

Communicating risk and promoting disease mitigation measures in epidemics and emerging disease settings

Renata Schiavo¹, May May Leung^{2,3}, Mason Brown³

¹Health Equity Initiative, New York, NY, USA, ²CUNY School of Public Health, New York, NY, USA, ³Hunter College, New York, NY, USA

Objective: This review aims to identify and assess evidence on interventions to communicate risk and promote disease mitigation measures in epidemics and emerging disease outbreak settings. The study focuses on data that are relevant to low and middle-income country (LMIC) settings.

Methods: We conducted a comprehensive literature search using five major electronic databases (Pubmed Medline, Biomed Central, EMBASE, Science of Citation Index, and Cochrane Library) and other sources to identify relevant studies published from January 2002 to July 2013. The review was guided by the socio-ecological model/perspective of public health and the ideation theory and focused on interventions at the community, healthcare, and multi-sectoral settings, which also reflect key intervention levels of the Ottawa Charter for Health Promotion. Eligible quantitative studies were selected according to specific study criteria and assessed using the Critical Appraisal Skills Program (CASP) framework. Conversely, qualitative studies, reviews, case studies, and editorials were not included. Studies were selected by two independent reviewers.

Results: Twenty-nine relevant studies from 16 countries were included. Most studies focused on a single intervention or intervention level, rather than multi-sectoral interventions. The majority of the evidence relates to programs aimed at behavioral and social results (or relevant intermediate steps) within a specific population group. Two studies included implications for improvements in health service delivery, two studies examined the intervention's impact on health systems-related outcomes, and three had also implications for environmental health outcomes. Cost- and health equity-related implications for select evidence were also discussed.

Conclusions: The paucity of well-designed quantitative evaluations of interventions to communicate health risk and promote disease control measures in LMICs does not allow for any definitive conclusions. Yet, the review identified several promising interventions and areas for future investigation. Among them, community-based and participatory interventions seemed to be central within epidemic and emerging disease settings, particularly in low-resource settings. Yet, evidence on their effectiveness is not conclusive and needs to be explored by future studies. Other promising areas for future investigation include multi-component and multi-sectoral approaches to intervention design. Major research gaps referred to any evaluation of the impact of these kinds of interventions on health policy adoption and/or implementation, and social determinants of health. Research on cost-effectiveness also needs to be strengthened. This review identified several research gaps and questions, and discusses potential future directions for increasing capacity for future and more rigorous assessments.

Keywords: Epidemics, Emerging diseases, Public health, Global health, Health promotion, Health communication, Risk communication, Outbreak control, Communication preparedness, Behavior change communication, Social change communication, Development communication, Cost, Health service delivery, Health systems, Low and middle-income countries (LMICs), Health equity, Vulnerable and underserved populations

Introduction

Epidemic risk is driven by complex factors. In many settings, such a risk is increasing as globalization, urbanization, and demand for and trade in animals and animal products is contributing to spreading

disease faster within and across multiple countries. The degradation of the physical and built environment in a variety of country settings also increases the risk that pathogens and their vectors would mutate and spread across countries. Poverty, overcrowding, population displacement, weak health systems, inadequate access to safe water and sanitation, and the health status of specific populations are

Correspondence to: Renata Schiavo, PhD, MA, Health Equity Initiative, 99 Madison Avenue, Suite 5017, New York, NY 10016, USA. Email: rschiavo@healthequityinitiative.org; renata@renataschiavo.com

all contributing factors to epidemics and emerging disease outbreaks.^{1–5}

More recently, a few public health emergencies including the 2001 Anthrax crisis in the United States, the SARS epidemic, and the 2009 H1N1 epidemic have highlighted the importance of communication preparedness and response and other interventions that seek to promote disease mitigation measures. Health risk communication has emerged as an important component of disease outbreak preparedness and control as there is ‘a significant communication demand in identifying serious health risks such as potential epidemics, ... preparing at-risk publics to confront health risks, and coordinating responses when these serious health crises occur’ (Ref. 6, p. 467). *Risk communication* is grounded within health communication principles and theories^{7,8} and includes the management of decision risks, implementation risks, and risks related to existing environmental, health, political, or social circumstances.⁶ For instance, in the health sector, risk communication addresses pandemics, natural disasters, bioterrorism, resource contamination, etc.^{6–8} Within this context, risk communication takes into account the participation of a variety of stakeholders to make sure that all interventions are informed by ‘an interactive process of exchange of information and opinions among individuals, groups, and institutions’ (Ref. 9, p. 4), and are also inclusive of vulnerable and underserved populations as well as address key factors that may prevent the adoption and sustainability of key disease mitigation measures.^{7,8} More recently, *emergency risk communication* has been integrating principles from risk and crisis communication in preparing for, responding to, and recovering from epidemics, emerging disease outbreaks, and other hazards (Ref. 7 (p. 77), 8, and 10). Within this context, health risk communication aims at behavioral and social results as well as to create the kind of sustainable change that may help prevent or control epidemics and disease outbreaks. Similarly, *health promotion* (defined as ‘the process of enabling people to increase control over, and improve their health... a commitment to dealing with the challenges of reducing inequities, extending the scope of prevention, and helping people to cope with their circumstances... create environments conducive to health, in which people are better able to take care of themselves’;¹¹ Ottawa Charter for Health Promotion) for epidemic prevention and control is a key function of epidemic readiness and interventions.¹²

Yet, our comprehensive literature search revealed that almost no reviews attempted to assess existing evidence on how to communicate risk and promote disease mitigation measures in outbreak settings. Among the very few reviews on relevant topics our search retrieved, most of them have focused on a specific disease area, geographic location, non low and middle-income country (LMIC) region, or type

of intervention.^{13–17} Other reviews have also focused mainly on examining individual behaviors within affected groups or populations.^{18,19} Finally, most reviews^{20,21} focus on actual mitigation measures (e.g. handwashing, use of masks, vaccination) rather than strategies to communicate risk and encourage the adoption of such measures. The paucity of information and very limited number of existing reviews on this topic within published peer-reviewed literature not only excluded the possibility of conducting a review of reviews as one of the potential methodological options but also confirmed the need for the present review.

Grounded in the socio-ecological model of public health (also referred to as social-ecological model of public health),^{22,23} the Ideation Theory^{24–26} and also reflecting the Ottawa Charter for Health Promotion,^{11,27} the primary objective of this review is to identify and assess existing evidence as it relates to interventions that were designed and implemented in community-based, healthcare and multi-sectoral settings to communicate risk and mitigate the impact of epidemics and emerging diseases outbreaks. This systematic review transcends specific disease-related boundaries and recognizes the influence of communities, health systems, and multiple sectors and interventions on mitigation measures and behaviors as well as indicators of behavioral readiness, adoption, and sustainability. The review describes and assesses identified studies and discusses patterns in health risk communication and health promotion interventions. Key findings may contribute to inform future research and/or intervention design to address epidemics and emerging disease outbreaks in LMIC settings.

Methods

Theoretical model and specific objectives

As previously mentioned, the objectives of this review were guided by the socio-ecological model/perspective (SME/SSE) of public health,^{22,23} which recognizes the influence of the environment on individual and community actions as well as the connection among different social and political elements in an environment. ‘In stark contrast with individual-level approaches’, ecological approaches like the SME/SSE ‘target multiple influences of health behaviors’ (Ref. 28, p. 231) such as those related to the support and/or services provided by local communities, health care settings, and different sectors or policies.

In support and integration of the above perspective, we also considered: (a) the Ideation Theory,^{24–26} which is used to identify and influence ideational elements, such as attitudes, knowledge, self-efficacy, social and peer support and approval, social norms, emotions, personal advocacy, and other factors that

can affect and determine *health* and *social behavior*. Within the context of our review, ‘*health behavior*’ refers to the action of individuals, groups, and organizations as well as their determinants, correlates, and consequences, including... improved coping skills, and enhanced quality of life’ and improved health outcomes. (Ref. 29 (p. 12) and 30). *Social behavior* is defined as (a) a collective behavior that arises from the interactions of different segments of society or groups and/or parts of systems working together;^{7,8,31,32} and (b) the concept of ‘collective efficacy’ (defined as ‘social cohesion among neighbors combined with their willingness to intervene on behalf of the common good’³³).

Informed by key principles from the above theoretical models, the review focuses on three specific intervention levels (community settings, healthcare settings, and multi-sectoral settings), which not only correspond to three of the action areas (‘strengthening community action; re-orientating health care services toward prevention of illness and promotion of health, and creating supportive environments’) of the Ottawa Charter for Health Promotion³⁴ but also reflects current wisdom recognizing that ‘an individual’s behavior is formed in the context of their community and society’.³⁵ Interventions in epidemics and emerging disease outbreak settings require community participation and consultation, linkages with partners at multiple levels, effective services and resources (including adequate health service delivery), and national plans and interventions that engage and impact various stakeholders ‘in order to facilitate the successful adoption of public health-related recommendations at the individual level’.³⁵ This also reflects key principles from the theories and models described in this section.

Given the above premise, and because of the interdependence and interrelation of different groups, stakeholders and systems, this review did not focus on interventions within the individual-level setting, which usually prioritize strategies to identify and address biological factors and personal history¹⁰ and to ‘develop personal skills’,²⁷ and was also the focus of the limited reviews on similar topics we retrieved via our comprehensive search. Instead, this review is focused on the other key intervention levels described by the Ottawa Charter of Health Promotion, so that we could learn about the potential impact of such interventions both on health, social, and policy behavior change as well as other parameters as described later in this article.

Ultimately, this systematic review sought to identify and assess the results of health communication and health promotion interventions to communicate risk and promote disease mitigation measures as they relate to LMICs settings and the three

aforementioned interventions levels. While some additional research questions were explored within the context of each of the above interventions levels (see Results sections), overall the review sought to address the following core questions: What is the documented and evidence-based impact of health risk communication and health promotion interventions within epidemics and emerging disease settings in LMICs (as it relates to the above interventions levels)? What are some of the key documented outcomes (e.g., health and social behavior change, policy change, improvements in health service delivery or the overall health system, or other kinds of outcomes) described within existing peer-reviewed literature in connection with these types of interventions at the community, healthcare, and multi-sectoral levels? (see also the Data analysis section for more detail).

Finally, if/when available, we attempted to extrapolate and assess information from eligible studies as it relates to (a) indicators of and/or intermediate steps toward behavioral readiness, adoption, and sustainability within different levels of society; (b) indicators of intermediate steps toward improved health service delivery as specifically related to epidemics and emerging disease control; and (c) potential implications (if any) for cost and health equity issues.

As our review focuses on intervention levels and not on specific channels, strategies, or interventions (e.g., mass media campaign, community mobilization, new media-based intervention, etc), we did not exclude any specific kind of media or intervention as long as the specific study met the eligibility criteria for this review that are described in the following sections.

Data sources and searches

The following databases were searched: Pubmed, Biomed Central, EMBASE, Web of Science, and the Cochrane Library. While multiple languages were initially included, it was concluded that most significant body of evidence is in the English language (including by authors from LMICs). Date range limits included 2002 (SARS epidemic) to July 2013; 2002 was selected as the date limiting range as the SARS epidemic could be considered the turning point regarding the way epidemics and emerging disease responses are handled by the global public health community.^{36,37} Whenever possible, MeSH terms were used for the diseases being reviewed, with all other search terms being considered key words (Table 1). The keywords in Table 1 were combined with the OR Boolean operator, as were the MeSH terms (when permitted by the database). These two groupings were then combined with the AND operator. This allowed a single search to bring

Table 1 Search Terms

Key words	Actions, behavioral communication, risk communication, social communication, behavioral and social communication behavioral counseling, business owner, business services, church, coalition building, COMBI, communication for behavioral impact, community, community dialogue, community empowerment, community engagement, community involvement, community mobilization, community participation, community readiness, community surveillance, continuity of services, control measures, culturally competent materials, disease outbreak, distance learning, emergency guidelines, emerging diseases, epidemics, evaluation of outbreak coordination, health care practitioner, health care professional, health care provider, health care worker, health communication, health literacy, health promotion, health services, intersectoral assessment, interventions, measures, media awareness campaign, mitigation, needs assessment, outbreak, outbreak detection, outbreak management, outbreak surveillance, pandemic (H1N1) 2009, participatory action, policy development, policy implementation, policy, poultry farmer, preparedness response, psychosocial response, psychosocial stress, public health emergency, public health emergency behavior, public health emergency communication, radio station, readiness, religious leader, response, risk assessment, school, slaughterhouse, slaughtering, social and behavioral interventions, social mobilization partner, social mobilization, social response, stakeholder action, teacher, training, treatment seeking behavior
MeSH terms	Anthrax, Influenza in Birds, Hemorrhagic Fever, Crimean, Dengue Hemorrhagic Fever, Hemorrhagic Fever, Ebola, Hendra Virus, Hepatitis, Influenza, Human, Lassa Fever, Marburg Virus Disease, Meningococcal Infections, Nipah Virus, Plague, Rift Valley Fever, SARS Virus, Smallpox, Tularemia, Yellow Fever

together every possible combination of keywords and MeSH terms.

Study selection and appraisal

The review aimed to focus on interventions in LMICs, as defined by the World Bank. Given the limited number of studies from LMICs, the search process also included studies from high-income countries (HICs) as a number of these interventions focused on vulnerable and underserved groups. These populations and LMIC's can share similar low economic status, lack of access to social and/or health services and information, and a history of social discrimination, which may all account for increased vulnerability and risk within epidemic and emerging disease settings.

As this review is primarily concerned with assessing key outcomes of the aforementioned interventions, we only included quantitative studies, which assessed the interventions' effectiveness. We excluded qualitative studies, case studies, and editorials. This approach is the same as the one implemented by the few reviews on similar topics our search retrieved.^{16,18}

As for our core research questions, we divided outcomes discussed by eligible studies within the

following categories: *Health, Social, and Policy Behaviors Outcomes* and related intermediate outcomes, *Improved Health Service Delivery* (e.g., coverage, outputs, delivery of supplies, efficiency of resource utilization), *Health Systems-Related Impact* (e.g., performance, interdependence of different levels, efficiency or resource utilization), and *Environmental Health Impact* (e.g., changes in human exposure to or presence of disease vectors; biological hazards reduction). The screening of literature was carried out in a three-stage procedure (screening of title, abstract, full text) whereby each level consisted of increasing scrutiny of the studies based on the eligibility criteria of the review (Table 2). Two independent reviewers assessed retrieved studies for inclusion using a checklist of eligibility criteria (Table 2).

Data analysis

We analyzed health promotion and health communication interventions in terms of their health, social, and political impact within epidemics and emerging disease outbreaks settings. Other authors have also highlighted the importance of health, social, and political consequences of communicable diseases as central issues for future interventions and challenges 'because of the

Table 2 Study selection and appraisal criteria

Selection Criteria <ul style="list-style-type: none"> • Quantitative studies only • Adequate sample size • Study design (preference for randomized control study) • Valid data collection tools • Systematic data collection process • Control group preferred • Relevance to LMICs 	Assessment Criteria (CASP) <p>Article relevance to research topic(s) and intervention levels</p> <ul style="list-style-type: none"> • Focus on issues of interest • Relevance of research settings <p>Significance of results</p> <ul style="list-style-type: none"> • Data accuracy and relevance • Causal associations <p>Validity of results</p> <ul style="list-style-type: none"> • Methodological quality <p>Relevance for health risk communication and health promotion interventions</p> <ul style="list-style-type: none"> • Applicability to future interventions • Impact on key outbreak control outcomes as defined by this review • Clear benefits of intervention • Overall public health significance
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CASP: Critical Appraisal Skills Program; LMIC: low and middle-income country.

enormous unfulfilled potential to reduce morbidity and mortality globally'.³⁸ Interventions evaluated by eligible quantitative studies were classified according to the three intervention levels considered for this study: community setting, health care setting, and multi-sectoral setting. *Multi-sectoral* interventions are defined as those that seek to engage and have an impact within multiple sectors and stakeholder groups and, therefore, to affect the policy, social, or economic environment in which epidemics and disease outbreaks may occur, also reflecting current wisdom that 'mitigation requires social, political, and economic commitment across governments and industries'.³⁹ This unit of analysis also reflects the corresponding intervention level from the Ottawa Charter for Health Promotion ('creating supportive environments'), which is reinforced by other relevant models such as the 'societal' level of the socio-ecological model of health (the *societal* level looks 'at the broad societal factors that help create a climate' in which specific health or social behaviors are encouraged or inhibited.⁴⁰) As interventions in this unit of analysis seek to achieve results among different groups and stakeholders who are part of and/or influence relevant social, political, economic, and the built or physical environments, our assumption is that they need to be multi-component for example, they integrate policy communication with social or community mobilization, mass media, new media communication, etc. Such assumption is also supported by a variety of integrated planning frameworks that are used both in health communication and health promotion within and outside epidemics and emerging disease settings.⁴¹⁻⁴⁹

We also considered the reproducibility of all interventions from eligible studies in multiple LMIC settings. Within the limitations of the evidence retrieved for this study, potential implications for cost-related issues as well as vulnerable and underserved populations are also discussed using a logical framework that considers the impact of social factors on health outcomes.

Finally, eligible studies were tabulated for analysis within a PICOT table. The PICOT method describes

the 'population (P), intervention or issue of interest (I), comparison intervention or issue of interest (C), outcome(s) of interest (O), and time it takes for the intervention to achieve the outcome(s) (T)'.⁵⁰ Our table includes the study's reference, unit of analysis/level, year of publication, type of evidence/study design, quality of study and applicability to LMICs, population group, country, intervention description, duration, key outcomes, limitations/risk of bias, and equity and gender issues (the latter two entries only when available) (See online Supplementary Material). Each study was graded according to the strength of their Critical Appraisal Skills Program (CASP)⁵¹ criteria and their relevance to LMICs (Table 3).

Results

Overall profile of the review

The search in the electronic databases identified a total of 51 532 records. In addition, 18 records were identified via Internet searches and citation follow-up. Of these, 38 868 were screened after removing all duplicates. There were 360 full text articles assessed for eligibility after excluding all other records on the basis of the title and abstract. Of these, 231 were not included in the final analysis because of one or more of the following reasons: (a) were qualitative studies, reviews, case studies, or editorials; (b) focused on scientific evidence as it relates to the effectiveness of actual mitigation measures (e.g., handwashing, use of masks, etc.) in controlling disease rather than on interventions to communicate risk or encourage the adoption of such control measures at different intervention levels; (c) evidence was related to interventions implemented at the individual level instead of community, healthcare or multi-sectoral settings; and (d) were not relevant to LMIC settings. Finally, 29 studies were considered for our review (all quantitative studies). Figure 1 outlines the flow of the search process and the number of articles that were identified at each stage of the process.

Overall the quality of the studies included in this review varies from 'High' to 'Moderate to Low' as it relates to the CASP criteria we used for this review,

Table 3 CASP and LMIC ranking criteria.

	CASP	LMIC
High	Study ranks high to moderate on all 4 CASP criteria	Intervention was implemented in LMIC and/or included methods and channels that are suited for vulnerable population outreach and engagement and/or was solely intended for disadvantaged or high-risk populations or low-resource settings (even if within developed country). If not in LMIC, two of the above criteria apply.
Moderate	Study ranks high to moderate on 2-3 of the 4 CASP criteria	Intervention was not implemented in LMICs but included methods and channels that are suited for vulnerable, high-risk or low-income population outreach
Low	Study ranks high only on 1 or less criteria	Intervention was not implemented in LMIC and did not include methods and channels suited for vulnerable population outreach or engagement and/or was not intended for disadvantaged populations/low-resource settings.

CASP: Critical Appraisal Skills Program; LMIC: low and middle-income country.

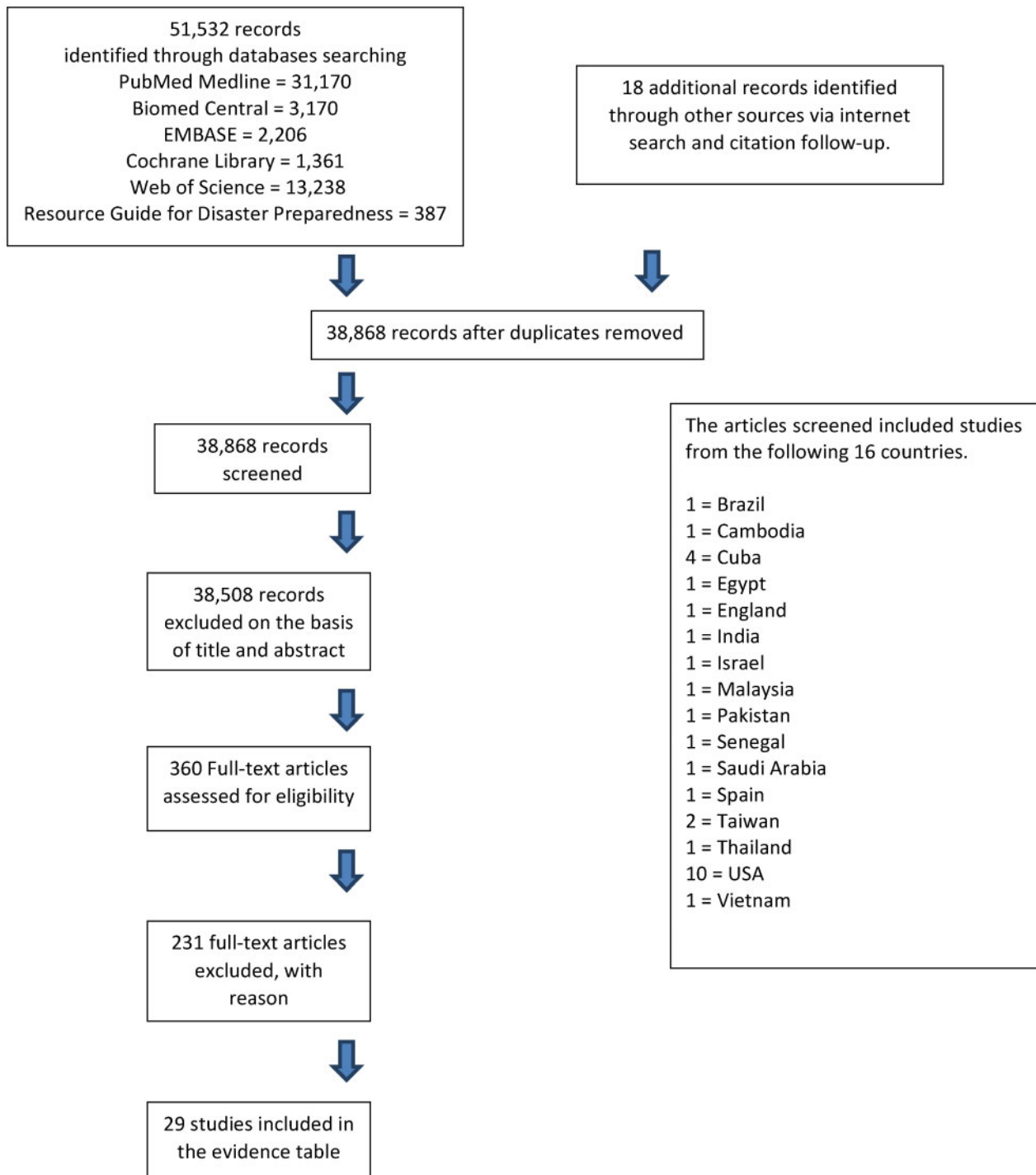


Figure 1 Flow of the Search Process

and from ‘High’ to ‘Low’ as it relates to the studies’ applicability for LMICs (see Table 4). Most of the eligible articles focus on a single intervention (e.g., web-based campaign, school program, etc.) and sector. The highest number of RCTs was found within the healthcare setting unit of analysis (six RCTs of which five are related to one specific intervention, health worker education and training), and the community setting (six RCTs divided among five different interventions).

Of interest, none of the articles that met the criteria for inclusion discussed any health promotion or

health communication intervention related to the development and enforcement of national or regional policies and/or the behaviors of policymakers. Therefore, we were not able to discuss any relevant evidence in reference to its potential impact on health policies or policy behaviors (*policy behavior* is defined here as the behavior of states, local authorities, institutions, and/or policy makers in reacting to, adopting, or implementing a given policy. Such behavior, and its related decision-making process, is usually influenced by multiple factors at the international system, state, and organizational levels as

Table 4 Quality of studies and outcomes

Unit of analysis/level of intervention	Quality of Studies/CASP	Applicability to LMIC	Types of outcomes
Community settings	High: 5 studies Moderate to High: two studies Moderate: 3 studies Moderate to Low: 3 studies	High: 8 studies Moderate: 4 studies Moderate to Low: 1 study Low: 1 study	Health and social behavior outcomes and intermediate steps Environmental health impact
Healthcare settings	High: 6 studies Moderate: two studies	High: 5 studies Moderate: 1 study Moderate to Low: two studies	Health and social behavior outcomes and intermediate steps Health services delivery improvement
Multi-sectoral settings	High: 3 studies Moderate: 3 studies Moderate to Low: two studies	High: 6 studies Moderate: 1 study	Health and social behavior outcomes and intermediate steps Environmental health impact Health systems-related impact

CASP: Critical Appraisal Skills Program; LMIC: low and middle-income country.

well as individual factors such as specific characteristics and belief systems of policymakers).^{52,53} No intervention causing any harm was found. Table 4 describes how different studies were ranked within each unit of analysis according to the review's criteria.

Description of results

Within the above limitations, the review identified several interventions that were supported by eligible studies, revealed emerging trends, and raised interesting questions for future investigation.

Community setting

While the review's working definition of 'community' more broadly 'indicates a variety of social, ethnic, cultural, or geographical associations' for example, a school, workplace, city, neighborhood' (Ref. 7 and 8 (p. 525)), for the most part, eligible studies focused on geographical communities. School-based settings were also a recurring 'community' within eligible studies and related interventions. Interventions at the community level are usually designed 'to strengthen community action' as for the Ottawa Charter of Health Promotion, and to 'foster community climates that promote healthy relationships' and behaviors.¹⁰ To this end, we also included interventions that although they may incorporate an individual counseling component (such as household visits), these are actually comprehensive efforts to identify, train, and engage community health workers and participatory groups (and the people they reach) in an iterative process that supports community action, as well as promotes healthy relationships,⁵⁴ and ultimately, leads to progress toward improved health outcomes.⁵⁵ Other authors have also classified 'home visits by community health workers' as 'community-based interventions' (Ref. 55, p. 191). As for other units of analysis, our core question was to assess key outcomes of community-based interventions within epidemics and emerging disease settings.

At the *community setting level*, eligible studies in this review used a variety of strategies and media and appear to support the role of community-based interventions (including *community 'participation', 'action', 'mobilization' or 'empowerment' or 'community-based health promotion' or 'household visits' or 'household-based communication'* as defined by different studies) on outcomes within the *Health and Social Behaviors* category or related intermediate steps. Such health and social behavior outcomes within intended groups and/or relevant communities were observed in reference to a variety of recommended mitigation measures – as they applied to specific disease areas – including increased immunization rates,^{56,57} control of vector-borne diseases and/or increased biosecurity behaviors,^{58–61} and impact of increased access and use of soap on reduced diarrhea incidence among children.⁶² A few studies also reported on outcomes of community-based interventions on intermediate steps (such increased knowledge, perception and/or self-efficacy) toward health and social behaviors.^{60,61} Shiram *et al.*⁵⁸ also describe improved *environmental health* outcomes (reduced larva indices) as a result of their community-centered approach to dengue control. Similarly, Abramides *et al.*⁵⁸ found that a multi-component intervention including community participation and homeowner engagement led to a reduction of the number of mosquito eggs (*Aedes*) in the study's geographical areas. This may suggest the potential influence of these types of interventions^{57,58} on long-term community action on vector control and other relevant environmental health outcomes.

One study⁵⁶ compared the impact of community mobilization interventions versus a mass media campaign to increase Hepatitis B immunization rates and showed similar results for the two interventions. Yet, the study did not test the two strategies in

combination, which may be an important area for further inquiry. As another example of a potential mass media communication intervention (the definition of 'mass media' varies in different contexts and depends on whether access and use of the Internet for health-related information is widespread among intended groups), Yardley *et al.*⁶³ described increased self-reported handwashing rates and intentions following a Web-based program, which was tailored to adult Internet users and also included self-regulation support.

School-based interventions appeared to have a positive impact on outcomes within the *Health and Social Behaviors* category or related intermediate steps, including the impact of a hand hygiene multi-component program on reduced school absences caused by laboratory-confirmed influenza,⁶⁴ and vector-borne disease knowledge or differences in relevant protective behaviors among children and their families.^{65,66}

The role of *entertainment education/communication* and, more specifically, street entertainers, in risk awareness and protective behavior at the community level was also highlighted by one study,⁶⁷ and so was a *worksites program* that did not seem to contribute to any difference in immunization rates, yet appeared to improve compliance to other protective behaviors (staying home during an infectious respiratory illness) and to increase positive attitudes and beliefs on the effectiveness of the influenza vaccine.⁶⁸ A *multi-channel mass risk communication campaign* (including interpersonal and print channels, and use of mobile technology/texting) within school settings to reverse an epidemic of acute hemorrhagic conjunctivitis (AHC) resulted in increased home confinement rates of symptomatic children.⁶⁹ This study also addressed barriers in reaching diverse populations via mobile technology, such as lack of access among low socio-economic groups due to high costs.

Studies in this unit of analysis varied in terms of duration of the intervention (with many of very short duration such as six to nine months), and study design and components. Moreover, many specific interventions (e.g., household visits, entertainment education/communication, web-based intervention, and others) are each supported only by one eligible study. These issues all point to the need for further investigation, which should also focus on assessing the potential long-term impact of these kinds of interventions on sustained community action as it relates to relevant issues and outcomes.

Healthcare setting

Health care institutions and systems have an important role in epidemic preparedness and control. As previously mentioned, this unit of analysis reflects

one of the key categories of the Ottawa Charter for Health Promotion ('reorient health services') as well as key principles from the socio-ecological model of public health, which recognizes the importance of clinical-based interventions and, as suggested by other authors, also calls for the integration of such interventions with strategies that engage geographical, ethnic, social, and other kinds of communities.⁷⁰

Reorienting health services entails that healthcare institutions and their partners work together to create systems that 'go beyond their responsibility for providing clinical and curative services'.²⁷ In the context of epidemics and emerging disease outbreaks, healthcare institutions and their professionals are often charged with breaking bad news, dealing with uncertain science and demanding deadlines, and implementing new protocols and practices that will effectively protect patients, health workers, and the workplace.^{37,71} 'Reorienting health services also requires stronger attention to health research as well as changes in professional education and training'²⁷ in addition to opening communication channels and pursuing partnerships that would connect clinical settings with local communities and different segments of society.^{27,70}

Yet, at the *healthcare setting level* most eligible studies focused primarily on interventions to build capacity among healthcare professionals via *health worker education and training*, one of the recommended interventions by the Ottawa Charter for Health Promotion, which were described by a large number (6) of the RCTs in this review. As the role of healthcare systems and their workers in epidemics and emerging diseases is critically linked 'to their ability to cope with challenges' and their timely prevention and control of epidemics,⁷² professional development and training interventions focus on improving patient and healthcare delivery outcomes as well as the implementation of safe and protective measures among health workers and their patients (versus individually-focused interventions, which as previously mentioned, deal with personal history and biological characteristics).

Overall, the quality of studies in this unit of analysis was higher than in other units. The impact of health worker education and training was examined by eligible studies in relation to *Health and Social Behaviors Outcomes* among health workers or patient groups (e.g., improved flu immunization rates) but, most important, vis-à-vis improved *Health Service Delivery Outcomes* (e.g., improved dengue diagnosis, knowledge and practice of infection control precautions, improvement of service efficiency). Three different studies reported increased influenza immunization rates among health workers following health worker education and training.⁷³⁻⁷⁵ As for two of

these studies,^{73,75} multi-component interventions (including a combination of interpersonal channels, email, and/or a Vaccine Day) are supported as an important approach in modifying health worker behavior. Yet, Abramson *et al.*⁷³ also note that their multi-component program did not appear to be effective among staff with prior objections to immunization. While the studies do not dwell in detail on the impact of health worker immunization on patient outcomes or other system-related outcomes, healthcare worker immunization is a widely recommended protective measure as ‘it provides benefits to workers, patients and health care services agencies’ and is essential ‘both for maintaining a safe work environment in healthcare settings and for ensuring staffing capacity’,⁷⁶ which are key issues in epidemics and emerging disease settings. One of the studies⁷³ suggested further investigation on the impact of health worker immunization on patient immunization rates.

The impact of *health worker education and training* was also examined by several other studies as it relates to: (a) health and social behaviors outcomes (or intermediate steps toward such outcomes) among different health workers and/or patient groups; and, more limited, (b) overall improvements in health service delivery. Such evaluations revealed improvements in different areas such as influenza immunization rates among patients in dialysis centers following multi-component interventions including materials and/or events for both staff and patients;⁷⁷ and increased knowledge of infection control precautions among nursing students following a 16-hour infection control education programming in addition to conventional nurse education curriculum.⁷⁸ Conversely, no significant impact on nursing students’ ability to apply infection precautions was shown by Wu *et al.*⁷⁸ Similarly, a single component intervention focusing on – either (a) a two-day health worker training course or (b) the introduction of rapid diagnostic tests to improve dengue diagnosis and treatment – or the combination of the two, did not show significant or sustainable improvements in dengue diagnosis.⁷⁹ However, process-related issues, such as potential lack of adherence to medical guidelines were not measured.

In another study, Eppes *et al.*⁸⁰ describe how a *telephone triage system* during the 2009 H1N1 pandemic improved the efficiency of utilization of resources among a high-risk population (pregnant women). Such improvement in the efficiency of resource utilization was associated with reduced volume of in-person encounters and overall good patient outcomes. The intervention also relied on *health worker education and training* (administered via multiple media channels) both on influenza and the importance of vaccination as well as the newly designed telephone triage system. This

is one of the only two studies in this unit of analysis that has implications for *Health Service Delivery* outcomes.

The other study⁸¹ describes the impact on improved patient outcomes and treatment adherence among TB patients in a resource-poor setting in Senegal of a treatment decentralization multi-component intervention (including improved provider-patient communication and counseling, treatment decentralization to remote health posts and community health workers training and engagement, patient selection of preferred treatment supporter and involvement of family members, increased supervision of health posts). While the focus of the Thiam *et al.* study is primarily on patient health outcomes, treatment decentralization via community and family engagement, use of remote health posts, and other methods described by their assessment may also have implications for health service delivery improvement, as may help ‘reorient health services’ and encourage community participation.

Overall, most eligible studies in this unit of analysis did not focus on comprehensive strategies to reorient health services and revealed the need for further evidence on interventions and models that integrate clinical and community-based settings. Finally, very limited and inconclusive evidence was discussed by eligible studies in this unit of analysis about hospital policies and guidelines or any formal coordination efforts among the healthcare sector and other sectors.

Multi-sectoral setting

Only seven eligible studies met the review’s inclusion criteria for this unit of analysis (*multi-sectoral setting*) as defined in the Data Analysis section, and examined the integration of different strategies intended to engage and have an impact within multiple segments of society, and ultimately, creating supportive environments that may encourage risk and disease mitigation behaviors. Very few of the interventions in other units of analysis also discuss multi-component interventions. Yet, with the exception of Thiam *et al.*, very few of them integrate communities and/or professionals from multiple sectors in their design or implementation, and at the same time seek to affect different aspects of society and/or discuss this aspect at length.

Of the seven studies categorized within this unit of analysis, four focused on the integration of health communication strategies with community involvement and mobilization for dengue prevention and control. These studies reported significant improvements in outcomes related to the *Environmental Health Impact or Health and Social Behaviors Outcomes* categories, including vector control,^{82,83} practices and knowledge about vector breeding sites and disease symptoms,⁸⁴ community participation in disease control and strengthening of intersectoral

coordination of all activities,^{82,85} and therefore are well poised to potentially affect social constructs and norms as well as citizen participation levels as it relates to the handling of epidemics and emerging disease outbreaks. All four of these studies relied on multi-sectoral approaches to program design and implementation, whether for example by: involving residents from multiple circumscriptions, consulting with local stakeholders and creating local multi-sectoral task forces;⁸² recruiting local volunteers to assist health inspectors and public health officials;⁸³ or building other types of intersectoral teams for program implementation,⁸⁴ which are all potential steps toward creating multi-sectoral engagement and fostering social change and stakeholder ownership as it relates to outbreak preparedness, management and control. However, at least two of these studies^{83,84} were of limited duration (less than one year) thus it was not possible to assess the sustainability of measured outcomes, and/or their social impact.

The other three studies in this unit of analysis were each related to different kinds of interventions that were implemented within a multi-sectoral framework. Coady *et al.*⁸⁶ describes increased interest in receiving influenza vaccine among hard-to-reach populations as a result of an integrated communication and social mobilization program through which both researchers and community members provided information and counseling via multiple channels. Conversely, Facanha *et al.*⁸⁷ examined the impact of health team training and active community surveillance by area residents on TB detection, with significant increases in the number of detected cases. Finally, Baly *et al.*⁸⁸ looked at the cost-effectiveness of multi-sectoral participatory approaches versus vertical interventions (see *Costs* section for additional details).

Eligible studies in this unit of analysis included only one RCT⁸² while other studies included designs such as longitudinal assessments, pre–post-test, and quasi experimental. Therefore, the quality of the evidence also varied as for the other units of analysis, and pointed to the need for additional studies on this topic.

Looking at indicators of behavior readiness, adoption and sustainability, and improved health service delivery.

Indicators of behavior readiness, adoption, and sustainability

As for the theoretical framework of this review relevant to the Ideation Theory,^{24–26} health and social behaviors are determined and influenced by multiple factors (ideational elements) including social norms, environmental support or constraints, knowledge, attitude, social support, self-efficacy, and others (see Theoretical Model and Key Objectives section for additional details). ‘Ideation refers to new ways of

thinking and the diffusion of those ways of thinking by means of social interactions’ and therefore provides a valuable framework to analyze key determinants of health and social behavior readiness ‘in local communities’⁸⁹ as well as within the healthcare, and multi-sectoral settings and the groups and stakeholders that belong to them. According to this theory, ‘the more ideational elements that apply to someone [or a community or a specific group], the greater the probability that they will adopt a healthy behavior’.⁹⁰ Within this perspective, a secondary objective of our review was to identify and assess within eligible studies any evidence on indicators of *emergency behavior readiness*, and ultimately, *adoption and sustainability*, in reference to the health and social behavior outcomes that the interventions within eligible studies may have achieved or sought to achieve. In the context of outbreak and/or emergency preparedness and response, ‘behavior readiness’ is a multi-dimensional construct consisting of a combination of cognitive processes of self-efficacy (confidence in own skills to adequately perform recommended behavior) and response efficacy (trust in the ability of recommended behavior to increase chances of staying healthy during an emergency/disease outbreak) as well as a checklist of the number of items that have been stored or the kinds of emergency plans that have been made in preparation for it.⁹¹ None of the studies identified for this review measured behavior readiness as defined above. However, most studies did measure various ideational elements that may contribute to behavior readiness, or adoption, and sustainability such as knowledge, self-efficacy and attitudes^{61,66} among specific groups or communities. Yet, no significant analyses of the correlation among each or all of these ideational elements and behavior readiness, adoption or sustainability was clearly emphasized by any of the studies in this review. Also, several of the studies that looked at intermediate steps toward behavior adoption and sustainability consisted of pre- and post-test measurements, and therefore carried major limitations within the actual study design to assess any kind of progression toward behavioral outcomes.

Indicators of improved health service delivery

Similarly, very limited evidence was available within eligible studies as it relates to potential *key indicators of improvement in health service delivery* during epidemics and emerging disease outbreaks. This was also a secondary objective of the review as we attempted to extrapolate and assess any relevant information on this topic within eligible studies. As most of the interventions assessed in this review focused on assessing behavioral and social outcomes (or intermediate steps that may lead to them), we did not have a large pool of eligible studies from which to

extrapolate and assess this kind of information. In fact, only two studies in the healthcare setting unit of analysis may have implications for health service delivery improvement and two studies in the multi-sectoral unit looked at health systems outcomes. Within these studies, only two may have implications and/or raise interesting questions for future research and practice as it relates to indicators for improved health care service delivery. For example, and as previously mentioned, Thiam *et al.*,⁸¹ described a treatment decentralization intervention to improve access to care and increase adherence to TB treatment. While no health service delivery data were presented in this study (which focused primarily on patient outcomes), treatment was found to be more successful when patients were given the flexibility to choose their therapy supporter (88% of patients supervised by a family member were cured compared to 77% of all other treatment supervisors, which consisted of nurses, community health workers or other community members). In addition, only 3.9% of patients defaulted when treatment was supervised by family members compared with all other treatment supporters (7.9%). The telephone triage system described by Eppes *et al.*⁸⁰ may also have implications for future technology-driven interventions to optimize the efficiency of resources in hospital settings, and ultimately health service delivery. Similarly, a third study⁸⁷ reported improved TB detection as the result of health team training and community-based surveillance strategies, which could be analyzed by future studies in reference to potential implications for improved health service delivery.

As in the case of indicators of behavior readiness, adoption, and sustainability, evidence on indicators of improved health service delivery was limited and inconclusive and, therefore, this warrants further studies and analyses.

Cost- and health equity-related issues: observations from select studies

Cost

As health and risk communication and health promotion interventions always afford some costs, key decision makers are often confronted with having to make decisions on cost-effectiveness and cost-benefit issues. This speaks in support of the need for rigorous assessments of such parameters⁹² especially in limited resources settings such as LMICs. In cost-effectiveness evaluations, 'only program costs are expressed in monetary terms. Benefits are expressed only in terms of the impacts or outcomes themselves (they are not given a dollar value)'.⁹³ Instead, cost-benefit evaluations assess programs 'in terms of costs. It measures both the program costs and the results (benefits) in monetary terms'.⁹³ While the scope of this review does not include an analysis of

any cost-related issues, a few interesting observations emerged from some of the studies included in this review and are reported here, so they may inform future research on this critical issue.

For example, a few of the studies that focused on evaluating community mobilization strategies,^{56,61} mentioned that 'such interventions can prove both cost-effective and cost-beneficial'.⁵⁶ Therawiwat *et al.*⁶¹ observed that 'the one cost-effective measure that provides effective disease control over the long run is involving the persons who are responsible for creating or tolerating' larval habitats in the control and elimination of such habitats in their communities. Another study⁸⁸ conducted cost-effectiveness and economic appraisals as they relate to different kinds of interventions for Dengue control, and more specifically to the control of the disease's vector, *A. aegypti*. Although both interventions in this study resulted in equivalent reductions of the number of foci of *A. aegypti* (the study's key effectiveness measure), Baly *et al.*⁸⁸ found that the community-based approach was more cost effective both from a health-systems perspective (USD 964 vs. USD 1,406 per focus) and a society perspective (USD 1,508 vs. USD 1,767 per focus) than routine top-down program activities. Other authors have also discussed the potential positive implications of community participation on cost-related issues⁹⁴ and/or noted that 'community participation may help us target resources more effectively and more efficiently'.^{95,97} Yet, it's unclear if any of the above findings and observations are applicable across different country settings, health systems, disease areas, and/or types of outcomes.

Differences in the cost-effectiveness of specific venues were also noted by a few eligible studies. For example, Gargano *et al.*⁵⁷ highlights that school-based vaccination clinics are potentially more cost-effective than similar interventions within primary care physicians' offices or public clinics because of the ability to efficiently vaccinate large numbers of children. This study found that the efficacy of a multi-component school-based vaccination program on improving vaccination rates was greater than in the case of a similar program administered via local healthcare providers in clinical settings. Both programs also included an education outreach component for both adolescents and their parents.

Cost-related analyses are also needed to assess the feasibility of broadening the reach of pilot programs and/or scaling up interventions that may have demonstrated effectiveness in small geographical areas or specific communities. For example, Luby *et al.*⁶² report on the effectiveness of households visits in encouraging handwashing to prevent childhood diarrhea among high-risk communities of Pakistan. Yet, the authors discuss that the cost of this kind of intervention may be

an important limitation to be considered in broadening its implementation in their specific country setting. Similar concerns on the potential implications of the intervention's cost for future scaling up phases were noted by Conan *et al.*⁶⁰ in relation to a program utilizing cascade training, which is also known as 'training of trainers'. Yet, a previous study to which we compared such observations, noted that cascade training can be advantageous because of its low cost and ease of implementation.⁹⁶ No specific cost data were collected in any of these studies, which points to the need for further investigation.

Measures of the intervention's direct costs or its impact on costs afforded by patients were included only in three out of the 29 eligible studies in this review (which we discuss above).^{75,79,88} For example, Kimura *et al.*⁷⁵ assessed interventions to increase health workers immunization rates in the US, and noted that their education campaign and 'Vaccine Day' event resulted in estimated costs of USD 1,150 for a facility of 100 employees, with the majority of costs being accounted for by the cost of the influenza vaccine. Phuong *et al.*⁷⁹ assessed a combined approach, including health worker training and the introduction of rapid diagnostic tests, and found that this intervention resulted in reduced prescriptions of antibiotics and lower costs for patients (median of USD 0.95).

Other cost-related observations within reviewed studies included issues about the intervention's sustainability⁶⁴ or country- and disease-specific strategies to reduce the cost of the intervention.⁶⁵ Overall, very limited concrete evidence was discussed within eligible studies on the cost-effectiveness or cost-benefits or any other cost-related issues and measures as applied to any of the interventions we discuss in this review. Additional research and reports on cost-related issues appear to be needed.

Reaching vulnerable populations and health equity-related issues

Health inequities are often the result of the environment in which people grow, live and work and the kinds of health systems and information they are able to access. Such inequities can affect all people as they relate to different health and social issues, from prevention of crime and violence, to obesity or disease outbreaks. Identifying the root causes of inequities and the contribution of different social factors that may determine them (also called 'social determinants of health' such as age, gender, socio-economic status, geographic location, built environment, and race) can assist community health workers, policy makers and others to guide decisions on where and how to effectively intervene.

Similar to the costs section, the scope of this review did not include an analysis of equity issues, however,

we have highlighted a few relevant observations that emerged. In approaching such observations, we address primarily two questions: (1) Were vulnerable and underserved populations and other high-risk groups (such as those defined by socio-economic status, geography, race, gender, age, disability status, or others that are identified to be at greater risk during epidemics and outbreaks), included in the reviewed studies? and (2) Were there any specific strategies highlighted by eligible studies as they relate to communicating risk and promoting outbreak control measures among such at-risk groups? If yes, did they have any impact also on social determinants of health?

Seven of the studies reviewed did focus on specific age groups.^{56,57,62,64–66,84} Of these studies, five specifically targeted only children and adolescents^{56,57,64–66} as this age group is considered not only vulnerable in contracting certain infections, but can also be important vectors of spreading infectious diseases, amongst their peers, families and communities. This is particularly relevant in densely populated urban areas of LMICs.

Gargano *et al.*⁵⁷ conducted their multi-component outreach interventions targeted at adolescents in middle and high schools in rural counties in southeast United States. In addition, the interventions were based in communities predominantly comprised of low-income African-Americans, a traditionally underserved population. The Sanchez *et al.*⁸⁴ study conducted in Cuba focused their communication and social mobilization messages towards both children and elderly, while McPhee *et al.*⁵⁶ not only focused on a specific age group, but also a specific ethnic group of the Vietnamese population in the US because of their greater risk of developing Hepatitis B.

Pregnant women and patients with end-stage renal disease (ESRD) are other examples of vulnerable populations at greater risk during epidemics and outbreaks.^{98,99} Eppes *et al.*⁸⁰ implemented a telephone triage system to improve capacity of a hospital to handle the needs of pregnant women during the 2009 H1N1 pandemic, while Bond *et al.*⁷⁷ focused on improving influenza vaccination rates of patients with ESRD in dialysis centers. Other examples of populations at greater risk include substance abusers, immigrants, sex workers and homeless persons,¹⁰⁰ who were the intended populations of Coady *et al.*'s⁸⁶ multi-level community-based participatory research intervention to increase influenza vaccination rates in New York City.

Two studies incorporated gender-specific approaches and women messengers into the design of their intervention as key strategies to increase the reach of health messages among parents of female high schoolers in Egypt⁶⁶ or female Cambodian villagers.¹⁰¹

Limited resource environments as found in LMICs also impact health equity and require the development of specific strategies to meet the needs of such settings. Several studies aimed to address this challenge in the design of their intervention through engagement and community participation.^{61,81,87} An intervention by Façanha *et al.*,⁸⁷ specifically designed for a low-income community in Brazil, engaged and trained health professionals/students and community health agents in the treatment and control of TB and/or active surveillance of TB cases. Therawiwat *et al.*'s⁶¹ study focused on engaging members of an at-risk community in Thailand as the rates of dengue hemorrhagic fever in the district was among the highest in the country. The community members were required to carry out source reduction measures with the goal of continuously linking such behaviors with the community's culture and lifestyle. Meanwhile, an intervention conducted in Senegal,⁸¹ focused on decentralizing the location of TB treatments to increase access to remote areas, also included community health workers that visited patients who were at risk of stopping treatment. These studies highlight the potential feasibility of implementing multi-level comprehensive interventions in a challenging environment, so that these communities won't be alienated from disease mitigation measures.

Many of the reviewed studies did include interventions intended for vulnerable, underserved and at-risk populations, whether by age, gender, race, geographic location or health status. Some discussed issues of language barriers within multi-cultural settings,⁶⁸ or limited access to or use of specific media^{69,63} within low-resource settings and or higher risk areas. Several studies also acknowledged the limitations of low-resource settings, which points to the potential for reproducibility of some of the interventions in LMICs, while other interventions were specifically designed and successfully implemented in LMICs, through such strategies as community engagement and decentralization of treatment clinics. While the findings of the select studies are promising, it is difficult to conclude the potential of impact of the interventions on social determinants of health. As they play a critical role in the development of health inequities, additional research related to the social determinants of health is warranted.

Discussion and Conclusions

The review identified a number (29) of quantitative evaluation studies on interventions that sought to communicate risk and/or promote disease control measures in epidemics and emerging disease settings at the community, healthcare or multi-sectoral levels. Such a number is comparable to that of eligible

studies within the few reviews on related topics we retrieved via our comprehensive search. While most eligible studies have implications for low-resource settings and/or vulnerable and high-risk populations such as those in LMICs, only a percentage of them (7 out of 29, 24%) were actually conducted in a LMIC setting, but all had implication for low socio-economic settings and/or vulnerable and underserved populations as for our inclusion and ranking criteria. This is a first limitation of this review vis-à-vis its objectives. Conflicting priorities, and limited resources and capacity for quantitative assessments may account for limited evidence from LMICs. Although on different topics or focusing only on one specific communicable disease, other reviews also confirm the paucity of evaluated interventions in LMICs.¹⁶ Overall, a systematic approach to the evaluation of health communication and health promotion interventions is still not as common as several organizations and authors would hope, with – for example – only an estimated one third of health communication campaigns being evaluated vis-à-vis measurable objectives.¹⁰² Moreover, a question needs to be raised here also about the potential frequency of and existing capacity within LMIC setting not only to assess but also to design and implement the kinds of interventions discussed within this review. Other authors,^{37,71,103} have highlighted the need to build capacity and capability of different countries and communities to 'manage efficiently all types of emergencies' (Ref. 103, p. 8), including but not limited to the research and evaluation component. Yet, the assessment and discussion of current capacity and organizational practices is outside the scope of this review.

Regarding methods for intervention assessment, the overall quality of the studies included in this review is reasonable ('high' to 'moderate-to-low' as it relates to CASP ranking, 'high' to 'low' as it relates to applicability to LMIC). Yet, several limitations need to be mentioned. These include the short duration of several studies, the fact some of the studies focused on evaluating only select components of larger interventions, and the absence of a control group such as in the case of studies with pre-post-test evaluation design. Other kinds of systematic reviews which also focus on assessing evidence that may be relevant to LMICs were presented with similar limitations in relation to the quality and nature of quantitative studies.¹⁶ Of interest, all eligible high-quality RCTs (14 out of the 29 eligible studies) were conducted from 2007 onward, thus perhaps signaling an increased emphasis on a more rigorous evaluation of these kinds of interventions within disease outbreak settings. Such emphasis may reflect the more recent call for accountability and investment on

monitoring and evaluation by several authors, funders and prominent organizations.^{104–107}

A third limitation is the fact that a few specific interventions (e.g. household visits, worksite programs) assessed by eligible studies are each supported only by one study or in any case by a very limited number of studies throughout the review. Finally, a limitation that is not unique to this review is that we may have inadvertently excluded studies that were not included within the resources we searched. Yet, we conducted a very comprehensive literature search over five major electronic databases as well as other Internet resources.

Because of the above limitations, no conclusions can be made in reference to the overall effectiveness of any of the specific interventions discussed in this review across different country settings and disease areas nor within a specific epidemic or emerging disease area or country setting. Yet, the review furthers our understanding of emerging themes in health risk communication and health promotion, and identifies several relevant interventions and research gaps for further investigation.

Most eligible studies focused on evaluating interventions that sought an impact on health and social behaviors within specific groups. As it relates to other types of outcomes only two studies had implications for improved health service delivery, two studies examined the intervention's impact on health systems-related outcomes, and three had implications for environmental health outcomes. This primary focus on health and social behaviors of specific communities and at-risk groups (and in few cases, healthcare providers) did not expand to include any conclusive analysis on the interventions' potential impact on key social determinants of health (e.g., socio-economic conditions, access to services and information, culture, ethnicity, etc.) and people's living, working and aging environments as they relate to epidemics and emerging disease control and relevant health outcomes. A few studies mentioned limitations in their approach in association with select determinants of health such as access to health services or specific media (e.g., mobile technology, web-based interventions) or language barriers but only two of them included, proposed and/or evaluated potential approaches to address them.^{68,79} As an increased focus on social determinants of health to eliminate health disparities in many health areas is supported by multiple authors and organizations,^{108–110} additional evidence and interventions to explore the impact of addressing such determinants within the context of communicating risk and promoting disease control measures is much needed. Even if we acknowledge that there might be interventions that seek to have an impact on such

determinants, they do not appear to be reported within the context of quantitative evaluations or they may be primarily discussed in the 'grey' literature that is more difficult to search or does not offer any conclusive evidence.

While most studies focused on single interventions, multi-component interventions, which combined different strategic areas and related media channels (e.g. interpersonal, community mobilization, event outreach, print media, mass media, etc.), emerged as a key theme within several studies in the healthcare and multi-sectoral settings units of analysis with fewer studies also within the community setting level. As communicating risk and promoting disease control measures is a complex endeavor, several theoretical models, and planning frameworks^{41–48,119,120,121} support the importance of integrating different strategic areas and media channels of health communication and health promotion in order to improve effectiveness and impact on health outcomes. Our review also includes preliminary evidence in support of an increased focus on multi-component and integrated approaches because of relevant outcomes in different country settings and disease areas and among lay and professional groups, which were highlighted by several eligible studies.^{69,73,75,82–86} Among them, relevant studies within the multi-sectoral unit of analysis all integrated strategic health communication and social mobilization approaches and related media channels. There is validity in the argument that no magic bullet, single-level intervention is likely to be effective in epidemics and emerging disease settings. Yet, as evidence is not conclusive, future studies should compare single interventions versus multi-component interventions to test such argument.

The role of community-based interventions as well as community participation in achieving health and social behavior outcomes within a variety of groups and communities appeared to be supported by a majority of the studies in the community setting unit of analysis and several studies in the other units (including a treatment decentralization intervention which involved remote health posts and the involvement of community health workers, and family members as treatment supporters, community empowerment and participation in dengue control, and several other community mobilization interventions). Since the quality of evidence varied across studies – along with the number of studies that discussed a specific type of intervention – more conclusive evidence on different approaches for community mobilization and citizen engagement is needed, including potential impact on long-term community action on relevant issues. The case for community mobilization and citizen engagement in public

health emergencies has been already made by lessons learned from past epidemics and other authors^{37,71,111–113,119,122} but needs to be supported by more conclusive evidence.

Linking intermediate steps, ‘ideational elements’, (e.g. knowledge, attitudes, changes in social norms, etc.) to progression (or lack of) toward health and/or social behavior readiness, adoption, and sustainability is also another area for future interventions and investigation identified by this review. While a few studies looked at such intermediate parameters, no connection with any progression toward behavioral outcomes was investigated because of the design or objectives of these specific studies. Several research questions to strengthen cost-effectiveness research and build adequate capacity to evaluate cost-related measures in LMICs were also identified: How best to compare different intervention strategies in terms of their cost-effectiveness as well as the influence of costs on the intervention’s long-term sustainability? What is the long-term cost-effectiveness of top-down programs versus interventions that include community participation and empowerment? How data collection on cost-effectiveness and benefits could be improved in LMICs? What kind of specific competencies are needed in LMICs to build capacity for cost-related research? As cost-related research continues to build, future evidence is well poised to answer the above questions and may assist in the development of a framework to prioritize resource allocation and future investments

Finally, two other findings unveiled promising themes and additional needs for future investigation. First, although only seven studies were eligible for inclusion in the multi-sectoral setting level (which includes interventions that sought to affect the policy, social, or economic environment, and therefore engage and have an impact within multiple sectors), two of them had implications for potential health system-related outcomes, suggesting that multi-sectoral approaches and strategic partnerships should be emphasized and assessed by future interventions as they may be best suited to affect outcomes at different levels of society during epidemics and emerging disease outbreaks as some authors and lessons learned from past outbreaks have been predicting.^{37,39,71,114} As health communication^{7,8,31} and health promotion are both relationship-building disciplines^{31,115,116} they can potentially contribute to furthering such collaborative agenda also within other kinds of public health interventions outside of these specific disciplines. Second, the review did not identify any eligible study focusing on health policy-related outcomes (whether policy adoption or enforcement) or health policy behavior. Other authors¹¹⁷ also reported on similar findings as no peer-reviewed article or systematic

assessment of the impact of strategies leading to animal health policies for highly pathogenic avian influenza was found. Yet, Stephen *et al.*¹¹⁷ also validated the importance of strengthening the foundation for this kind of evidence and concluded that the ‘core public health competencies of leadership, communication, collaboration, research to action, and capacity for assessment and analysis can serve as a foundation for emerging zoonotic diseases policy development’. Outside of – but including emerging zoonotic diseases – our review revealed a significant gap in the literature and pointed to the need for advocacy tools, increased investment, formal guidance, and further engagement of policymakers and other key players (e.g., international organizations, academia) to strengthen evidence on interventions that may have an impact on health policy-related outcomes.

Overall, this review provides useful background information and relevant topics to be considered for further investigation both within research and practice settings in support of the work of academicians, practitioners from multiple sectors, local and international organizations, and policymakers who are engaged in global health and development and, more specifically, in communicating risk and promoting disease mitigation measures within epidemics and emerging disease settings.

Moving forward

This review identified several promising interventions and research questions for further exploration. Yet, given the many conflicting priorities, limited resources and capacity of LMIC settings,¹¹ the ability of a variety of government agencies, academic institutions, non-profits, and other types of organizations from these countries to strengthen evidence on suitable interventions to communicate health risk and promote disease control measures may be strictly dependent upon: (a) a comprehensive assessment of current research, monitoring and evaluation, and intervention design, implementation, and assessment competencies as well as training needs of different organizations, professionals, communities, and country settings; (b) the development and implementation of capacity building and professional development interventions that address the needs identified by the aforementioned assessment; (c) increased coordination among governments and different professional sectors and community leaders; and (d) the development and dissemination of formal guidance, resources, and implementation tools by multi-lateral/international organizations and other relevant stakeholders, so that new thinking and skills could be honed by key players in LMICs.

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