UK Health Security Agency

Effective strategies for communicating with the public about chemical, biological, radiological, nuclear, or explosive events

A rapid systematic review

Contents

Main messages

1. This rapid review was a partial update of a systematic review published in 2012 (1). This rapid review (search between 1 January 2011 to 7 April 2024) identified and summarised evidence relating to the effectiveness of strategies for communicating with the public about chemical, biological, radiological, nuclear, or explosive (CBRNe) attacks and relevant civil events (accidental CBRNe events).

2. Twelve articles were included which measured the effectiveness of communication after a CBRNe attack or relevant civil event (2 to 13). Of these, 9 reported on the 2011 nuclear accident in Japan (2 to 10), one reported on a bombing in the United States in 1995 (12), one reported on an accidental explosion in 2013 in Canada (11), and one reported on a chemical spill in 2005 in the United States (US) (13).

3. The outcomes of the included studies were indicators of the effectiveness of communication strategies after CBRNe or similar accidental civil events, including levels of concern (2), mental fatigue (defined as often feeling mentally tired or depressed (3)), risk perception (4), and communication lessons learned (5 to 13).

4. Three cross-sectional studies found that people who used television, radio, or the internet as their primary sources of information about the Fukushima nuclear accident reported increased risk perception (4) but also increased feelings of concern relating to radiation (2), and reported mental fatigue (3). One of these studies also reported that people were less concerned about radiation after attending a seminar on radiation (2).

5. One study analysed newspaper articles relating to the Fukushima nuclear accident, reporting that the media often misrepresented radiation information (5).

6. One study conducted interviews and analysed media communications about an accidental explosion which occurred as a result of the Lac-Mégantic train crash in Canada, involving a freight train carrying crude oil in 2013 (11). This study reported that crisis communication using social media was made difficult by power cuts and the remote location of the crash site. They also noted that not all members of the public use social media, and use of community gatherings and radio was more effective to convey information.

7. One narrative opinion piece described lessons learned from a community engagement strategy regarding a train crash involving a chlorine gas release in Graniteville in the US in 2005 (13). The article discussed that a collaborative communication strategy involving public health officials, academics and community residents helped to foster trust in and transparency of information, as well as active participation in public health research years after the chemical spill.

8. Critical appraisal of the included studies highlighted that all studies had potential risks of bias in their findings. Cross-sectional surveys relied on subjective data about participants' emotions, and self-reported information use, which may lead to bias in the outcomes. The majority of included studies were descriptive rather than analytical and relied on subjective researcher interpretations of findings. There is no validated tool to critically appraise grey literature, but these studies may still be subject to the same risks of bias as published literature.

9. In summary, this rapid review identified limited new evidence about the effectiveness of communication strategies during and after CBRNe events, since publication of an earlier systematic review conducted in 2012 (1). Most of the included studies reported on the Fukushima nuclear accident in Japan. There was some evidence suggesting that people who use television and internet as their primary information source about a CBRNe event may experience increased risk perception, but also increased levels of concern and mental fatigue. However, the evidence identified was mostly descriptive, therefore it was difficult to draw conclusions about the effectiveness of communications strategies used in these CBRNe events.

Purpose

The purpose of this rapid review was to identify what communication methods are effective in delivering public health messages to the public before, during, and after a chemical, biological, radiological, nuclear, or explosive (CBRNe) attack.

Methods

A rapid review was conducted, following streamlined systematic methods to accelerate the review process. A literature search was undertaken to look for relevant published studies and grey literature, between 1 January 2011 to 7 April 2024.

Grey literature was defined according to the Luxembourg definition, which includes "that which is produced on all levels of government, academics, business and industry in print and electronic formats, but which is not controlled by commercial publishers" (14).

Screening title and abstract was undertaken in duplicate by 2 reviewers for 20% of the eligible studies, with the remainder completed by one reviewer. Screening full text was undertaken by one reviewer and checked by a second. Data extraction was performed by one reviewer and checked by a second.

Risk of bias assessment was conducted in duplicate by 2 reviewers using the JBI critical appraisal checklists for cross-sectional studies, qualitative studies, and textual evidence (narrative and expert opinion checklists).

A protocol was produced before the literature search was conducted, including the review question, the eligibility criteria, and all other methods. Full details of the methodology are provided in the protocol in Annexe A. There were no deviations from the protocol.

The search dates were chosen to follow from a systematic review on a similar topic conducted in 2012 (1) The inclusion criteria of this review was amended to exclude studies about communication strategies in hypothetical CBRNe attacks, and to include studies which summarised newer forms of communication strategies, such as social media. To capture all potentially relevant evidence that might inform what to do in an attack, evidence from accidental CBRNe events were also included. A full list of the amendments made are available in Annexe A.

CBRNe events were defined as follows (15):

- chemical: poisoning or injury by chemical substance
- biological: malicious exposure to harmful bacteria, viruses, or toxins and the illnesses or disease they cause
- radiological: exposure to harmful radioactive materials
- nuclear: exposure to thermal or blast effects arising from a nuclear detonation
- explosions: a sudden release of energy from a device, using chemical or nuclear means, resulting in a shock wave (highly compressed air spreading rapidly from the centre of the explosion source)

Communication strategies were defined as any communication channel used to deliver a public health message to the general population.

Evidence

In total, 7,872 primary studies and 44 grey literature articles were screened at title and abstract. The full text for 4 studies could not be retrieved (16 to 19). Twenty-two additional studies were identified from citation searching, and 116 studies were screened at full text. Of these, 12 studies met the inclusion criteria.

A PRISMA flow diagram summarising the screening process is available in Annexe B. Studies excluded on full text screening are available with the reasons why in Annexe C. Full details of included studies are available in Annexe D. Results from risk of bias assessment are available in Annexe E.

The 12 included studies described 4 CBRNe events, including the nuclear accident in Fukushima (Japan) in 2011 (2 to 10), the accidental explosion as a result of the Lac-Mégantic train crash (Canada) in 2013 (11), the bombing in Oklahoma City (US) in 1995 (12), and the chemical spill from a train crash in Graniteville (US) in 2005 (13).

There were 3 cross-sectional studies (2 to 4), one qualitative study (11), one descriptive media content analysis (5), 4 narrative opinion pieces (8 to 10, 13), and 3 grey literature articles (6, 7, 12). The grey literature included were 2 unpublished doctoral theses (6, 12), and one report by the Fukushima Nuclear Accident Independent Investigation Commission (7). Six studies were conducted in Japan (2, 3, 7 to 10), 3 in the US (6, 12, 13), one in Canada (11), one in Belgium (4), and one was conducted collaboratively between researchers in 5 countries (Belgium, Italy, Norway, Russia, Spain and Slovenia (5)).

The outcomes of the included studies were indicators of how effective communication strategies were after CBRNe events. These outcomes included levels of concern (2), mental fatigue (3), risk perception (4), and other communication lessons learned (5 to 13).

Nuclear accident in Fukushima, Japan, 2011

Nine studies investigated communication strategies about the nuclear accident which occurred as a result of an earthquake which caused a tsunami on the 11 March 2011 in Fukushima, Japan (2 to 10).

Cross-sectional studies

Sugimoto and others conducted a survey after the nuclear accident in Fukushima in 969 people, aged 16 to 70 years old (70% female, 64% aged 50 years and older), between June and July 2011 (2). The survey asked respondents about their concern regarding the effect of radiation on health, and the information sources they used about the nuclear accident, immediately before and immediately after receiving seminars on the effects of radiation on health. Concern was measured on a 5-point scale from not concerned at all (1 point) to very concerned (5 points). The study identified 3 categories of radiation concerns, which included fears about health, fears about the future, and fears about social disruption. The study reported a decrease in radiation concerns across all themes after receiving the radiation health seminars ($p < 0.0001$, no raw data provided). Respondents who used regional newspapers as their source of information reported greater fears about the future (beta coefficient: 0.18, 95% confidence intervals [CI]: 0.04 to 0.32, p=0.01), than respondents who used national newspapers (beta coefficient: -0.14, 95% CI: -0.26 to -0.01, SE: 0.06, p=0.03). Fears about social disruption were higher in respondents who used radios as their source of information (beta coefficient: 0.16, 95% CI: 0.05 to 0.27, p=0.003).

Yumiya and others conducted a survey in 2,130 people, between 2013 to 2015, after the nuclear accident in Fukushima, Japan (3). The survey asked respondents about the information source they used regarding progress of reconstruction after the disaster (newspaper, television, radio, internet, social media, public relations sources, and printed papers). Mental fatigue was defined as feeling mentally tired or depressed often. The survey was conducted independently 3 times over the 3 years, with 758 respondents in 2013 (79% male), 699 respondents in 2014

(67% male) and 673 respondents in 2015 (74% male). The study identified 5 categories of information sources used by respondents:

- cluster 1 (599 participants) primarily used major media (such as newspapers or television) and multiple public relations sources (national, prefecture, and municipal)
- cluster 2 (366 participants) used a combination of all information sources measured
- cluster 3 (237 participants) primarily used municipal public relations and major media
- cluster 4 (399 participants) used a combination of television, radio and word of mouth
- cluster 5 (529 participants) used major media only (such as newspapers or television)

The highest levels of mental fatigue were reported in clusters 2 (variable information sources used, odds ratio [OR]: 2.35, 95% CI: 1.27 to 4.33, p=0.01) and 4 (a combination of television, radio and word of mouth, OR: 2.56, 95% CI: 1.41 to 4.66, $p < 0.01$). This analysis adjusted for the effects of survey year, age, sex, regional area, and occupation.

Vynke and others collected data from a public opinion survey after the Fukushima nuclear accident in 938 Belgium residents, between August to September 2013 (4). The survey asked respondents about their perceived health-related risk of the nuclear accident and the source of information they used about the accident (traditional media, new media, social media, and interpersonal communication). The study reported higher risk perception in people who used television as their primary information sources about the nuclear accident (unstandardised beta coefficient: 0.353, SE: 0.149, $p < 0.05$) as well as 'other' secondary information sources such as YouTube (unstandardised beta coefficient = -0.647, SE: 0.208, $p < 0.05$).

These cross-sectional surveys collected data about the participants' emotions and self-reporting of information source used. The subjective nature of the reported outcomes may therefore be at risk of bias.

Descriptive analysis

Tomkiv and others analysed 1340 newspaper articles directly and indirectly related to Fukushima, from 2 selected newspapers in 5 countries (Belgium, Italy, Norway, Russia, Slovenia and Spain), published between March and May 2011 (5). The countries were chosen because of their mixture of nuclear energy status (some countries have no nuclear energy production, others use nuclear energy to varying extents). Articles were categorised by quantitative information (such as radiation measurement units) or qualitative information (such as risk comparisons). Direct quotations from the articles were analysed for misinterpretations and mistakes by 2 independent researchers. The authors concluded that:

- "one of the most common misinterpretations was referencing to norms, which do not exist (like normal levels of radionuclide content in seawater) or using the wrong norm. In addition, articles often referred to 'norm' or 'normal level' without explaining what is meant by a normal level"

- “another mistake was mixing up of the allowed levels for the population and for the emergency workers”
- “journalists were often mixing up dose and dose rate or simply did not present the difference between them”
- “another issue found was misrepresentation, or oversimplification, of the rationale behind the official norms and limits. In some of the articles, permitted levels of radiation were referred to as safe”

It should be noted that this study did not discuss the potential for the values and beliefs of the researcher to influence interpretation of the study’s findings (such as their cultural background or prior beliefs), which may have biased the study conclusions.

Narrative opinion pieces

Three narrative opinion pieces conducted between 2011 to 2013, described the need for accessible language in communication of information about the Fukushima nuclear accident (8 to 10).

These studies did not conduct any quantitative or qualitative analyses, but rather provided the author’s opinions on data collected elsewhere without providing detail. Their discussions can be summarised as follows:

- people were confused about the quality of information provided and often did not know which information to believe (8)
- scientific information was not effective at communicating risk unless conveyed using accessible language (8, 9)
- the public might misunderstand risk comparisons (for example, they might become afraid of the risk comparison instead of feeling reassured, or they might start to take preventative medication with harmful side effects because they are worried, even though they live in a low risk radiation area) (9, 10)

Murakami and others also noted that small group discussions with members of the community (such as village representatives, doctors and public health officials) were effective in allowing people to share their concerns about radiation and improve relations between the public and local authorities (8).

It should be noted that as these narrative pieces are author opinions on data collected elsewhere, and the professional background of the authors was not reported, the findings of these articles are subjective.

Grey literature

Two articles about the Fukushima nuclear accident were included, one report by the Fukushima Nuclear Accident Independent Investigation Commission (7) and one thesis (6).

The report by the Fukushima Nuclear Accident Independent Investigation Commission included a postal survey (conducted between March to April 2012) of 10,633 people (response rate: 50%) who were forced to evacuate as a result of the Fukushima nuclear accident (7). The respondents provided their opinions about emergency communication strategies from municipalities, police, television, radio or internet and the Fukushima power plant owner. There were different communication strategies used in different local areas. Municipalities and the police served as the sources of accident information for 40% of residents of Futaba and Naraha, but only for 10% of residents of Minamisoma, Iitate, and Kawamata. The authors concluded that there was a delay in information communication from both the operators of the Fukushima power plant and the government:

- “awareness of the accident was extremely low among evacuated residents despite releases of information according to Article 10 at 15:42 on 11 March, a report according to Article 15 at 16:45, and declaration of state of emergency at 19:03”
- “there were significant differences in the speed of transmission of accident information to the evacuation areas”

A doctoral thesis by Li investigated information technologies in disasters, including an analysis of 38,300 ‘retweets’ (reposting another users’ Twitter post) about radiation after the Fukushima nuclear accident, from March to April 2011 (6). The nuclear accident occurred on 11 March 2011, and the analysis of data was separated into 3 periods. Period one included retweets about radiation up to 29 March 2011 (579 retweets), period 2 included retweets about radiation between 29 March to 3 April 2011 (493 retweets), and period 3 included retweets about radiation between 4 April to 8 April, 2011 (450 retweets). The thesis reported that, of the 25 most retweeted messages, 9 (30%) conveyed information from a government organisation or official about the nuclear accident (23 of which were conveyed from authenticated major media, 2 were from personal accounts). Li reported that the remaining information came from a variety of independent sources. Period one had the highest number of retweets of government messages (5.7% distinct messages accounted for 14% of total retweets in the sample, a 145% amplification). A reduction was seen in total number of retweets of government messages in period 2 (dropping to 7.4% of total retweets from the sample), which rose again in period 3 (returning to 13.4% of total retweets, a 46% amplification). The author noted that there was a large increase in messages which communicated doubt in period 2, corresponding with the drop in amplification of information from the government.

These articles were not critically appraised because there is no validated tool for critical appraisal of grey literature. Grey literature has not been peer-reviewed and may be subject to similar risks of bias as peer-reviewed published evidence.

Explosions

Two articles investigated communication strategies about explosions including the explosion resulting from the accidental Lac-Mégantic train crash in 2013 (11), and the Oklahoma City bombing in 1995 (12).

David and others conducted semi-structured interviews of local authorities involved in the crisis response to the Lac-Mégantic train crash in Canada between April and September 2015 (11). Participants were interviewed about their experience of the explosion event, including their opinions on the usefulness of and various issues with communication strategies used. Details of the recruitment process to the interviews were not provided, but participants included spokespersons, officials, members of public safety, government, police, other government bodies, and health management. The study also analysed more than 60 communication artefacts about the train explosion (such as radio programmes, printed communication, and press releases), and a press review of news media coverage between 6 July to 31 July 2013. The authors concluded that:

- initial communication strategies, in particular social media, were hindered by the accident site's remote location, as well as electrical blackouts caused by the destruction, and literacy issues ("direct communication with the victims was problematic owing to major difficulty understanding such messages")
- adaption of initial communication strategies to focus more on local media (radio, distribution of simplified leaflets and community gatherings) were more effective at conveying public health messages

A doctoral thesis by Heltz included a historical review of 84 documents from government and non-government agencies relating to the Oklahoma City bombing in the US between April 1995 and September 2015 (12). The documents included were local, state, and federal government reports, public records, research publications, published histories, personal accounts, and media reports. The author summarised that:

- "alternative options for communication networks needed to be in the plan"
- "media often overstepped their roles and caused additional recovery challenges due to the release of misinformation"
- "media coverage of the event helped maintain public awareness and ensured that all requests for additional resources were communicated at a national level"
- "the high casualty rate, the pace of recovery operations and the poor communication networks became significant factors leading to the initial miscommunication challenges"
- "accurate information was difficult to get in a timely manner"
- "maintaining open lines of communication between government agencies and the nongovernment volunteer staffs was especially challenging"

This thesis could not be critically appraised because there is no validated tool to evaluate grey literature, but grey literature has not been peer-reviewed and may be subject to similar risks of bias as peer-reviewed published evidence. Furthermore, in both of the above studies, the authors did not provide direct quotations from participants, therefore interpretations may have been subjective dependent on the researchers theoretical and cultural background.

Chemical spill

A narrative opinion article by Abara and others described the effectiveness of community based communication strategies about the Graniteville chemical spill in 2005 (13). The authors discussed a community coalition which was formed to assist recovery, where members of the Graniteville community met with residents to form a list of environmental and health concerns because of the chemical spill. These were addressed by South Carolina Department of Health and Environmental Control, who also developed a fact sheet detailing answers in accessible language and held a series of town hall public meetings and training workshops to address community members questions and issues. The authors concluded that:

- community meetings created opportunities for the community to actively "participate in recovery strategies", "creating a feeling of control and ownership" in community members, as well as "an atmosphere of trust and transparency"
- this approach facilitated continuous engagement in public health and public health research 3 years post disaster

It is important to note that the professional status of the authors was not reported, the findings of this article are highly subjective and therefore the confidence in the findings is low.

Health inequalities

This review did not identify any evidence which evaluated the effectiveness of communication strategies before, during, or after CBRNe events, that was specific to any vulnerable populations or inclusion health groups. Inclusion health groups may be more likely to be disproportionately affected by CBRNe events and may be less able to access appropriate information.

Limitations

This rapid review used streamlined systematic methods to accelerate the review process. Sources of evidence searched included databases of peer-reviewed research and some grey literature databases, but an extensive search of other sources was not conducted and most article screening was completed without duplication, so it is possible relevant evidence may have been missed.

Much of the evidence included in this review was descriptive (4 narrative opinion articles and 3 grey literature pieces). These articles report the researcher's interpretation of the effectiveness of communication strategies, which is subjective and may be dependent on the researchers theoretical and cultural background.

Findings from the grey literature articles were not critically appraised because there is no validated tool for this purpose. However, grey literature has not been peer-reviewed and may be subject to similar risks of bias as peer-reviewed published evidence.

There was also likely to be differences in participant's levels of concern, mental fatigue and risk perception which were not caused by their primary information source used, (known as confounding factors), therefore we cannot say that information source used directly caused increased concern, mental fatigue, and risk perception.

The qualitative studies did not discuss the influence of the researcher on the research, or the researchers cultural or theoretical background, which may have influenced how the findings were interpreted by the researchers. Furthermore, they did not always provide direct quotations from participants, which so it was not possible to assess if participant voices were accurately represented.

Evidence gaps

This review builds on the evidence from a similar systematic review conducted in 2012 (1). Limited new evidence was identified in this review of the effectiveness of communication strategies for chemical, radiological, nuclear and explosion events. No new evidence relating to biological events was identified.

As the studies often described a combination of information sources used by participants about CBRNe events, it was not possible to compare the effectiveness of distinct communication strategies.

This study also did not identify any evidence about communication strategies for before a CBRNe event occurs.

Conclusion

This rapid review identified limited published evidence and grey literature about the effectiveness of communication strategies during and after CBRNe events, since publication of the similar review published in 2012 (1).

The majority of included studies were about the Fukushima nuclear accident. This included some evidence suggesting that people who used television, radio and internet as their source of information experienced higher risk perception, but also higher levels of concern and mental fatigue. A study which analysed newspaper articles related to the nuclear accident reported that newspapers frequently misrepresented information about the accident. A grey literature report by the Fukushima Nuclear Accident Independent Investigation Commission found that information was not communicated in a timely way, and narrative opinion articles highlighted

that communication of scientific information, such as risk comparisons, was often not accessible to lay audiences.

Two studies reported on lessons learned from explosive events, including the importance of having alternative communication strategies or the ability to adapt the initial strategy, due to the factors such as power outages, remote site locations, or literacy issues in the population.

Finally, one study of a chemical spill in the US reported that a community coalition between residents and public health professionals was effective in allowing the community to participate in recovery, and to facilitate future community engagement in public health research.

The evidence identified was mostly descriptive and subjective dependent on the researcher's interpretation. Therefore, it was difficult to draw conclusions about the effectiveness of communications strategies identified for CBRNe events.

Acknowledgment

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Disclaimer

UKHSA's rapid reviews aim to provide the best available evidence to decision makers in a timely and accessible way, based on published peer-reviewed scientific papers, unpublished reports and papers on preprint servers. Please note that the reviews:

- use accelerated methods and may not be representative of the whole body of evidence publicly available
- have undergone an internal, but not independent, peer review
- are only valid as of the date stated on the review

In the event that this review is shared externally, please note additionally, to the greatest extent possible under any applicable law, that UKHSA accepts no liability for any claim, loss or damage arising out of, or connected with the use of, this review by the recipient or any third party including that arising or resulting from any reliance placed on, or any conclusions drawn from, the review.

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Annexe A. Protocol

Review question

There was one review question:

1. What communication methods are effective in delivering public health messages to the public before, during, and after a real CBRNe attack?

A search for primary evidence to answer this review question will be conducted from 1 January 2011 up to 7 April 2024. The date range for the search has been chosen to follow from a previous systematic literature review on a similar topic, which was published in 2012 (1). The literature search performed in the 2012 review covered literature up to November 2011. A like-for-like update of the search strategy used in the 2012 review is not possible within the resource and time constraints posed by this rapid review. A test of a direct update of the 2012 review search indicated that the screening burden for this update would be more than 10,000 results. Some changes are required to the 2012 review search to include literature on accidental release of CBRNe hazards, including specific agents such as Anthrax, Novichok and Polonium-210. These agents were chosen to increase relevance as much as possible to CBRNe incidents in the real world. The present review will also summarise evidence relating to newer forms of communication such as social media, web apps and Short Message Service, which may now be used to communicate with the public during or before emergency situations. As a result of these factors, significant updates will be made to the 2012 review search strategy, with the aim of including additional elements of CBRNe hazards and communications related to these hazards, whilst also increasing the precision of the search to retrieve a volume of literature which can be screened and synthesised within the resource constraints posed by this rapid review.

The 2012 review was concerned with identifying what psychosocial factors are most important when communicating public health messages during a CBRNe attack (1). The previous review did not include attacks involving explosives. However, the current review specifically investigates what public health communication channels are most effective when delivering messages to the public during a CBRNe attack including those involving explosives. Changes to the research questions from the 2021 review were made to specifically retrieve evidence that can be readily translated to the real world by adopting the most effective public health communication channels during a CBRNe attack.

Chemical: poisoning or injury caused by chemical substance.
Biological: exposure to harmful bacteria, viruses or toxins and the illness or disease they cause.
Radiological: exposure to harmful radioactive materials.
Nuclear: exposure to thermal or blast effects arising from a nuclear detonation.
Explosions: sudden release of energy from a device using chemical or nuclear means resulting in a shock wave.

Eligibility criteria

Table A.1 Inclusion and exclusion criteria

	Included	Excluded
Population	All (general population)	Convenience samples (when explicitly stated)
Context	Any communication channel used to deliver a public health message to the general population Actual or suspected, deliberate or accidental real-world use of any CBRNe agent Natural disaster involving a CBRNe agent Deliberate or accidental attack using explosives using any CBRNe agent	Emergency or disaster preparedness without presence of a CBRNe attack Hypothetical scenario of a CBRNe attack Use of CBRNe agents in war (including explosives)
Settings	Any	
Intervention or exposure	Mass communication Public health communications or messages including but not limited to: 1. Radio 2. Television 3. Government guidance 4. Any internet sources 5. Leaflets	Communication within the public at the individual level Use of CBRNe agents in war (including explosives) The assessment and application of ‘nudges’
Comparator	No comparator	
Outcomes	Any outcome of effectiveness	
Language	English	Any other language
Date of publication	1 January 2011 (including) up to 7 April 2024	
Study design	• observational studies including case series and cross-sectional • experimental studies (randomised controlled studies) • qualitative studies • mixed methods	• systematic reviews • narrative reviews • modelling studies • case reports

	Included	Excluded
Publication type	• peer-reviewed published research • grey literature (Luxembourg definition (14))	• preprints • conference abstracts • editorials • letters • news articles • blogs

Identification of studies

The following databases will be searched for studies published from 1 January 2011 up to 7 April 2024: Medline, Embase and PsycInfo and the EU Health Inequalities Portal). The search strategy is presented below.

Grey literature searches of the following websites will be conducted using Google domain searches or browsing of publications sections of sites:

- US Centers of Disease Control
- US Federal Emergency Management Agency
- US Environmental Protection Agency
- Robert Koch Institute
- UN Scientific Committee on the Effects of Atomic Radiation
- International Atomic Energy Agency
- WHO Europe
- WHO International
- Collective Service
- Proactive
- Society for Radiological Protection
- NATO
- JESIP

Screening

Title and abstract screening will be undertaken in duplicate by 2 reviewers for at least 20% of the eligible studies, with the remainder completed by one reviewer. Disagreement will be resolved by discussion or with involvement of a third reviewer where necessary.

Screening on full text will be undertaken by one reviewer and checked by a second.

Data extraction

Summary information for each study will be extracted and reported in tabular form. Information to be extracted will include country, study period, study design, type of setting (for example hypothetical radiation) intervention, participants, results and outcomes (including type of

message or source, as well as psychosocial factors), and any relevant contextual data. This will be undertaken by one reviewer and checked by a second.

Risk of bias assessment

Two reviewers will independently complete a risk of bias assessment for the included studies, with disagreements resolved by discussion or with a third reviewer. Primary studies will be assessed using the Joanna Briggs critical appraisal tools according to the correct study design. The risk of bias will be done at the study level.

Synthesis

Studies will be grouped between quantitative, qualitative, or mixed methods designs. Where quantitative studies present data in a consistent format, a narrative synthesis will be produced to interpret the findings; results such as the number of studies, the number of participants in each study, effect size and their imprecision and a summary of the risk of bias across studies will be summarised and presented. Alternatively, if studies present methodological differences, a narrative synthesis of each study will be provided.

Health inequalities

Aligning with the Evidence Networks Health Equity Checklist and UKHSA's target populations, the following groups have been identified as having the possibility to experience health inequalities when receiving communication methods regarding a CBRNe attack. Where evidence is available, differences in study outcomes between vulnerable populations will be investigated. The populations are:

- people experiencing deprivation
- people experiencing homelessness
- vulnerable (new) migrants
- ethnic minority groups

These are populations outside of the Health Equity Checklist framework and target populations, that have also been identified in the literature as being vulnerable.

- those with a disability
- those with low literacy and language proficiency

Search strategy

Database: Ovid MEDLINE(R) ALL (1946 to 5 April 2024)

1. exp *Chemical Warfare/ (974)
2. *Disaster Planning/ (12,483)
3. exp *Nuclear Warfare/ (3,705)
4. exp *Biological Warfare/ (4,417)
5. Nuclear Power Plants/ (1,618)
6. exp *Terrorism/ (10,469)
7. exp biohazard release/ (153)
8. exp chemical hazard release/ (615)
9. exp radioactive hazard release/ (8,284)
10. terrori*.tw,kf. (7,668)
11. cbrn.tw,kf. (262)
12. bioterror*.tw,kf. (4,301)
13. explosion*.tw,kf. (15,850)
14. bomb*.tw,kf. (32,978)
15. Explosions/ (4,389)
16. Bombs/ (674)
17. (chemical adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw,kf. (10,439)
18. ((radiation* or radiolog*) adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw,kf. (12,671)
19. (radioactiv* adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw,kf. (2,099)
20. (atomic* adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw,kf. (1,072)
21. (nuclear* adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw,kf. (5,399)
22. (bio* adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw,kf. (30,223)
23. (acid* adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw,kf. (12,936)
24. (hazard* adj2 (warfare* or attack* or accident* or incident* or release* or weapon*)).tw,kf. (1,471)
25. Ricin/ (2,971)
26. ricin.tw,kf. (3,690)
27. Anthrax/ or Bacillus anthracis/ (7,439)
28. (anthrax or anthracis).tw,kf. (10,036)
29. Polonium/ (1,280)
30. polonium.tw,kf. (701)
31. exp *Chemical Warfare Agents/ (17,239)

32. Organophosphate Poisoning/ (2,305)
33. nerve agent*.tw,kf. (2,955)
34. novichok.tw,kf. (61)
35. hazmat.tw,kf. (211)
36. or/1-35 (184,151)
37. exp *Communication/ (196,711)
38. (Public adj3 (inform* or communicat* or outreach or advice or advis* or messag* or educat* or announc*)).tw,kf. (33,363)
39. (citizen* adj3 (inform* or communicat* or outreach or advice or advis* or messag* or educat* or announc*)).tw,kf. (1,174)
40. (civilian* adj3 (inform* or communicat* or outreach or advice or advis* or messag* or educat* or announc*)).tw,kf. (115)
41. (general population* adj3 (inform* or communicat* or outreach or advice or advis* or messag* or educat* or announc*)).tw,kf. (972)
42. (mass adj3 (inform* or communicat* or outreach or advice or advis* or messag* or educat* or announc*)).tw,kf. (6,210)
43. leaflet*.tw,kf. (26,971)
44. marketing.tw,kf. (35,006)
45. adverti*.tw,kf. (23,072)
46. ((mass or campaign* or communicat* or channel* or source* or messag* or outlet* or public or Inform* or outreach* or advice or advis* or announc*) adj2 media).tw,kf. (15245)
47. Health Education/ or exp *Consumer Health Information/ or exp *"Patient Education as Topic"/ or Health Promotion/ (187,980)
48. Health Knowledge, Attitudes, Practice/ (128,161)
49. (Civil Defense/ or exp Government Agencies/) and (Health Communication/ or Information Dissemination/) (1,277)
50. *Information Dissemination/ (10,412)
51. (government* adj3 (inform* or communicat* or outreach* or advice or advis* or messag* or educat* or announc*)).tw,kf. (4,398)
52. (official* adj3 (inform* or communicat* or outreach* or advice or advis* or messag* or educat* or announc*)).tw,kf. (1,840)
53. (authorit* adj3 (inform* or communicat* or outreach* or advice or advis* or messag* or educat* or announc*)).tw,kf. (2,468)
54. Public Opinion/ (20,011)
55. broadcast*.tw,kf. (5,369)
56. (TV or televis*).tw,kf. (32,607)
57. (news or newspaper*).tw,kf. (37,211)
58. radio.tw,kf. (52,502)
59. (website* or internet or online).ab. /freq=3 or (website* or internet or online).ti,kf. (85794)
60. ((text or SMS or chat* or MMS or multimedia or multi-media) adj messag*).tw,kf. (7149)
61. exp *Communications Media/ (230,557)
62. Internet/ or Internet-Based Intervention/ (83,621)
63. (telephon* or phone* or smartphone* or mobile app* or web app*).tw,kf. (160,681)

64. Mobile Applications/ (12,357)
65. (information adj3 (seek* or search* or source* or disseminat*)).tw,kf. (55,157)
66. (spokesperson* or spokes-person*).tw,kf. (338)
67. (communit* adj3 (trust* or representative* or leader*)).tw,kf. (9,226)
68. Information Sources/ (228)
69. or/37-68 (1,162,796)
70. 36 and 69 (6,963)
71. limit 70 to dt=20110101-20240408 (3,802)
72. limit 70 to yr="2011 -Current" (3,784)
73. 71 or 72 (3,842)

Database: Embase (1974 to 5 April 2024)

1. exp *chemical warfare/ (2,384)
2. *disaster planning/ (8,921)
3. exp *atomic warfare/ (1,925)
4. exp *biological warfare/ (4,429)
5. exp *terrorism/ (5,149)
6. exp biological accident/ (364)
7. exp chemical accident/ (749)
8. exp nuclear accident/ (10,761)
9. radiation accident/ (2,254)
10. exp *"nuclear energy and related phenomena"/ (22,439)
11. terrori*.tw,kf. (9,226)
12. cbrn.tw,kf. (331)
13. bioterror*.tw,kf. (4,960)
14. explosion*.tw,kf. (17,406)
15. bomb*.tw,kf. (34,713)
16. exp bomb/ (1,617)
17. explosion/ (6,726)
18. (chemical adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw,kf. (12,347)
19. ((radiation* or radiolog*) adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw,kf. (17,096)
20. (radioactiv* adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw,kf. (2,510)
21. (atomic* adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw,kf. (239)
22. (nuclear* adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw,kf. (6,697)
23. (bio* adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw,kf. (38,311)
24. (acid* adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw,kf. (14,357)

25. (hazard* adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or threat* or poison* or risk*)).tw,kf. (11,646)
26. ricin/ (3,148)
27. ricin.tw,kf. (4,084)
28. exp anthrax/ or Bacillus anthracis/ or anthrax toxin/ (11,987)
29. (anthrax or anthracis).tw,kf. (9,981)
30. polonium/ (1,809)
31. polonium.tw,kf. (706)
32. exp *nerve gas/ or exp *chemical warfare agent/ (4,150)
33. organophosphate poisoning/ (1,190)
34. biological warfare agent/ (575)
35. nerve agent*.tw,kf. (3,360)
36. novichok.tw,kf. (55)
37. hazmat.tw,kf. (283)
38. or/1-37 (218,543)
39. exp *interpersonal communication/ (223,269)
40. (Public adj3 (inform* or communicat* or outreach or advice or advis* or messag* or educat* or announc*)).tw,kf. (38,914)
41. (citizen* adj3 (inform* or communicat* or outreach or advice or advis* or messag* or educat* or announc*)).tw,kf. (1,296)
42. (civilian* adj3 (inform* or communicat* or outreach or advice or advis* or messag* or educat* or announc*)).tw,kf. (136)
43. (general population* adj3 (inform* or communicat* or outreach or advice or advis* or messag* or educat* or announc*)).tw,kf. (1,357)
44. (mass adj3 (inform* or communicat* or outreach or advice or advis* or messag* or educat* or announc*)).tw,kf. (7,975)
45. leaflet*.tw,kf. (39,452)
46. marketing.tw,kf. (47,937)
47. adverti*.tw,kf. (29,036)
48. ((mass or campaign* or communicat* or channel* or source* or messag* or outlet* or public or Inform* or outreach* or advice or advis* or announc*) adj2 media).tw,kf. (17,801)
49. health education/ or consumer health information/ or patient education/ or exp health promotion/ (343,349)
50. attitude to health/ (133,733)
51. (government/ or civil defense/) and information dissemination/ (1,172)
52. *information dissemination/ (5,696)
53. (government* adj3 (inform* or communicat* or outreach* or advice or advis* or messag* or educat* or announc*)).tw,kf. (4,886)
54. (official* adj3 (inform* or communicat* or outreach* or advice or advis* or messag* or educat* or announc*)).tw,kf. (2,197)
55. (authorit* adj3 (inform* or communicat* or outreach* or advice or advis* or messag* or educat* or announc*)).tw,kf. (3,172)
56. public opinion/ (19,333)

57. broadcast*.tw,kf. (5,779)
58. (TV or televis*).tw,kf. (44,903)
59. (news or newspaper*).tw,kf. (39,442)
60. radio.tw,kf. (68,045)
61. (website* or internet or online).ab. /freq=3 or (website* or internet or online).ti,kf. (106,809)
62. ((text or SMS or chat* or MMS or multimedia or multi media) adj messag*).tw,kf. (9,180)
63. exp *mass communication/ (255,282)
64. internet/ or web-based intervention/ (129,260)
65. (telephon* or phone* or smartphone* or mobile app* or web app*).tw,kf. (225,833)
66. exp mobile application/ (27,895)
67. (information adj3 (seek* or search* or source* or disseminat*)).tw,kf. (68,377)
68. (spokesperson* or spokes-person*).tw,kf. (405)
69. (communit* adj3 (trust* or representative* or leader*)).tw,kf. (11,240)
70. exp information source/ (3,043)
71. or/39-70 (1,518,248)
72. 38 and 71 (8,761)
73. limit 72 to dc=20110101-20240408 (4,982)
74. limit 72 to yr="2011 -Current" (4,744)
75. 73 or 74 (4,985)
76. limit 75 to conference abstract (923)
77. 75 not 76 (4,062)

Database: APA PsycInfo (2002 to March week 4 2024)

1. exp chemicals/ and (exp weapons/ or exp war/) (181)
2. chemical exposure/ (2,022)
3. emergency preparedness/ (1,571)
4. exp terrorism/ (8,737)
5. nuclear war/ (130)
6. radiation/ (1,182)
7. industrial accidents/ (784)
8. terrori*.tw. (10,307)
9. cbrn.tw. (32)
10. bioterror*.tw. (267)
11. explosion*.tw. (2,508)
12. bomb*.tw. (2,770)
13. (chemical adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw. (424)
14. ((radiation* or radiolog*) adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw. (191)
15. (radioactiv* adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw. (32)
16. (atomic* adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw. (17)

17. (nuclear* adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw. (527)
18. (bio* adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw. (1,971)
19. (acid* adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or hazard* or threat* or poison* or risk*)).tw. (246)
20. (hazard* adj2 (warfare* or attack* or accident* or incident* or release* or weapon* or threat* or poison* or risk*)).tw. (913)
21. ricin.tw. (6),
22. (anthrax or anthracis).tw. (172)
23. polonium.tw. (5)
24. nerve agent*.tw. (93)
25. novichok.tw. (0)
26. hazmat.tw. (22)
27. or/1-26 (25,351)
28. exp communication/ (292,234)
29. (Public adj3 (inform* or communicat* or outreach or advice or advis* or messag* or educat* or announc*)).tw. (15,347)
30. (citizen* adj3 (inform* or communicat* or outreach or advice or advis* or messag* or educat* or announc*)).tw. (2,021)
31. (civilian* adj3 (inform* or communicat* or outreach or advice or advis* or messag* or educat* or announc*)).tw. (98)
32. (general population* adj3 (inform* or communicat* or outreach or advice or advis* or messag* or educat* or announc*)).tw. (231)
33. (mass adj3 (inform* or communicat* or outreach or advice or advis* or messag* or educat* or announc*)).tw. (2,010)
34. leaflet*.tw. (883)
35. marketing.tw. (30,218)
36. adverti*.tw. (19,213)
37. ((mass or campaign* or communicat* or channel* or source* or messag* or outlet* or public or Inform* or outreach* or advice or advis* or announc*) adj2 media).tw. (12216)
38. health education/ or public health campaigns/ or exp health information/ or health promotion/ (39,337)
39. health knowledge/ or exp health attitudes/ or health awareness/ (20,924)
40. government agencies/ and (exp communication/ or information dissemination/) (219)
41. *information dissemination/ (1,554)
42. (government* adj3 (inform* or communicat* or outreach* or advice or advis* or messag* or educat* or announc*)).tw. (2,388)
43. (official* adj3 (inform* or communicat* or outreach* or advice or advis* or messag* or educat* or announc*)).tw. (849)
44. (authorit* adj3 (inform* or communicat* or outreach* or advice or advis* or messag* or educat* or announc*)).tw. (1,408)
45. public opinion/ (7,709)

46. broadcast*.tw. (3,517)
47. (TV or televis*).tw. (16,922)
48. (news or newspaper*).tw. (20,896)
49. radio.tw. (3,848)
50. (website* or internet or online).ab. /freq=3 or (website* or internet or online).ti. (55,476)
51. ((text or SMS or chat* or MMS or multimedia or multi media) adj messag*).tw. (3,409)
52. exp communications media/ (89,481)
53. digital media/ or exp social media/ (26,238)
54. exp internet/ or exp digital interventions/ (34,824)
55. (telephon* or phone* or smartphone* or mobile app* or web app*).tw. (56,132)
56. mobile applications/ or exp electronic communication/ or exp mobile phones/ or "smartphone use"/ or smartphones/ (82,448)
57. (information adj3 (seek* or search* or source* or disseminat*)).tw. (23,056)
58. (spokesperson* or spokes-person*).tw. (363)
59. (communit* adj3 (trust* or representative* or leader*)).tw. (5,825)
60. exp information/ (36,294)
61. or/28-60 (557,080)
62. 27 and 61 (4,590)
63. limit 62 to yr="2011 -Current" (2,892)

Health inequalities portal and Health Equity Resource Database

https://health-inequalities.eu/
https://health-inequalities.eu/resources/jwddb/

Note, the same search terms were used to search both areas of the Health Inequalities portal website linked above.

Date of search: 8 April 2024

CBRN OR explosion OR bomb OR terrorism OR Chemical OR radiation OR nuclear OR polonium OR hazard OR anthrax OR anthracis OR terrorism OR ricin OR biohazard OR bioterrorism OR novichok

0 results

Summary of changes made to search strategy used in 2012 review

The search carried out for the 2012 review was structured into 2 concepts: 1 concept of terms describing CBRN threats and another concept of terms describing communication and marketing terms. The search for the present review is structured with the same 2, broad concepts. However, a number of changes have been made to the search terms within these concepts – for transparency, these changes are summarised below.

This review will also search a slightly different combination of databases, using Embase instead of Scopus, in line with our team Standard Operating Procedures which state that we will always search Medline and Embase at a minimum.

CBRN concept

The following changes have been made:

1. Terms to capture accidental release of chemical, biological, radiation or nuclear hazards have been added. These terms were introduced into the Medline MeSH thesaurus relatively recently in 2009. While they would have been available to search in the 2012 review, there is greater benefit to be gained by including them in the search for the present review, due to the time elapsed since their introduction, which will mean a higher number of potentially relevant references now indexed under these headings.
2. Text-word (title and abstract) search terms have been amended to increase the sensitivity of the search, by using proximity operators to search for key terms such as nuclear, radioactive, chemical within 2 words of terms such as release, hazard, warfare and so on.
3. Most subject headings have been focused – this ensures that searches on these headings retrieve only results where the relevant index subject heading has been marked as the main or most important topic of an individual research abstract. This serves to restrict the number of results retrieved by searching these subject headings.
4. Terms have been added to capture specific biological and radiological hazards Anthrax, Ricin, Novichok and Polonium. This is an expansion of the 2012 search which did not include these terms.
5. Subject headings relating to biological and chemical warfare agents have been added.
6. Incorrect MeSH (Medline thesaurus) terms which were used in the PsycInfo search for the 2012 review have been removed and replaced with the closest available equivalent terms from the correct PsycInfo thesaurus.

Communication concept

The following changes have been made:

1. Some of the subject headings have been focused - this ensures that searches on these headings retrieve only results where the relevant index subject heading has been marked as the main or most important topic of an individual research abstract. This serves to restrict the number of results retrieved by searching these subject headings.

2. Thesaurus terms for ‘Education’ have been removed from Medline and PsycInfo searches – this thesaurus term is used to index references for publications on formal and professional curricula and education. As the present review focused on information and communications for the general public, this term is not appropriate. Removal of these terms helps to increase the precision of the search in retrieving literature on the desired topic, whilst also reducing the screening burden of the review.

3. More general text word (title and abstract) search terms for readiness and preparedness have been removed, in order to keep the screening burden manageable by ensuring results are focused on information and communication rather than more general preparedness topics.

4. Text word (title and abstract) terms for education, communication and media have been made more specific to communication with citizens and the general public with the use of proximity operators to search for these key terms within 2 words of terms such as citizen, civilian, public, government and so on.

5. Thesaurus and text word (title and abstract) terms for newer forms of communication and information sharing such as social media, messaging and mobile apps have been added.

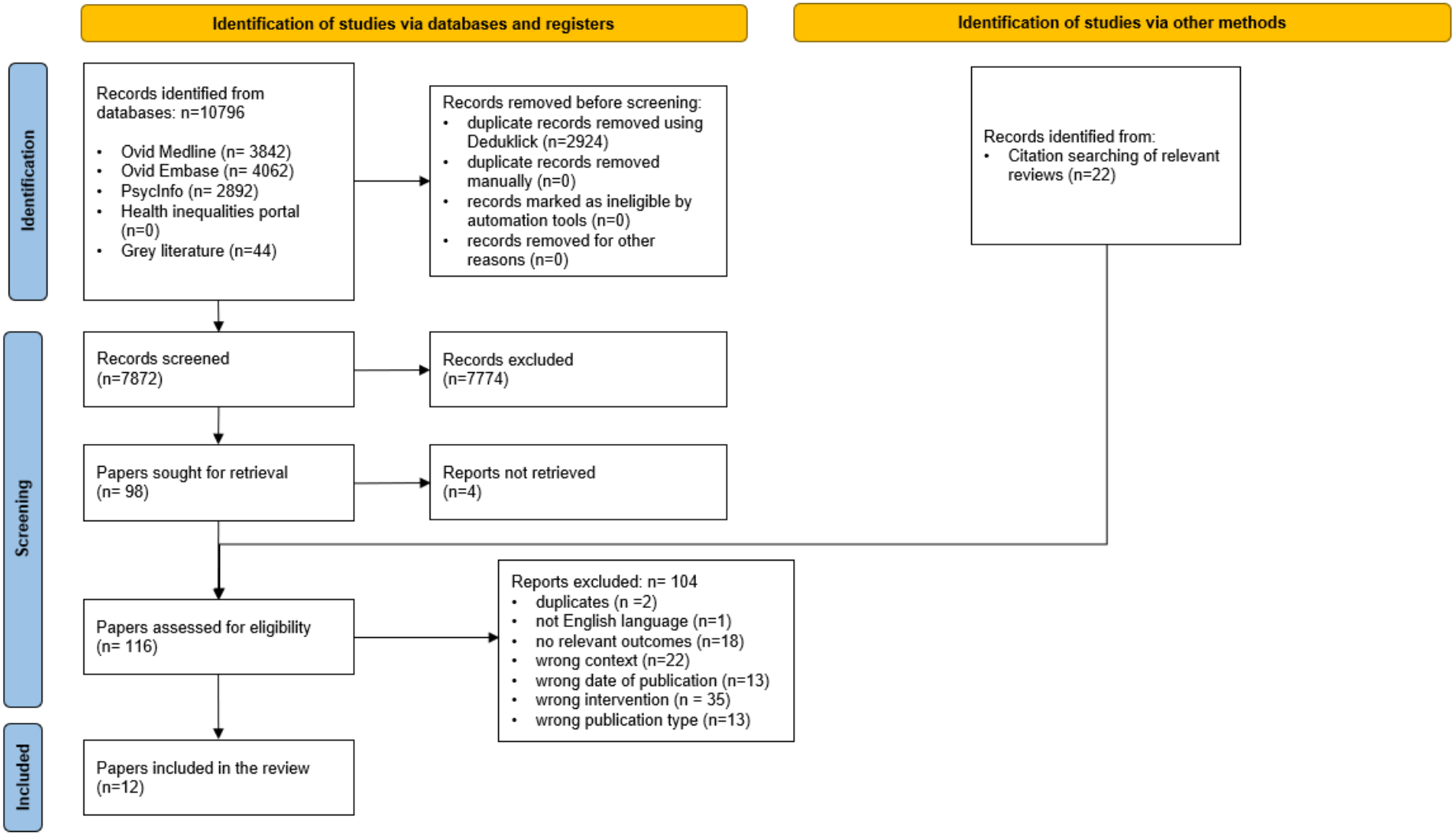
6. Some additional thesaurus terms have been added to maximise the chances of retrieval of potentially relevant literature on public attitudes and knowledge around CBRN communications and information.

Throughout the whole search, all text word search terms have been limited to searches of title, abstract and word indexed keyword fields, rather than the default multi-field search used by Ovid databases. This change limits the search results to those where search terms are mentioned in the listed fields, meaning that these results are more likely to be relevant to the topic at hand.

The limit to ‘human’ studies will be removed from all searches – given the nature of the topic this limit is probably unnecessary and would only reduce the screening burden by a negligible amount, whilst also increasing the risk of failing to retrieve potentially relevant results.

Annexe B. PRISMA flow diagram

Figure B.1. PRISMA diagram



Text version of Figure B.1. PRISMA diagram

A PRISMA diagram showing the flow of studies through this review, ultimately including 12 studies.

From identification of studies via databases and registers, n=10,796 records identified from databases:

- Ovid Medline (n=3,842)
- Ovid Embase (n=4,062)
- PsychInfo (n=2,892)
- Health inequalities portal (n=0)
- Grey literature (n=44)

From these, records removed before screening:

- duplicate records removed using Deduklick (n=2,924)
- duplicate records removed manually (n=0)
- records marked as ineligible by automation tools (n=0)
- records removed for other reasons (n=0)

n=7,872 records screened, of which n=7,774 were excluded, leaving n=98 papers sought for retrieval, of which n=4 were not retrieved.

n=22 studies were identified from citation searching of relevant reviews.

Of the n=116 papers assessed for eligibility, n=12 reports were excluded:

- duplicates (n=2)
- not English language (n=1)
- no relevant outcomes (n=18)
- wrong context (n=22)
- wrong date of publication (n=13)
- wrong intervention (n=35)
- wrong publication type (n=13)

n=12 papers were included in the review.

Annexe C. Excluded studies

Duplicate (2 studies)

Becker SM. 'The Fukushima Dai-ichi accident: additional lessons from a radiological emergency assistance mission' Health Physics 2013: volume 105, issue 5, pages 455 to 461

Protection SfR. 'Guide to communicating radiation risk in support of action before, during and after a radiation emergency' (2021)

Not English language (one study)

Hirofumi F and others. 'Increased Radiation Dose Issues in Tokatsu Area in Chiba Prefecture, Japan : How the Situation and Measures were Explained to the Local Residents' Radiation Emergency Medicine 2013: volume 2, issue 1, pages 76 to 81

No relevant outcomes (18 studies)

Agency IAE. 'Communication with the Public in a Nuclear or Radiological Emergency' (2012)

Agency IAE. 'Communication with the Public in a Nuclear or Radiological Emergency – Training Materials' (2012)

Burrer SL and others. 'Assessment of Impact and Recovery Needs in Communities Affected by the Elk River Chemical Spill, West Virginia, April 2014' Public Health Reports 2017: volume 132, issue 2, pages 188 to 195

Cui L. 'Risk communication in the post-Fukushima era' Radiation Medicine and Protection 2021: volume 2, pages 79 to 82

Diers AR and others. 'Synchronizing crisis responses after a transgression: an analysis of BP's enacted crisis response to the Deepwater Horizon crisis in 2010' Journal of Communication Management 2013: volume 17, issue 3, pages 252 to 269

Falkheimer J. 'Crisis communication and terrorism: The Norway attacks on 22 July 2011' Corporate Communications 2014: volume 19, issue 1, pages 52 to 63

Gallego E and others. 'Mass Media Communication of Emergency Issues and Countermeasures in a Nuclear Accident: Fukushima Reporting in European Newspapers' Radiation Protection Dosimetry 2017: volume 173, issue 1, pages 163 to 169

Hondula DM and others. 'Emergency management in the era of social media'. Public Administration Review 2014: volume 74, issue 2, pages 274 to 277

Kai M. 'Some lessons on radiological protection learnt from the accident at the Fukushima Dai-ichi nuclear power plant' Journal of Radiological Protection 2012: volume 32, issue 1, pages N101 to 105

Langdon P and others. 'Inclusive wireless technology for emergency communications in the UK' International Journal of Emergency Management 2010: volume 7, pages 47 to 58

Ohmori M. 'Looking back on media reports on the nuclear accident' Annals of the ICRP 2016: volume 45, issue 2, pages 33 to 36

Perko T. 'Importance of risk communication during and after a nuclear accident' Integrated Environmental Assessment and Management 2011: volume 7, issue 3, pages 388 to 392

Perko T and others. 'Units related to radiation exposure and radioactivity in mass media: the Fukushima case study in Europe and Russia' Radiation Protection Dosimetry 2015: volume 164, issue 1, pages 154 to 159

Sakoda A and others. 'Review of engagement activities to promote awareness of radiation and its associated risk amongst the Japanese public before and after the Fukushima Daiichi Nuclear Power Plant accident' Journal of Radiological Protection 2021: volume 41, issue 4, pages 24

Shimura T and others. 'Public health activities for mitigation of radiation exposures and risk communication challenges after the Fukushima nuclear accident' Journal of Radiation Research 2015: volume 56, issue 3, pages 422 to 429

Takamura N and others. 'Experiences of crisis communication during radiation emergency and risk communication for recovery of the community in Fukushima' Journal of Radiation Research 2021: volume 62, pages i95 to i100

Tupin EA and others. 'U.S. EPA response to the Fukushima Daiichi Nuclear Power Plant accident' Health Physics 2012: volume 102, issue 5, pages 563 to 599

Yuan L and others. 'Medical Response to a Radiological Accident Involving an Iridium-192 Source in Nanjing, China' Radiation Protection Dosimetry 2018: volume 182, issue 1, pages 25 to 30

Wrong context (22 studies)

Agarwal S and others. 'Tourist security, terrorism risk management and tourist safety' Annals of Tourism Research 2021: volume 89, pages 1 to 13

Agency IAE. ‘Method for Developing a Communication Strategy and Plan for a Nuclear or Radiological Emergency’ 2015

Allen KC and others. 'Prevention of post-disaster sequelae through efficient communication planning: analysis of information-seeking behaviours in Montana and Alabama' Public Health 2016: volume 140, pages 268 to 271

Anson S and others. ‘Inclusive communication in times of crisis: lessons learned and recommendations from COVID-19 and other CBRNe incidents based on recent COVINFORM and PROACTIVE findings’ 2021

Carbon D and others. 'Crisis communication in CBRNe preparedness and response: Considering the needs of vulnerable people' International Journal of Disaster Risk Reduction 2022: volume 79, 103187

Chico-Jarillo TM and others. 'Strategies From American Indian and Alaska Native Community Partners on Effective Emergency Response Collaboration' American Journal of Public Health 2018: volume 108, pages S366 to S368

Croteau MC and others. 'Strategies to improve chemical-related risk communication in Canada' Integrated environmental assessment and management 2010: volume 6, pages 782 to 783

Deitchman S and others. 'Lessons from Hawaii: A Blessing in Disguise' Health Security 2018: volume 16, issue 3, pages 213 to 215

Dickmann P and others. 'Biological Risks to Public Health: Lessons from an International Conference to Inform the Development of National Risk Communication Strategies' Health Security 2016: volume 14, issue 6, pages 433 to 440

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Annexe D. Data extraction table

Study	Country, time period	Study design, GreyLit type	CBRNe event	Mass communication strategies	Method of evaluating effectiveness of communication strategies	Relevant outcomes
Abara 2014 (13)	US, not reported	Narrative opinion piece on engagement of the Graniteville community post chemical disaster	Chemical spill (Graniteville, January 2005)	Community participatory service approach, developed by a coalition of academics and state public health agencies (the Graniteville community coalition). Members of the Graniteville community coalition met with residents to form a list of environmental and health concerns, which were addressed by South Carolina Department of Health and Environmental Control, who also developed a fact sheet in accessible language and held town hall public meetings and training workshops to address questions and issues.	Narrative opinion	The authors noted that: Community meetings created opportunities to actively "participate in recovery strategies", "creating a feeling of control and ownership" in community members, as well as "an atmosphere of trust and transparency" The Graniteville community coalition was an active partner in the recovery strategy, and that this approach facilitated continuous engagement in public health and public health research 3 years post disaster.
David 2017 (11)	Canada, analysis of media 2013, participant interviews 2015	Qualitative research (combination of interviews and media content analysis)	Accidental explosion (Lac-Mégantic, July 2013)	Communication about the event from public health officials and media channels.	Interviews: Eight semi-structured in-depth interviews, conducted between April and September 2015, lasting between 2 and 7 hours. Participants were selected if they were a direct manager of the crisis response team which responded to Lac-Mégantic, and according to their roles (spokesperson, official, members of public safety, government, police, municipal body, health management). Details of recruitment and selection process were not provided interview topics included participants perception of communication strategies used and of various issues in the crisis management. Transcripts were	Main findings: Crisis communication was hindered by a "digital divide [see explanation below] that created a dead zone for emergency". "The Lac-Mégantic site was remote (meaning there was lack of signal for cell phones, pagers, internet-based devices for social media), and communication was further hindered by electrical blackouts caused by the event (temporary dead zone). The first digital divide observed in the case of communications management at Lac-Mégantic had to do with the site's remote location, while the second, circumstantial in nature, had to do with the electrical blackouts and the destruction of the town's only fiber-optic networks." There were also problems with literacy: "direct communication with the victims was problematic owing to major difficulty understanding such messages (literacy)" Complexity of crisis communication messages: The digital divide meant that public safety communication coordinators and public health officers had to increase onsite presence. Onsite dialogue reflected that public

Study	Country, time period	Study design, GreyLit type	CBRNe event	Mass communication strategies	Method of evaluating effectiveness of communication strategies	Relevant outcomes
					analysed using NVivo qualitative research software. Analysis of communication artifacts: More than 60 documents including crisis management plans, information documents (including questions and answers, promotional posters, radio programmes, printed communication [including an information document for evacuees of Lac-Mégantic], press releases). NVivo qualitative research software used to analyse recurrent subjects, topics, and themes. Analysis of news media coverage: from 6 July to 31 July 2013 analysis of a press review from Estrie public health, including written and electronic media (internet, radio, TV and social media) authors developed an analytical grid using discourse analysis.	health messages were not received as intended (such as information about water and pollution), partly due to the digital divide and partly due to low-literacy of many of the citizens communications experts adapted initial strategies by changing key messages and tools used - stepping away from social media which was not communicating their desired method and focusing more on local media (communicating via radio, door-to-door information leaflet distribution, organised community gatherings to answer queries) officials recognised that complex public health messages were not being understood, so simplified and reduced communications messages, held weekly information sessions and gathered citizens to answer frequently asked questions.
Heltz 2018 (12)	US, not reported	Grey literature Thesis on 'Government and Nongovernmental Collaboration to Build Community Resiliency Against Terrorism in Oklahoma City'	Bombing (Oklahoma City, 1995)	Emergency communication from government and non-government agencies	Historical review of 84 documents from government and non-government agencies (local, state, and federal government reports, public records, research publications, published histories, personal accounts, and media reports), dated between April 1995 and September 2015, to identify recurrent themes. Data were	From government documents: • "adequate communication between agencies was critical to recovery efforts and getting the resources to the right place at the right time" • "alternative options for communication networks needed to be in the plan" • "a media plan needed to be in place" • "media often overstepped their roles and caused additional recovery challenges due to the release of misinformation"

Study	Country, time period	Study design, GreyLit type	CBRNe event	Mass communication strategies	Method of evaluating effectiveness of communication strategies	Relevant outcomes
					analysed using Atlas.ti 8.0 software.	• ”the high casualty rate, the pace of recovery operations and the poor communication networks became significant factors leading to the initial miscommunication challenges” From non-government documents: • “accurate information was difficult to get in a timely manner. Several organizations worked on the outskirts of the barricaded site and addressed community needs as they arose (for example, food, water, and shelter for victims and volunteers)” Media influence: • “media coverage of the event helped maintain public awareness and ensured that all requests for additional resources were communicated at a national level” • “maintaining open lines of communication between government agencies and the nongovernment volunteer staffs was especially challenging. Much of the critical coordination took place at the government level therefore it was difficult to coordinate support services in the early days”
Li 2011 (6)	US, 2011	Grey literature Thesis on ‘Investigating information technologies in disasters’	Nuclear accident (Fukushima, March 2011)	Communication about the event from the government and media channels.	Analysis of 38,300 retweets regarding radiation during the month after the earthquake. Only top retweets were included in the analysis. The data was separated into 3 periods: Period 1: Retweets before March 29, 2011 (579 retweets) Period 2: Retweets between March 30 and April 3 (493 retweets)	Of the top 25 most commonly retweeted messages, 9 (30%) conveyed information from a government organisation or official about the nuclear accident (23 of which were conveyed from authenticated major media, 2 were from personal accounts). The thesis quotes that “Twitter allowed those seeking more information to access a large amount of it quickly.” Period 1: 145% amplification of government messages (government tweets accounted for 5.7% of distinct messages retweeted, but accounted for over 14% of total retweets in the sample).

Study	Country, time period	Study design, GreyLit type	CBRNe event	Mass communication strategies	Method of evaluating effectiveness of communication strategies	Relevant outcomes
					Period 3: Retweets between April 4 to April 8, 2011 (450 retweets)	Period 2: Government message amplification reduced, dropping to 7.4% of total retweets. The thesis author notes that as the government attempted to get more information to the public, this did not translate to information being more widely distributed. There was a surge in interest in period 2 of tweets overall, but the voice of the government was either being drowned out or ignored by the Twitter community. Period 3: Government message amplification returned to 13.4% of total retweets (a 46% amplification from period 2 to 3), composing 9.2% of distinct retweets. There was a large increase in messages that communicated doubt in period 2, which directly corresponds with the drop in amplification of information from the government. Government messages were more reassuring than those from non-government sources. Forty-seven and 36% of government messages communicated calm in periods one and 2 respectively, whereas only 14% and 15% of non-government organisations communicated calm.
Murakami 2017 (8)	Japan, 2012 to 2013	Narrative opinion piece on communicating risks with residents post Fukushima.	Nuclear accident (Fukushima, March 2011)	Peer group or online media communication sessions, tailored to the needs of residents affected by the accident, that were performed by a medical professional.	Discussion of lessons learned from medical professionals' communication activities, from Fukushima Medical University, the University of Tokyo, Nagasaki University, Minamisoma Municipal General Hospital, Researchers in Minamisoma City and Soma City. Lessons learned specific to communication strategies were identified from Fukushima Medical University and researchers in Minamisoma or Soma city only.	Fukushima Medical University: The general health consultation project showed that people could not "share their radiation anxieties easily and update their initial perceptions". Discussed the value of small group discussions with "local key persons" Peer group session in Iitate Village: Villagers were surveyed initially on risk communication received. The most frequent response was, "There are numerous opinions and I do not know which one is true". The quantity of information provided left many residents confused. In response to this, a committee of village representatives, doctors and public officials was formed to conduct peer group sessions. This improved relations between local authorities and residents.

Study	Country, time period	Study design, GreyLit type	CBRNe event	Mass communication strategies	Method of evaluating effectiveness of communication strategies	Relevant outcomes
						Researchers in Minamisoma City and Soma City: Accurate scientific information is necessary but not effective at communicating risk, it needs to be portrayed using accessible language.
National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission 2012 (7)	Japan, 2012	Grey literature The official report of Executive summary The Fukushima Nuclear Accident Independent Investigation Commission (includes cross-sectional survey)	Nuclear accident (Fukushima, March 2011)	Emergency communication from: municipalities, police, TV, radio or internet, the Fukushima PowerPlant owner (Tokyo Electric Power Company Holdings)	Postal survey of 10,633 respondents who were forced to evacuate as a result of the Fukushima nuclear accident. Duration: March to April 2012 Response rate: 50% Targeted villages: Futaba, Okuma, Tomioka, Naraha, Namie, Hirono, Tamura, Minamisoma, Kawauchi, Katsurao, Kawamata, Iitate	Delay in information communication: “Awareness of the accident was extremely low among evacuated residents. despite releases of information according to Article 10 at 15:42 on March 11, a report according to Article 15 at 16:45, and declaration of state of emergency at 19:03.” There were significant differences in the speed of transmission of accident information to the evacuation areas. Municipalities, the emergency radio system, or the police served as the sources of accident information for 40% of residents of Futabamachi and Narahamachi, but only for 10% of residents of Minamisoma, Iitate, and Kawamata. Time of evacuation: “Residents expressed criticism that the government was slow to issue evacuation order, or they did not issue the evacuation order for their area.” Dissatisfaction about disclosing information from SPEEDI or monitoring data: “Many comments by the residents of Namie, Minamisoma, and Iitate showed dissatisfaction over disclosure of information from the System for Prediction of Environmental Emergency Dose Information (SPEEDI) or monitoring data” Number of evacuations: “The government was slow in disclosing monitoring information” “We had no clue what was going on but we were told to evacuate”

Study	Country, time period	Study design, GreyLit type	CBRNe event	Mass communication strategies	Method of evaluating effectiveness of communication strategies	Relevant outcomes
						Method of communication: Municipalities and the police served as the sources of accident information for 40% of residents of Futaba and Naraha, but only for 10% of residents of Minamisoma, Iitate, and Kawamata.
Ochi 2021 (9)	Japan, not reported	Narrative opinion piece describing non-scientific rationality of Fukushima residents post nuclear accident	Nuclear accident (Fukushima, March 2011)	Small group lectures and dialogues between radiation experts and members of the Fukushima community.	Author discussion, with direct quotes from residents during the sessions.	Perception of fact communication: Despite communication of low risks, many residents remained skeptical. The author notes that lay people may rely greatly on personal experiences when making judgements. A quote from one resident: “Why are academic papers more reliable than our own experience?” Perception of probability communication: The author notes that lay audiences may have low understanding of statistics and are mistrustful of experts who place emphasis on estimations, even where the probability of risks are 99.9%. Risk comparison strategies: With reference to experts comparing radiation as less harmful than smoking, one resident commented “I understand the radiation levels are negligible compared with other risks like smoking, but it still exists. Why do you pretend as if there is no risk?” And: “My child is not a smoker. It sounds deceiving that you compare radiation risk with such an unrealistic risk” The author notes that people may interpret risk comparison as “hiding” risks, or than anxious people may not be relieved by risk comparison but rather, become afraid of the risks used for comparison. One resident stated “I became afraid of eating bananas because they contain radioactive substances” Experts learning from lived experiences of residents:

Study	Country, time period	Study design, GreyLit type	CBRNe event	Mass communication strategies	Method of evaluating effectiveness of communication strategies	Relevant outcomes
						Experts refused to learn from their communication effort "You experts always try to change our behaviours, but it is experts who never changed behaviours"
Robertson (10)	Japan, March to April 2011	Narrative opinion piece describing challenges of risk communication following the nuclear accident in Fukushima	Nuclear accident (Fukushima, March 2011)	Emergency communication from public health authorities	Author discussion only.	• direct quotations from authors which pertain to any outcome of effectiveness of communication strategies • "determining the presence or absence of radioactive material in water or food and updating that information regularly is crucial because failure to do so can fatally undermine trust in the management of a radiological emergency. in this instance, the Japanese government regularly provided updates on the food and water situation" • "one group needs particular attention. the risk of a given level of environmental radiation to pregnant women and infants needed to be provided regardless of the scale of risk. of particular importance was advice around breastfeeding and the excretion of radionuclides in breast milk. although this is unlikely to lead to significant doses of radiation, factual information is expected, given the perception that radiation is acutely dangerous for babies" • "the Japanese authorities reported the total amount of radioactivity in bulk food or water in becquerels. As a unit, this contributed to the risk communication problems because the unit has no direct relationship to absorbed dose or the human health impact of ingesting the contaminated food or water. to effectively communicate this, the total activity needs to be converted into realistic figures that can be presented to the general public, such as the quantity required to be consumed to get to the normal background dose" • "simple advice about sheltering, food, water, and related matters was important in avoiding

Study	Country, time period	Study design, GreyLit type	CBRNe event	Mass communication strategies	Method of evaluating effectiveness of communication strategies	Relevant outcomes
						an information vacuum of how to respond in the context of potentially inflammatory media reporting of an unstable emergency becoming worse” • “the public was often not aware that substantial buildings, such as brick houses, offer 2 to 10 times reduction in the absorption of radiation and that basement car parks can have much higher levels of protection” • “advice about minimising unnecessary travel outdoors, closing windows, and turning off air conditioning to reduce radiation exposure to as low as reasonably achievable were useful in providing people with measures they could undertake themselves, even if the underlying health risk was very low” • “information about the need to take potassium iodide tablets in an area with very low levels of radioactive contamination may do little to alleviate interest in having tablets ready just in case. this can be a problematic public health issue because people may take potassium iodide in response to media reports or a personal perception of risk and suffer unnecessary adverse effects”
Sugimoto 2013 (2)	Japan, June to July, 2011	Cross-sectional	Nuclear accident (Fukushima, March 2011)	Emergency communication post accident including: TV News, TV tabloid shows, national newspapers, regional newspapers, radio news, radio tabloid shows, internet news, internet personal websites notice boards. Radiation information seminars between 20 June and 19 July 2011 at 12 different locations, including the city hall, hospitals and schools of Fukushima Prefecture.	Participants were given a questionnaire to assess their level of concern regarding the effect of radiation on health and the extent of change in concern, before and after receiving the seminar. Of the 1560 seminar participants, valid responses were collected from 1277 participants (response rate: 79%). Responses from participants aged less than 16	Factor analysis on the concern section of the questionnaire identified a 3-factor solution explaining 95% of the variance. variables were considered associated with a factor if its loading was above 0.4. Three dimensions of radiation concerns were identified, including radiation or health fears, fears for the future and fears about social disruption. There was a decrease in pre to post seminar concern for all 3 dimensions ($p < 0.0001$). Fears for the future were associated with national and regional newspapers:

Study	Country, time period	Study design, GreyLit type	CBRNe event	Mass communication strategies	Method of evaluating effectiveness of communication strategies	Relevant outcomes
					years and more than 70 years were excluded (reason given: “suspicion that people in these age groups might be rephrasing their answers to describe their opinions on family members worries or concerns”, which reduced the final number of included participants to 969 (62% response rate). Rate of missing responses was less than 10%. Key demographics: Participants were 70% female, 64% were aged 50 years and older, and 46% had a family history of cancer. TV News was used by 95% of participants as a common media source.	• lower in respondents who used national newspapers (beta coefficient: -0.14, 95% CI: -0.26 to -0.01, standard error: 0.06, p=0.03) • higher in respondents who used regional newspapers (beta coefficient: 0.18, 95% ci: 0.04 to 0.32, standard error: 0.07, p=0.01) Fears about social disruption was associated with radio use: • higher in respondents who used radios (beta coefficient: 0.16, 95% ci: 0.05 to 0.27. standard error: 0.05, p=0.003)
Tomkiv 2016 (5)	Multiple countries (Belgium, Italy, Norway, Russia, Spain and Slovenia), March to May 2011	Descriptive media content analysis	Nuclear accident (Fukushima, March 2011)	Media (newspaper articles)	Analysis of 1,340 newspaper articles directly and indirectly related to Fukushima from 5 countries in Europe and Russia, published between 11 March 2011 and 11 May 2011. Two newspapers (noted as 'quality newspapers' by authors) were selected from each country: • ‘Le Soir’ and ‘De Standaard’ in Belgium (260 articles) • ‘Corriere della Sera’ and ‘La Repubblica’ in Italy (270 articles)	Direct quotations from authors about misrepresentation and mistakes in the text of newspaper articles: • “one of the most common misinterpretations was referencing to norms, which do not exist (like norms for radionuclide content in the seawater) or using the wrong norm. In addition, articles often referred to ‘norm’ or ‘normal level’ without explaining what is meant by a normal level” • “another mistake was mixing up of the allowed levels for the population and for the emergency workers” • “journalists were often mixing up dose and dose rate or simply did not present the difference between them” • “another issue found was misrepresentation, or oversimplification, of the rationale behind

Study	Country, time period	Study design, GreyLit type	CBRNe event	Mass communication strategies	Method of evaluating effectiveness of communication strategies	Relevant outcomes
					• 'Aftenposten' and 'Dagsavisen' in Norway (133 articles) • 'Komsomolskaya Pravda' and 'Izvestiya' in Russia (172 articles) • 'Večer' and 'Delo' in Slovenia (158 articles) • 'El País' and 'El Mundo' in Spain (315 articles) The countries were chosen based on their different status of nuclear energy: • Belgium is in the process of phasing out of nuclear energy production • Slovenia, Russia and Spain produce nuclear energy to different extents • in Italy all nuclear power plants were closed as result of the referendum in 1987 • Norway does not produce nuclear energy and has 2 research reactors only but was significantly affected by the Chernobyl accident All newspapers chosen are representative of the high quality press within each country. Articles were coded according to whether information was presented quantitatively (such as radiation risk) or qualitatively	the official norms and limits. in some of the articles, permitted levels of radiation were referred to as safe"

Study	Country, time period	Study design, GreyLit type	CBRNe event	Mass communication strategies	Method of evaluating effectiveness of communication strategies	Relevant outcomes
					(such as comparisons between different radiation risks). Direct quotations were analysed for misinterpretations and mistakes. Articles were also checked for the presence of visual information on radiation doses and effects. Each article was coded by 2 independent researchers, inter-coder reliability was more than 0.84.	
Vyncke 2017 (4)	Belgium, August to September 2013	Cross-sectional	Nuclear accident (Fukushima, March 2011)	Media (traditional media, new media, social media) communication about Fukushima nuclear powerplant	Data was analysed from a previously conducted public opinion survey (SCK-CEN Barometer 2013. Perceptions and attitudes towards nuclear technologies in the Belgian population). The public opinion survey conducted interviews in 10 Belgian provinces between 15 August 2013 and 12 September 2013, lasting approximately 35 minutes. One section of the interview related to the Fukushima nuclear accident (the others related to general knowledge about nuclear energy and trust in nuclear energy). The total number of participants interviewed was 1002, determined to be representative of the Belgium population with respect to gender, age, region, size of locality, education, professional activity and size of the household.	Risk perception of the nuclear accident by primary information source: • television: unstandardised B: 0.353 (SE: 0.149), standardised B: 0.083, $p < 0.05$ (only significant finding) • radio: unstandardised B: 0.049 (SE: 0.068), standardised B: 0.024, $p>0.05$ • newspapers: unstandardised B: -0.103 (SE: 0.070), standardised B: -0.052, $p>0.05$ • internet: unstandardised B: -0.036 (SE: 0.074), standardised B: -0.017, $p>0.05$ Risk perception of the nuclear accident by secondary information source: • online newspapers: unstandardised B=0.107 (SE: 0.160), standardised B=0.040, $p>0.05$ • television and radio station websites: unstandardised B=-0.041 (SE: 0.116), standardised B=-0.021, $p>0.05$ • non-governmental agencies websites: unstandardised B: 0.202 (SE: 0.131), standardised B: 0.094, $p>0.05$ • Twitter: unstandardised B: 0.112 (SE: 0.328), standardised B: 0.021, $p>0.05$ • Facebook: unstandardised B: 0.092 (SE: 0.136), standardised B: 0.042, $p>0.05$

Study	Country, time period	Study design, GreyLit type	CBRNe event	Mass communication strategies	Method of evaluating effectiveness of communication strategies	Relevant outcomes
					Sixty-four participants of the public opinion survey (6.4%) were not aware of the nuclear accident in Fukushima, and were excluded from the secondary analysis conducted by this study, (938 respondents were analysed by Vyncke and others).	• blogs: unstandardised B: -0.206 (SE: 0.195), standardised B: -0.066, p>0.05 • others (for example YouTube): unstandardised B: -0.647 (SE: 0.208), standardised B: -0.186, p<0.05 (B coefficient standardisation method not reported)
Yumiya 2019 (3)	Japan, 2013 to 2015	Cross-sectional	Nuclear accident (Fukushima, March 2011)	Information sources regarding the progress of reconstruction after the disaster, including newspaper, TV and, or, radio, internet (excluding administrative websites), Facebook, Twitter, prefecture public relations, municipal public relations, national public relations, printed papers (except administrative papers).	Used data from the years 2013 to 2015 of annual public opinion survey on prefectural policies conducted by the Fukushima Prefecture Government Public Consultation Unit. Details of this survey are described elsewhere, but authors provided a brief summary: questionnaires were sent to 1,300 community residents of 28 municipalities of the Fukushima Prefecture, using a two-stage stratified random sampling method. Total number of participants over all 3 years, before exclusions: 2,257 Participant numbers by year before exclusions with response rates: • 2013: 803 participants (response rate = 61.8%) • 2014: 741 participants (response rate = 57.0%)	Five clusters of information sources were determined. The authors noted that “Fewer than 5 clusters grouped together too many information sources into each cluster, and more than 5 clusters created unwieldy outcomes with less than 200 participants in some clusters” The authors classed reliable information sources as: “municipal public relations in addition to major media (newspaper, TV and radio)” and unreliable information sources as “internet” and “a combination of TV, radio and word of mouth” Cluster 1 (599 participants) primarily used major media and multiple public relations: 86.8% used newspapers, 93.8% used TV and/or radio, 6% used internet (except administrative websites), 4.8% used internet (including administrative websites, Facebook or Twitter), 82.1% use prefecture public relations, 59.8% used municipal public relations, 38.2% used national public relations, 17.0% used word-of-mouth, 15.5% used printed papers, and 1% used other information sources. Cluster 2 (366 participants) used various information sources: 71.9% used newspapers, 47.3% used TV and/or radio, 38.5% used Internet excluding administrative websites, 29.2% used Internet including administrative websites, Facebook, and Twitter, 22.1% used prefecture public relations, 41.3% used municipal public relations, 3% used national public relations, 1.4%

Study	Country, time period	Study design, GreyLit type	CBRNe event	Mass communication strategies	Method of evaluating effectiveness of communication strategies	Relevant outcomes
					• 2015: 713 participants (response rate = 54.8%) Total number of participants included in analysis, over all 3 years, after exclusions: 2,130 Participant numbers by year after exclusions: 1. 2013: 758 participants (ratio of male to female: 0.79) 2. 2014: 699 participants (ratio of male to female: 0.67) 3. 2015: 673 participants (ratio of male to female: 0.74) Exclusion reasons: • respondents aged 19 years or younger (115 participants) • respondents who did not provide information about the progress of reconstruction after the disaster (12 participants)	used printed papers and 15.6% used word of mouth, and 5.2% used other information sources. Cluster 3 (237 participants) primarily used municipal public relations and major media: 100% used newspaper, TV and/or radio, and municipal public relations. Cluster 4 (399 participants) used combination of TV, radio and word of mouth: 100% used TV and/or radio, 24.3% used Newspaper, 8.8% used prefecture public relations,27.6% used municipal public relations, and 37.3% used word of mouth. Cluster 5 (529 participants) used major media only: 100% of used newspapers, TV and/or radio. Logistic regression analysis Model 1 (clusters of information sources used as explanatory variables of high mental fatigue). Cluster 3 was the reference category (“Cluster 3 was selected as the reference, as it showed the lowest proportion of respondents with high mental fatigue”): • cluster 1: OR = 1.5, 95% CI: 0.88 to 2.56, p=0.13 • cluster 2: OR = 2.13, 95% CI: 1.23 to 3.68, p=0.01 • cluster 4: OR = 2.35, 95% CI: 1.37 to 4.02, p<0.01 • cluster 5: OR = 1.47, 95% CI: 0.86 to 2.53, p=0.16 Clusters 2 (variable information sources used) and 4 (a combination of TV, radio and word of mouth) displayed the highest mental fatigue of the clusters (p less than or equal to 0.01). This remained consistent across adjusted models: Model 2 (adjusting for survey year 2013, 2014 and 2015): • Cluster 2: aOR: 2.11, 95% CI: 1.22 to3.66, p<0.01 • Cluster 4: aOR = 2.30, 95% CI: 1.34 to 3.94, p<0.01

Study	Country, time period	Study design, GreyLit type	CBRNe event	Mass communication strategies	Method of evaluating effectiveness of communication strategies	Relevant outcomes
						Model 3 (adjusting for survey year as well as age, sex, regional area and occupation): • Cluster 2: aOR = 2.32, 95% CI: 1.29 to 4.15, p<0.01 • Cluster 4: aOR = 2.50, 95% CI: 1.42 to 4.41, p<0.01 Model 4 (adjusting for survey year, previously stated demographic variables and mental support): • Cluster 2: aOR = 2.35, 95% CI: 1.27 to 4.33, p=0.01 • Cluster 4: aOR = 2.56, 95% CI: 1.41 to 4.66, p<0.01 Cluster 5 (major media only), displayed high mental fatigue which was statistically significant in models 3 and 4: • Model 3: aOR: 1.80, 95% CI: 1.02 to 3.18, p=0.04 • Model 5: aOR: 1.93, 95% CI: 1.07 to 3.50, p=0.03 Cluster 1 was not significant for any model (p>0.05)

Annexe E. Critical appraisal tables

Table D.1. JBI cross sectional risk of bias assessment

N/A: not applicable

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Comments (including reason for no)
Sugimoto 2013	Yes	Yes	No	N/A	Yes	Yes	No	Yes	Q3: information source self-reported Q4: not applicable as no standard for a condition Q7: outcome 'concern' is subjective Other note: this study excluded responses from participants under 16 and over 70
Vyncke 2017	Yes	No	No	N/A	Yes	Yes	No	Yes	Q2: no clear detail of study subjects Q3: information source self-reported Q4: not applicable as no standard for a condition Q7: outcome 'risk perception' is subjective
Yumiya 2019	Yes	Yes	No	N/a	Yes	Yes	No	Yes	Q3: information source self-reported Q4: not applicable as no standard for a condition Q7: outcome 'mental fatigue is subjective

JBI cross sectional risk of bias questions:

1. Were the criteria for inclusion in the sample clearly defined?
2. Were the study subjects and the setting described in detail?
3. Was the exposure measured in a valid and reliable way?
4. Were objective, standard criteria used for measurement of the condition?
5. Were confounding factors identified?

6. Were strategies to deal with confounding factors stated?
7. Were the outcomes measures in a valid and reliable way?
8. Was appropriate statistical analysis used?

Table D.2. JBI qualitative risk of bias assessment

N/A: not applicable**.**

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Comments: including reason for no
David 2017	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Q8: direct quotes from participants not reported
Tomkiv 2016	Yes	Yes	Yes	Yes	Yes	No	No	Yes	N/A	Yes	Q6: no statement on authors positions culturally or theoretically Q7: no discussion on researcher position on research Q9: not applicable, ethics would not have been necessary

JB qualitative studies risk of bias questions:

1. Is there congruity between the stated philosophical perspective and the research methodology?
2. Is there congruity between the research methodology and the research question or objectives?
3. Is there congruity between the research methodology and the methods used to collect data?
4. Is there congruity between the research methodology and the representation and analysis of data?
5. Is there congruity between the research methodology and the interpretation of results?
6. Is there a statement locating the researcher culturally or theoretically?
7. Is the influence of the researcher on the research, and vice-versa, addressed?
8. Are participants, and their voices, adequately represented?
9. Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body?
10. Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?

Table D.3. JBI text (narrative) risk of bias assessment

Study	Q1	Q2	Q3	Q4	Q5	Q6	Comments (including reason for no)
Abara 2014	Yes	Yes	Yes	Yes	Yes	Yes	
Murakami 2017	Unclear	Yes	No	Yes	Yes	Yes	Q1: authors profession, or position within the incident unclear. Not first-hand account Q3: narrative of events hard to follow
Ochi 2021	Unclear	Yes	No	Yes	Yes	Yes	Q1: authors profession, or position within the incident unclear Q3: narrative of events not presented
Robertson 2012	Unclear	Yes	Yes	Yes	Yes	Yes	Q1: authors profession, or position within the incident unclear. Not first-hand account

JBI text (narrative) risk of bias questions:

1. Is the generator of the narrative a credible or appropriate source?
2. Is the relationship between the text and its context explained? (where, when, who with, how)
3. Does the narrative present the events using a logical sequence so the reader or listener can understand how it unfolds?
4. Do you, as the reader or listener of the narrative, arrive at similar conclusions to those drawn by the narrator?
5. Do the conclusions flow from the narrative account?
6. Do you consider this account to be narrative?

About the UK Health Security Agency

UK Health Security Agency (UKHSA) prevents, prepares for and responds to infectious diseases, and environmental hazards, to keep all our communities safe, save lives and protect livelihoods. We provide scientific and operational leadership, working with local, national and international partners to protect the public's health and build the nation's health security capability.

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