standards and application examples**. *Int J Health Geogr* 2011, **10**:67–96.

3. Martinello N, Donelle L: **Online conversations among Ontario university students: environmental concerns**. *Inform Health Soc Care* 2012, **37**:177–89.

4. Bernardo TM, Rajic A, Young I, Robiadek K, Pham MT, Funk J a: **Scoping review on search queries and social media for disease surveillance: a chronology of innovation**. *J Med Internet Res* 2013, **15**:e147.

5. Thackeray R, Neiger BL, Smith AK, Van Wagenen SB: **Adoption and use of social media among public health departments**. *BMC Public Health* 2012, **12**:242–248.

6. **Individual Internet use and e-commerce, 2012** [http://www.statcan.gc.ca/daily-quotidien/131028/dq131028a-eng.htm]

7. **Social networking: analysis of the english-language market** [https://www.mtm-otm.ca/files/PressReleases/Social Networking - Anglophones - Summary.pdf]

8. Brossard D, Scheufele DA: **Science, new media, and the public**. *Science (80-)* 2013, **339**:40–41.

9. Ogden LE: **Tags, blogs, tweets: social media as science tool?** *Bioscience* 2013, **63**:148.

10. Kaplan AM, Haenlein M: **Users of the world, unite! The challenges and opportunities of Social Media**. *Bus Horiz* 2010, **53**:59–68.

11. Centola D: **Social media and the science of health behavior**. *Circulation* 2013, **127**:2135–44.

12. Bramlett Mayer A, Harrison J a: **Safe Eats: an evaluation of the use of social media for food safety education**. *J Food Prot* 2012, **75**:1453–63.

13. Gaspar R, Gorjão S, Seibt B, Lima L, Barnett J, Moss A, Wills J: **Tweeting during food crises: A psychosocial analysis of threat coping expressions in Spain, during the 2011 European EHEC outbreak**. *Int J Hum Comput Stud* 2014, **72**:239–254.

14. Freberg K, Palenchar MJ, Veil SR: **Managing and sharing H1N1 crisis information using social media bookmarking services**. *Public Relat Rev* 2013, **39**:178–184.

15. Kass-Hout TA, Alhinnawi H: **Social media in public health**. *Br Med Bull* 2013, **108**:5–24.

16. Williams A, Schiavo R: **Raising awareness of sustainable food issues and building community via the integrated use of new media with other communication approaches**. *Public Heal Commun Mark* 2008, **2**:159–177.

17. Schmidt CW: **TRENDING NOW : using social media to predict and track disease outbreaks**. *Environ Health Perspect* 2014, **120**:A30–A33.

18. Kemble SK, Westbrook A, Lynfield R, Bogard A, Koktavy N, Gall K, Lappi V, DeVries AS, Kaplan E, Smith KE: **Foodborne outbreak of group a streptococcus pharyngitis associated with a high school dance team banquet--Minnesota, 2012**. *Clin Infect Dis* 2013, **57**:648–54.

19. Brownstein JS, Freifeld CC, Madoff LC: **Digital disease detection - harnessing the web for public health surveillance**. *N Engl J Med* 2009, **360**:2153–2158.

20. Abdullah S, Wu X: **An Epidemic Model for News Spreading on Twitter**. In *2011 IEEE 23rd Int Conf Tools with Artif Intell*. Boca Raton: IEEE; 2011:163–169.

21. Lwin MO, Vijaykumar S, Fernando ONN, Cheong SA, Rathnayake VS, Lim G, Theng Y-L, Chaudhuri S, Foo S: **A 21st century approach to tackling dengue: Crowdsourced surveillance, predictive mapping and tailored communication**. *Acta Trop* 2014, **130**:100–107.

22. Newkirk RW, Bender JB, Hedberg CW: **The potential capability of social media as a component of food safety and food terrorism surveillance systems**. *Foodborne Pathog Dis* 2012, **9**:120–124.

23. Kamel Boulos MN, Sanfilippo AP, Corley CD, Wheeler S: **Social Web mining and exploitation for serious applications: Technosocial Predictive Analytics and related technologies for public health, environmental and national security surveillance**. *Comput Methods Programs Biomed* 2010, **100**:16–23.

24. Duggan M, Brenner J: *The Demographics of Social Media Users — 2012*. Washington, D.C.; 2013:1–14.

Appendix – Article Summaries

Reference	EH Applications of Social Media Identified in Article	Article Key Points
Mayer and Harrison (2012), quasi-experimental study	• Information dissemination	• Using a survey, researchers found that university students had limited food safety knowledge and were at high risk of foodborne illness • Based off of survey results and focus group discussions, researchers developed a tailored food safety education program on Facebook for students • Focus group recommended short videos and recipe demonstrations incorporating safe food practice be included in the education program • After the intervention, 97% of participants agreed that they will change the way they handle food • Students preferred food safety education program over traditional food safety university lecture • Social media allows educators to give students a venue for social interaction and the opportunity to learn, share ideas and reflect • Researchers conclude that the use of social media in food safety education campaign can lead to behavior changes can reduce risk of foodborne illness
Gaspar et al. (2014), psychosocial analysis	• Information dissemination	• Researchers conducted a psychosocial analysis of Twitter messages during an E. coli outbreak in order to determine how people cope during a crisis • Using social media to assess how people are coping with a crisis can assist stakeholders in adapting communications to provide necessary information and warnings • Risk communicators can use social media to transmit important info to many people promptly
Freberg et al. (2013), analysis of social media bookmarks	• Information dissemination • Engaging public, stakeholders and policy makers in conversation about EH issues	• Media, including social media, has the power to influence how public receives and perceives information about risk • Investigators sought to determine the types and sources of social media being used during the H1N1 epidemic in 2009 based off of social media bookmarking services • Researchers found that the CDC was one of the most frequently bookmarked sources of information

		• Social media allows health organizations to engage with key stakeholders and understand and address their concerns and perspectives on health crises • Important to recognize that health professionals need to exert control over what is presented on social media and so that they can influence, manage and construct perceptions
Williams et al. (2008), case study	• Information dissemination • Engaging public, stakeholders and policy makers in conversation about EH issues	• Article provides an overview of the Sustainable Table program developed by a non-profit organization to educate the public on food-related issues like antibiotic resistance, pesticide use and large transportation systems • As part of the program, a blog was created to educate the public about food-related issues and encourage consumers to take action • Evaluation of the blog found that user comments tend to discuss action steps, how to take action and how to make use of existing resources to address food-related issues • Online poll show that people prefer action-oriented topics (like buying ad eating local, health issues, sustainable food) • Blog found to be useful in encouraging discourse surrounding action
Thackeray et al. (2012), cross-sectional study	• Information dissemination • Engaging public, stakeholders and policy makers in conversation about EH issues	• Researchers conducted a cross sectional study to determine extent of social media use within health departments in the US • Found 60% of health departments used social media • ~8% of health department social media (Twitter) posts were EH related • Most health departments only using social media to disseminate information rather than engage public in conversation • Emphasize need for health departments to maximize potential benefit of social media by incorporating it into overall communication strategy
Grossberndt et al. (2010), methodology article	• Engaging public, stakeholders and policy makers in conversation about EH issues	• Article provides overview of EU Health and Environment Network (HEVINET) project • HEVINET is an interactive network portal that allows researchers & other stakeholders to interact with policy makers – a "virtual meeting place" • HEVINET facilitates collaboration, networking and evidence-informed political decision making • Nearly all participants surveyed indicated that they were interested in investing time into the portal

		• HEVINET project success indicates that social media can be a new source of two-way communication at the science-policy interface
Martinello and Donelle (2012), qualitative content analysis	• Engaging public, stakeholders and policy makers in conversation about EH issues	• Researchers conducted a qualitative content analysis by analyzing data collected from archived wall and discussion postings on Ontario university Facebook groups • Any posts related to the environment and determinants of health were highlighted • Study found that environmental health issues (such as the built environment, water and air quality and recycling) are important among university students • Through Facebook students engaged in dialogue, shared opinions, debated and discussed strategies for improving environmental health issues • Facebook provides an opportunity for communication with policy and other decision makers • Social networking and social engagement through Facebook facilitates shift towards community activism and civic participation • Limitations of the study include lack of demographic information, only examining posts in English and that the researchers had no way of verifying that Facebook users actually were Ontario university students
Kass-Hout and Alhinnawa (2013), review article	• Crowd-sourcing • Surveillance and outbreak investigation • Information dissemination	• Social media presents opportunities for user-driven innovations to monitor and investigate disease trends • Many health issues tend to cluster in the population, and the highly contextualized and networked nature of social media can help to better understand such health issues • Data-mining from social media sources can be used to predict epidemics like influenza, West Nile Virus and meningitis • Benefits of social media include that it is low cost, the information is open source and timely • Social media can also be used for engaging the public and for disseminating health information • Must cross-validate social media data with other sources to increase validity • Article provides examples, including screenshots, of websites that use information mined from of social media for disease surveillance

Boulos et al. (2011), review article	• Crowd-sourcing • Surveillance and outbreak investigation • Information dissemination	• New opportunities exist in EH research with crowdsourcing through social media • Crowdsourcing involves mass citizen participation to achieve goals (Ex. Using street level audio samples recorded on smartphones with GPS to map citywide noise pollution) • Citizen engagement and crowdsourcing allows for monitoring of almost any issue, anywhere in real time • Other uses of social media include data mining of microblogging sites (like Twitter) for rapid identification and insight into unfolding trends such as outbreaks or natural disasters and other crises • Relevant and timely information can inform emergency management actions and policy decisions • Social media can also be used by emergency management personnel for rapid dissemination of information • Challenges of social media data mining and crowdsourcing include information overload, bias and misinformation
Kemble et al. (2013), case study	• Surveillance and outbreak investigation	• Article outlines an epidemiological investigation into a foodborne outbreak of Group A Streptococcus among high school students in Minnesota • Outbreak was first suspected when students discussed being sick with strep throat on Facebook • Social media played critical role in bringing potential outbreak to attention of public health officials • Estimates of sick individuals based on Facebook corresponded with estimates from epidemiological investigation • Researchers conclude that social media played a critical role in the epidemiological investigation and recommend future use of social media as a tool for informing outbreak investigations
Brownstein et al. (2009), perspective article	• Surveillance and outbreak investigation	• Authors suggest Internet technology becoming integral to surveillance • Data mining of social media can identify trends, reduce time to recognize an outbreak and allow for visualization of online information about outbreaks in real time • Having real-time, freely available information on outbreaks and other crises

		• can guide public and environmental health decision making • Although mining social media and other Internet sources can provide valuable information, they cannot replace efforts of public health practitioners • Limitations such as information overload, lack of sensitivity and specificity, false reports
Bernardo et al. (2013), scoping review	• Surveillance and outbreak investigation	• Researchers conducted a scoping review on the use of social media for disease surveillance • 66% of articles reviewed found good correlation between social media based surveillance and existing surveillance program • Developing social-media based surveillance programs requires multidisciplinary, multijurisdictional collaboration • Social media can allow for communication between health professionals to facilitate response to health crises • Social media can be used to supplement existing surveillance systems and should be used for active engagement with users rather than just information dissemination • Biggest challenges of social media for surveillance include false positives and false negatives • Need for further research to improve sensitivity and specificity
Newkirk et al. (2012), commentary	• Surveillance and outbreak investigation	• Need for improved food surveillance systems due to numerous recent high profile foodborne-illness outbreaks • Current foodborne illness surveillance systems limited by underreporting • Need rapid detection of outbreaks to reduce number of exposed individuals • Social media has potential to be mined for signs of foodborne illness in real time • Can also be used to distribute foodborne outbreak questionnaires to facilitate outbreak investigation • Social media can improve ability of individual groups to self-identify foodborne illness as well as common exposures • Challenges of social media for surveillance include low specificity and low positive predictive value as well as privacy concerns

		• Cannot replace traditional surveillance systems but can supplement them
Abdullah and Wu (2011), epidemiological model	• Surveillance and outbreak investigation	• Researchers found that life cycle of Twitter trends can be modeled in the same way as infectious diseases • Modeling Twitter trends can help identify and predict dynamics of outbreaks
Schmidt (2012), news/innovations article	• Surveillance and outbreak investigation • Engaging public, stakeholders and policy makers in conversation about EH issues	• Social media can provide two-way communication in environmental and public health research • Traditional surveillance techniques can take weeks to identify an outbreak, whereas monitoring Twitter and other social media trends can serve as an early warning system for outbreaks • Twitter is able to predict flu outbreaks 1-2 weeks ahead of CDC surveillance average • Challenge with using twitter for surveillance is determining what information is important, and excluding "noisy" (irrelevant) twitter messages
Lwin et al. (2014), methodology article	• Surveillance and outbreak investigation • Crowd-sourcing • Information dissemination	• Article overviews the "Mo-Buzz" social media application in Sri Lanka designed to predict impending dengue fever outbreaks, engage the public in surveillance efforts and communicate health risks to the public • The program uses computer algorithms based on weather, vector and human data to predict outbreaks and inform the public and health officials • Citizens can use the Mo-Buzz application on their phones to inform health authorities of mosquito breeding sites and report symptoms of dengue fever • The application can also be used to provide users with health alerts and health protection recommendations • Identified challenges include validity of information from citizens and encouraging collaboration among various stakeholders including researchers, policy makers, telecommunications companies and health practitioners • The application is currently in the testing phase and researchers soon hope to make the application available to the general public in the city of Colombo