World Health Organization
REGIONAL OFFICE FOR Europe

EFFECTIVE RISK COMMUNICATION FOR ENVIRONMENT AND HEALTH

A strategic report on recent trends, theories and concepts

HERA
Health Environment Research Agenda for Europe

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ABSTRACT

This report provides a strategic overview of effective risk communication for environment and health (EH) globally, with a focus on Europe. An overview is provided of the latest trends, theories and concepts of risk communication for EH, and key challenges and good practices are identified. The report's findings are complemented by three cases studies: promoting indoor air quality in schools in Hungary; water contamination in the Veneto region, Italy; and heat health action in Styria, Austria.

KEYWORDS

RISK COMMUNICATION

ENVIRONMENT

HEALTH

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Contents

Abbreviations

BSE	bovine spongiform encephalopathy
CJD	Creutzfeldt–Jakob disease
EH	environment and health
EU	European Union
HERA	Health Environment Research Agenda for Europe
NGO	nongovernmental organization
NPHC	National Public Health Center (Hungary)
PFAS	poly- and perfluoroalkyl substances
QR code	quick response code
ZAMG	Zentralanstalt für Meteorologie und Geodynamik [Central Institution for Meteorology and Geodynamics] (Austria)

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Interviews and case study reviews

Case study 1. Promoting indoor air quality in schools, Hungary

Dr Tamas Szigeti, leader of the InAirQ project, Head of Laboratory, Air Hygiene Laboratory, National Public Health Center, Budapest, Hungary.

Case study reviewed by Dr Szigeti and Veronika Gál, Head of Communications, National Public Health Center, Budapest, Hungary.

Case study 2. Water contamination in the Veneto region, Italy

Dr Gisela Pitter, Medical Director, UOC Screening and Health Impact Assessment, Azienda Zero, Veneto region, Italy.

Case study reviewed by Dr Pitter, Leda E. Nemer, WHO Consultant, WHO European Office for Investment for Health and Development, Venice, Italy, and Dr Francesca Russo, Director of Public Health and Hygiene Development Promotion Services, Veneto region, Italy.

Case study 3. Heat health action in Styria, Austria

Dr Eva Franziska Matthies-Wiesler, Senior Scientist, Helmholz Centre, Munich, Germany.

Christian Pollhammer, Officer of the Styrian Provincial Government, Department 8—Health, Nursing, and Science and Care Management Department, Medical Directorate, Graz, Austria.

Sonja Spiegel, Deputy Head, Section VII—Health System, Department 2—Radiation Prevention, Environment and Health, Federal Ministry of Social Affairs, Health, Care and Consumer Protection, Vienna, Austria.

Introduction

Healthy environments are key to improving health and saving lives. The response to COVID-19 and other health, climate and environment hazards has produced considerable research, experience and knowledge on effective risk communication relevant to the environment and health (EH).

To contribute to these efforts, this report provides a strategic overview of effective risk communication in EH globally, with a focus on Europe. The report describes the main theory, concepts and challenges, in addition to good practices for effective risk communication for EH. Three case studies from across Europe are also provided to illustrate current practices and challenges for effective risk communication for EH.

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The aim of HERA is to set the priorities for an EH research agenda in EU countries on environment, climate and health by adopting a holistic, systemic and inclusive approach in the face of global environmental changes and covering key strategic research and policy aspects.

Definition

Risk communication has been defined by WHO as follows:

> The real-time exchange of information, advice and opinions between experts or officials and people who face a threat (hazard) to their survival, health or economic or social well-being. Its ultimate purpose is that everyone at risk is able to take informed decisions to mitigate the effects of the threat (hazard) such as a disease outbreak and take protective and preventive action (WHO, n.d.).

Risk communication can refer to a wide range of issues beyond public health, including technological, environmental, societal or catastrophic risks and hazards (Glik, 2007; Leiss, 2004). Risk perception is the subjective judgement that people make about the characteristics and severity of a risk, such as a potential hazard (Gellman & Turner,

2013; Sandman, 1989). The focus of this report is on risk communication for EH. Key aspects of risk communication for EH include the following (Gamhewage, 2014; Glik, 2007; WHO, 2013):

- Traditionally risk communication was about the dissemination of information to the public about investment risks (for instance, cargo ships not reaching their harbour of destination), health risks or threats (such as an oil spill) or disease outbreak (such as an epidemic), but it has now evolved to consider a broader range of risks and threats.
- Risk communication for EH includes addressing both acute risks such as industrial accidents and long-term chronic risks such as air pollution. While the same communication theories and tactics apply, the nature of the risks influences how to deal with them.
- The focus of risk communication has shifted from not only disseminating information but to understanding better the communication process leading to changes in beliefs and behaviours.
- Risk communication has no borders and is both appropriate and applicable locally as it is globally.
- Risk communication entails both internal communication – for example, with frontline health workers—and external communication, with affected publics.
- Global mega-trends have shaped risk communication, both heightening its visibility and creating significant challenges (see below).
- Risk communication for EH draws on interdisciplinary perspectives from many areas, including risk management, disaster management, health promotion, media studies, crisis communication, and broader fields such as psychology, anthropology, health, law and philosophy.

Although the terms are often used synonymously, there are some key distinctions between risk communication and crisis communication. Crisis communication often involves communicating about risk, but it is also largely focused on maintaining or restoring the reputations of organizations impacted by crises (Coombs & Holladay, 2011; Heath & O'Hair, 2010). Furthermore, risk communication carried out in crisis situations has a strong preparedness element (Glik, 2007). Risk communication is equally applicable to chronic and acute health risks. Nevertheless, interlinkages between risk and crisis communication are strong: a risk not managed well could lead to a crisis situation (Coombs & Holladay, 2011) and risk communication in crises such as public health emergencies is a key focus (WHO, 2017a).

Mega-trends

There have been a number of major shifts and changes ("mega-trends") in recent decades that have influenced risk communication for EH.

Increasingly complex, global and uncertain risks

Although there have been enormous gains in the health of the global population in the past century, the variety of environmental hazards and risks for public health has evolved and multiplied, becoming more complex, uncertain and global in nature (Martuzzi & Tickner, 2004; WHO, 2020b). While the COVID-19 pandemic has been the dominant crisis of the period 2020–2021, longer-term chronic risks such as air pollution, noxious chemical agents, waste and contaminated sites continue to threaten the health and well-being of European citizens, especially the most vulnerable (Jakab, 2017; WHO, 2020b). As traditional public health risks linked to the environment, such as unsafe drinking-water and poor sanitation, persist, new risks are emerging rapidly; recent examples include the management of electronic waste and the dangers of microplastics (WHO, 2020a). The health implications of climate change are becoming more widely recognized, as are the varying risks seen in coastal, rural and urban areas of Europe (WHO, 2018b).

Declining trust in experts and authorities

Worldwide polls have shown declining public trust in government, business, media and nongovernmental organizations (NGOs); there has been a loss of faith in these institutions and their systems (Edelman, 2021; Hosking, 2019). Although trust in individual health professionals has traditionally been high (Brownlie, 2008), the COVID-19 pandemic saw politicians publicly questioning the trustworthiness of public health experts' warnings (Cairney & Wellstead, 2021). Declining trust in authorities and politicians is also linked to any inconsistencies in their own behaviours in response to hazards and risks. An example was seen in the United Kingdom, where the breaking of COVID-19 lockdown rules by a government official was thought to have undermined public health messaging and the confidence of the public in the government's responses (Fancourt, Steptoe & Wright, 2020). However, the evidence on "declining trust" is not homogenous, and there is the risk of a "decline syndrome" that is cultivated to nurture it: there is evidence that some institutions are losing their trust foothold in society, but not all of them (there are sector-specific trends, as in the case of medical doctors in the United States since the 1970s). Trust could be lost during a crisis but then recovers, as in the case of climate scientists during "Climategate 2009"—what Bauer, Pansegrau & Shukla (2019) call the "bungee jump" model of authority of science. In certain countries—for example, in the United Kingdom and the United States—overall trust in science has remained steady or even risen during the COVID-19 pandemic; trust in science is declining only among certain groups, such as those politically on the right (Bauer, 2018; Bauer, Pansegrau & Shukla, 2019). Globally, trust in scientists remains high (73% in global polling in early 2021, though this is down

from 80% in 2020); a review of global polling on COVID-19 and trust concluded that "scientific and medical experts are enjoying a surge in public support" (Jensen, Kennedy & Greenwood, 2021). Trust in government officials has been consistently lower—41% (down from 43% in 2020) (Edelman, 2021).

A move from one-way to two-way and multidirectional communication

Communication between organizations and publics is no longer thought of as a one-way process in which organizations and their officials speak and publics listen and do what they are told. Organizations, whether they are companies, government agencies or NGOs, have increasingly recognized the value in having, and the need to have, a dialogue with audiences through interaction, engagement, listening and relationships (Macnamara, 2016). Furthermore, two-way and multidirectional communication has proven to be more effective than one-way communication. In risk communication, a greater understanding of the positions of publics and listening to their concerns have been found to make them more open to dialogue and change (Renn, 2010; van Zwanenberg & Millstone, 2006). The three case studies for this research (sections 2–4 below) all highlight the use of multidirectional communication and the importance of dialogue with concerned publics.

Loss of influence of traditional media and fragmentation of channels

Traditional media such as radio, television and newspapers have held an important "gatekeeper" and "agenda-setting" role for publics, effectively selecting and filtering what they consider important and appropriate for their audiences and supporting the political, social or economic issues they see as vital. However, in recent decades, this influential role of traditional media has diminished as media channels have fragmented and multiplied; increasingly, people receive news and information from multiple sources, and notably from social media. In the United States, just over half (55%) of the population in 2020 relied on social media for news "sometimes" or "often", and the figure was even higher for those under 30 years old (Infield, 2020). A 2017 survey found that 42% of Europeans consulted social media daily, with the figure rising annually by some 4%, and the same heightened use was seen for youth as in the United States (Eurobarometer, 2018; Infield, 2020). Social media can also create an "echo chamber" effect, where people consume news aligned to their political beliefs, are rarely challenged, and share news and views only with like-minded people (Malecki, Keating & Safdar, 2021). Although people rely on social media for news, it has consistently been the least trusted source since 2016; people's use of search engines is the most trusted source, above traditional media (Edelman, 2021).

The rise of fake news, malinformation and infodemics

Today, "misinformation" (unintentionally sharing false information) has morphed into "disinformation" (deliberately sharing misleading information) and further into the more sinister "malinformation" (reconfigured true information shared to cause harm) (Baines

& Elliott, 2020). This shift has been exacerbated by the COVID-19 pandemic and the "infodemic"—the rapid spread of excessive information, both accurate and inaccurate—that it has produced. Such developments were observed previously during the bovine spongiform encephalopathy (BSE)/Creutzfeldt–Jakob disease (CJD) outbreak crisis (commonly known as "mad cow" disease) of the 1980s and 1990s (Dora, 2006). In early 2020, it was found that the amount of low-credibility COVID-19 information being shared on the social media platform Twitter matched the amount of information coming from more credible sources such as traditional media and disease control centres (Buchanan, 2020). "Fake news" and belief in mistruths or false claims on such topics as vaccines and climate change were already a concern prior to COVID-19. It has been shown that this is not a question of people being uniformed or unaware of basic scientific facts; rather, it is a reflection of their broader beliefs and ideology (Scheufele & Krause, 2019). Even when mistruths are corrected directly with the people who hold them, such people do not necessarily change their opinion; they are more likely to self-justify and even reinforce their original views (Krause et al., 2020; Uscinski et al., 2020). However, it is one thing to be misinformed and hold such views; it is another to share them: studies show that false news spreads more quickly than verified news and, worryingly, up to 100 times more widely (Vosoughi, Roy & Aral, 2018). Trust in all sources of information—traditional media, social media and owned media (that is, websites of official entities)—declined globally between 2020 and 2021, a drop that is reckoned to be a result of the COVID-19 infodemic (Edelman, 2021).

The importance of risk communication highlighted by COVID-19

The COVID-19 pandemic has accelerated and crystallized many of the above trends: the global and uncertain nature of the threat, the mistrust of health experts and facts by some publics, and the rapid spread of misinformation. COVID-19 has illustrated even further the importance of effective risk communication. Studies to date on how people perceive the risks of COVID-19 show the importance of experiential, social and cultural factors in motivating preventive health behaviours (Abrams & Greenhawt, 2020; Dryhurst et al., 2020). Perceptions have become further polarized as reluctance to carry out preventive behaviours such as wearing a mask has been found to be reinforced by belief in conspiracy theories and reliance on conservative media (Romer & Jamieson, 2020). Nor is this only a "western" phenomenon: a study in sub-Saharan Africa found that a belief in false statements about COVID-19 (such as the claim that COVID-19 was designed to reduce the world population) were associated with noncompliance with health measures (Osuagwu et al., 2021). As is evidenced by case study 3 on heat health action in Austria (section 4 below), COVID-19 has dominated communication channels and potentially reduced the attention paid by publics to other EH risks, such as heatwaves.

These mega-trends have clear and concrete implications for carrying out effective risk communication for EH, as discussed further below.

1. Theories and concepts

1.1 Theories and concepts of risk communication for EH

Theories of risk communication for EH draw on a number of fields, as mentioned above, and on a combination of scholarly literature and guidance and actual practices of health agencies and actors. It is not surprising, therefore, that there are competing theories and approaches to risk communication for EH (Covello, Slovic & von Winterfeldt, 1986; van Zwanenberg & Millstone, 2006). However, there is general consensus about the relevance and importance of certain concepts for risk communication for EH, as outlined in this section.

At a high level, risk communication for EH can be conceptualized within the elements of the classic communication model (Covello, Slovic & von Winterfeldt, 1986; Berry, 2007). While recognizing the limitations of the classic model—that it is oversimplified and largely one-way—it provides an overview of the similarities and specificities of risk communication compared to communication in general (Table 1).

Table 1. Specificities of risk communication against the classic communication model[1]

Element	Specificities of risk communication for EH
Sender (source)	• multiple scientific/health sources • expert disagreement • pseudoscientific and/or non-credible sources • lack of trust in sources • different interests • audiences as sources (for example, in disaster situations)
Message	• complexity or overtechnical nature of messages • uncertainty of message content • competing messages between EH themes
Channel	• selective or biased reporting • social media highlighting false over verified information • focus on sensational aspects

1 Model adapted from Covello, Slovic & von Winterfeldt (1986) and Berry (2007) based on the Shannon–Weaver 1947 model, with "Context" and "Feedback" added by the current authors (these elements feature in many later models).

Table 1 contd.

Noise	• considerable internal noise implicit in crisis situations that affect ability to send/receive information • overwhelming quantity of information available • considerable external noise (false and misleading information including conspiracy theories) implicit in infodemics that distract receivers from verified information
Receiver	• both captive and noncaptive audiences • misunderstanding/misinterpreting of information • inaccurate perception of risks
Context	• key role of experiential, social, political and cultural factors • local adaption needed despite global phenomena • role of pre-existing conditions, structures, systems • presence of acute and/or chronic risk(s)
Feedback	• understanding publics' beliefs/perceptions of risks • social listening and monitoring to facilitate understanding • establishing channels for feedback from publics

The four types of intended effects (or objectives) of risk communication can be summarized in four general categories (Covello, Slovic & von Winterfeldt, 1986; Gamhewage, 2014; Renn, 2010):

Enlightenment function: to develop understanding of risks, risk assessments, threats and hazards, providing reassurance, ideally taking into account the dominant risk perceptions of publics.

Behaviour change function: to encourage people to adopt risk-reduction behaviour and reduce or eliminate the risk to their life and health and to the health of others.

Trust-building function: to promote credibility in those institutions that deal with risks.

Participative function: to involve publics in risk management decision-making planning; enabling reciprocal dialogue and understanding and improving relationships.

To achieve these intended effects, there are two key issues for which there is general agreement on their importance for risk communication for EH: risk and trust.

1.1.1 Perceptions of risk

The notion of risk arises both in expert assessment—that is, in expert perceptions—and in public perceptions. A key point established on risk is how perceptions differ between experts and the public. The opinionated public (and politicians and decision-makers) are influenced not only by the scientific facts but by additional and different factors and constraints that can be grouped as follows (Dryhurst et al., 2020; Gamhewage, 2014; WHO, 2013):

- **cognitive:** people's knowledge and understanding of the risky situation and their competence to deal with it;
- **emotional and experiential:** direct personal experience and that of friends and family; and
- **social-cultural constraints:** social, religious and cultural influences and values that prioritize certain hazards over others—the selection of certain hazards for special attention and the ignoring of others are influenced by gender, education, economic and political beliefs, ideology and class.

Sandman (1989) maintained that risk perception is a subjective judgement formed by two components: hazard and outrage. The higher the sense of outrage, the stronger the intensity with which people will perceive risk, which can then dominate the actual hazard. Even an insignificant hazard can be perceived as high-risk when outrage is stronger (Gilk, 2007; WHO, 2013). Risk and benefit perceptions are heavily influenced by message content that has little to do with facts. For an unknown and emerging hazard such as the COVID-19 pandemic, outrage with an emotional response will dominate perception more than scientific facts (Malecki, Keating & Safdar, 2021). As seen in case study 1 on tackling indoor air pollution in schools in Hungary (section 2 below), where risk perception is low, there will also be less public pressure on policy-makers to respond to the risks. A range of factors have been identified that can trigger outrage (Gamhewage, 2014; Gilk, 2007; Sandman, 1989); these include:

- unfamiliarity or newness of a hazard
- the involuntary nature of the issue
- a hazard that affects future generations
- the artificial (industrial) nature of the risk
- a hazard that cannot be seen or sensed
- the use of cover-up or silence
- potentially fatal and/or catastrophic results
- attempts to persuade publics about the issue
- the occurrence of accidents

- two simultaneous truths around the issue
- disagreement among experts
- conflicts of interest
- contradictory types of behaviour
- inequitable distribution of risk.

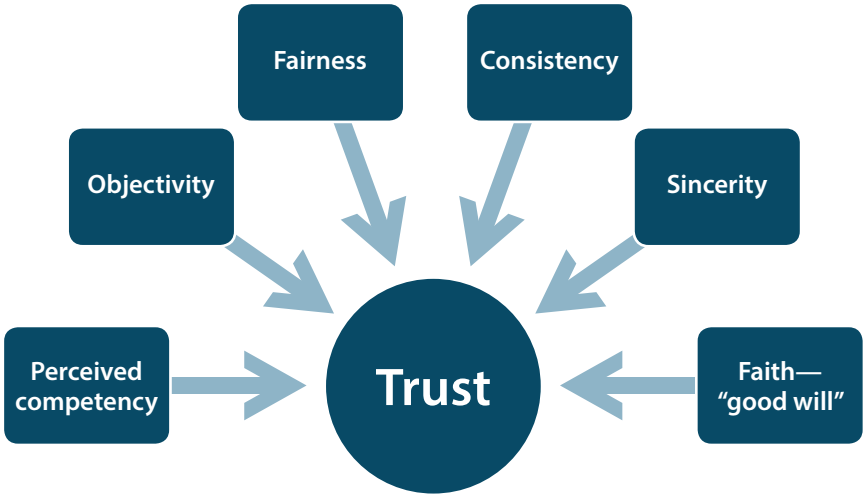
At the same time, perception of risk and outrage varies widely among people. The response to the COVID-19 pandemic has shown starkly the influence of existing beliefs, worldviews and ideology on perceived risk. This is not new; a strong correlation has previously been found between cultural values and perceived risks of nuclear waste and climate change (Balog-Way, McComas & Besley, 2020). People tend to perceive risks as more threatening if their other beliefs contain negative connotations, and less threatening if their other beliefs contain positive connotations (Renn, 2010). Understanding publics' perceptions of risk for more effective messaging has therefore been an ongoing concern for risk communication and is a key reason for the focus on developing dialogue and relationships with publics (Glik, 2007; WHO, 2013).

1.1.2 Gaining and maintaining trust

Effective risk communication involves much more than just "getting the numbers right" (Fischhoff, 1995); risk comprises people's experiences, values and trust in institutions (Dryhurst et al., 2020). Loss of trust in authorities and experts, as described above, is a major concern for risk communication. Trust in a health authority, for example, can compensate for a negative risk perception, while lack of trust can add to the negativity of such perceptions (Renn, 2010). Problems caused by loss of trust are further compounded in crisis situations because, when people are distressed, they often become distrustful and are less likely to accept the validity of communication messages (Glik, 2007). The contrary was also shown by the experience of COVID-19, when people's trust in scientists and health workers actually increased (Jensen, Kennedy & Greenwood, 2021). At the same time, when people have low knowledge and only indirect experience of a risk, trust in authorities and experts is even more important, while there are varying roles for so-called "elites", such as politicians, media personalities and celebrities (Siegrist & Cvetkovich, 2000; Uscinski et al., 2020). When people have trust in authorities—if they have faith in authorities to "look out" for them—they can also have less perception of risk and be less interested in learning about it.

Trust is multifaceted and can be split into six components (Renn, 2010; Renn & Levine, 1991) (Fig. 1).

Fig. 1. The six components of trust



To gain trust, it is not necessary for authorities to comply with all components, but persistent inconsistencies can lead to mistrust; when publics do not trust the source, they will not trust the message (van Zwanenberg & Millstone, 2006). Perversely, mistrust can also have a positive outcome for risk communication in some situations; for instance, reduced trust in government on the part of some citizens in the COVID-19 pandemic was a motivator for complying with social distancing and wearing a mask because some politicians were advising the contrary (Cairney & Wellstead, 2021). Studies show that establishing and gaining trust is a complex task and that sharing information and showing empathy with publics alone will not do; listening, systematic feedback and dialogue are needed (Glik, 2007; Macnamara, 2016; Renn, 2010).

Linked to the concepts of risk and trust are the predispositions of publics. As illustrated by the COVID-19 pandemic, people's predispositions, such as their existing beliefs and opinions, were found to be predictive of their attitudes and behaviour towards preventive health measures to combat COVID-19 (Dryhurst et al., 2020; Green et al., 2020; Romer & Jamieson, 2020). There is increasing recognition that educating the public on scientifically valid information will have limited success if it does not consider their predispositions together with their perceptions of risk and trust (Ho et al., 2019). Scientific facts, devoid of emotions, have to compete with emotionally charged stories that accompany greater outrage and grab attention, as was seen in the COVID-19 pandemic (Krause et al., 2020). When processing scientific information (or misinformation), people often rely on "heuristics"—mental short-cuts to make complex information easier to digest—which do not always lead to the most rational or optimal beliefs and consequent behaviours, given the potential influence of predispositions and emotionally charged arguments (Krause et al., 2020).

1.1.3 Communicating complexity and uncertainty

Dealing with the concepts of complexity and uncertainty is often part of risk communication for EH, particularly in emergencies. An early preoccupation of risk communication was the feeling of an obligation to explain complex scientific topics to publics in order to counter their misunderstanding, scientific illiteracy or pure ignorance (Glik, 2007; van Zwanenberg & Millstone, 2006). However, the notion of the public as a whole struggling to understand scientific facts, known as the "knowledge deficit model", has mainly been debunked (Krause et al., 2020). Furthermore, studies in the United Kingdom show that the public's knowledge of scientific facts is actually increasing (Bauer, 2018). Global polling in early 2021 showed that the public's desire to "increase my science literacy" had jumped 43% from 2020 to 2021 (Edelman, 2021).

The obligation to explain complex scientific topics has been superseded by the need to better understand what publics already know, where their key knowledge gaps are, and how the risk being communicated fits within their predispositions, existing risk perceptions and trust levels (Abrams & Greenhawt, 2020; Renn, 2010). For example, in Europe there is a high level of awareness about climate change, but awareness of the health implications appears to be lower (WHO, 2018). Publics in Europe systematically underestimate the risks of heat and the most vulnerable (such as the elderly) have an even lower risk perception (WHO, 2021b) (see also section 4 below, featuring case study 3 on heat health action in Styria, Austria). Communicating scientific uncertainty is also an issue that has preoccupied risk communication, based on two assumptions: (1) that messages should be based only on the final definitive scientific findings; and (2) that publics cannot cope with disagreement between experts. Both of these assumptions have been challenged. First, publics do need to be involved and engaged even as scientific findings are emerging; and second, publics do adopt coherent approaches to understanding disagreements and differences between experts. Being transparent about scientific uncertainty does not necessarily undermine public trust in facts or the communicator (Dieckmann et al., 2017; Dora, 2006; van der Bles et al., 2020).

The need for participatory and two-way or multidirectional communication has been emphasized in the literature and practice as described above. Participation of publics and stakeholders in risk assessment and management has been found to improve the quality of decision-making and lessen confrontations between publics and authorities (Renn, 2010). Even the more directive type of communication, such as encouraging personal behaviour changes (for instance, "wear a mask"), can benefit from public involvement, direct interaction and exchanges (Covello, Slovic & von Winterfeldt, 1986). Organizations involved in risk management also need to be able to integrate dialogue and feedback with publics and stakeholders into their procedures and carefully manage the timing, considering what is feasible in crisis situations (Renn, 2010). However, two-way or multidirectional risk communication has also been found to be mainly extractive, with publics as passive participants in providing information to researchers rather than being

actively engaged (Dowler et al., 2006). This is not only limited to risk communication; all types of organizations, private, nonprofit or public, have a lack of resources, capacity and skills to enter dialogue with publics and genuinely listen to them (Macnamara, 2016). The COVID-19 response has shown the importance of combating infodemics with monitoring, social listening and integrating publics' reactions and feedback into communication responses (WHO, 2021e).

Risk communication is also pertinent for health research outcomes and their acceptance by the public and their eventual adoption by policy-makers (Box 1).

Box 1. Research outcomes and risk communication for EH

Risk communication for EH has implications for the dissemination and uptake of health research outcomes. In framing research, there needs to be a recognition of the differences between how experts and the public perceive the same risks and hazards (van Zwanenberg & Millstone, 2006). Researchers should engage with policy-makers and publics during the research process and not wait until their research findings have been completed. Researchers also need an ability to manage uncertainty in their findings, recognizing that it does not undermine public trust in them as is often assumed (van der Bles et al., 2020). It is through engagement and dialogue that findings will be better accepted and that researchers will come to understand the context in which their research will be used and any risk perception issues (Balog-Way, McComas & Besley, 2020; Dora, 2006; van Zwanenberg & Millstone, 2006). As seen in case study 1 on tackling indoor air pollution in schools in Hungary (section 2 below), carrying out research in schools was also a means of engaging and involving key publics (such as teachers) with the research. It should also be recognized that scientific findings alone will not be sufficient to influence policy-makers and the public—social, cultural, political and economic dimensions have to be taken into consideration as well. The researcher also has to anticipate moving from the research setting, where findings were scientifically validated (and therefore valued), to a competitive communication setting, where they are competing with nonscientific messages from interest groups and/or political actors that are not scientifically validated but are equally consumed and potentially valued by the public (Scheufele & Krause, 2019). Researchers also have to think beyond communicating scientific facts and consider their objectives in doing so—for example, to foster trustworthiness, trigger behaviour change, etc. (Balog-Way, McComas & Besley, 2020).

Trust is not only a matter of trust between authorities and the public, as described above; it is also a matter of trust between authorities and scientists and researchers—a fact that has proved crucial in the response to the COVID-19 pandemic, notably in

Box 1. contd.

North America and Europe (Cairney & Wellstead, 2021). A contrast was seen between the United Kingdom and the United States in the trust placed by the authorities in experts on COVID-19 and their research. In the United Kingdom, the authorities largely adhered to the advice of their experts, although their pool of experts was criticized for being an insulated environment that dismissed outside expert advice. In the United States, researchers observed that there was a low reliance on expert advice at the federal level and a consequent incoherent approach at the state level (Cairney & Wellstead, 2021). Researchers also, arguably, have a role to play in the substantial gap between the academic study of risk communication and the actual practice of authorities (Balog-Way, McComas & Besley, 2020). When necessary—as, for example, in the case of climate change—researchers can also help by translating language and timescales that are appropriate to the scientific research domain to those that are relevant for policy-makers (WHO, 2018b).

The uptake of research outcomes is also reliant on the institutional arrangements in place to ensure that a dialogue can take place (Dowler et al., 2006; Renn, 2010). This implies the integration of dialogue and feedback between research organizations and policy-makers, as well as with publics.

1.2 Challenges for risk communication for EH

The overview of mega-trends and of theories and concepts associated with risk communication for EH has highlighted some key challenges. To build on this, a review was systematically carried out of 25 articles, studies and reports to identify common challenges and good practices for risk communication for EH; the results of this review are shown in Annex 1. The selection of these sources was not exhaustive but based on their relevance to the topic and limited to those published after 2000. In this respect, 13 out of 25 were focused on COVID-19, with the remainder focusing on general risk communications or on some specific hazard or risk—for example, polio eradication in South-East Asia and the BSE/CJD "mad cow" crisis in Europe in the 1980s and 1990s.

For all sources, challenges and good practices were largely not the opinions of their authors but grounded in their own direct experiences as health professionals and/or communicators, based on primary research such as public polling, focus groups and media content analysis, and/or drawn from existing empirical studies.

Based on this analysis, six challenges for risk communication for EH were identified, ranked here in order of their consensus in the sources.

1 Difficulties in closing the gap between expert and public risk perceptions

This was seen as a challenge mainly for experts in science and health, concerning their ability to take on board and consider what to them might seem "irrational" perceptions of risk on the part of the public and then to adapt their communication and messages. As Leiss (2004) commented (p. 402): "There is a fundamental and permanent divide between the way in which risk assessment experts present risk information, on the one hand, and the way in which most members of the public think about risk issues, on the other. And this divide is not going to go away."

2 Dealing with uncertainty and changing scientific evidence

Risk communication for EH has long had to deal with uncertainty and changing scientific evidence. This was further reinforced by the COVID-19 pandemic, in which both uncertainty and changing evidence meant that messages needed to be adapted and publics advised accordingly, for example in the case of face masks. This issue is particularly pertinent in facing acute risks and less so with chronic ongoing risks, such as air pollution, where the science and evidence are established (see case study 1 on promoting indoor air quality; section 2 below). Case study 2 on water contamination in Italy illustrates the challenges in communicating as the science is evolving and emerging (section 3 below). The challenge for communicators and health experts is not so much recognizing uncertainty as understanding that it is acceptable and how it can be managed when communicating (see section 1.3, good practice no. 9).

3 The shift in who is considered a trusted source

Deference to science and health experts has remained strong during the COVID-19 pandemic, although some publics have listened to other sources. The quality of the science has not changed (arguably, it has improved); rather, other sources, such as the elites, that, knowingly or not, promote misinformation and potentially harmful practices, have received equal or greater attention. Their emotional and sensationalist messages gain attention and, if aligned with existing values and predispositions, can dominate the rational and scientifically valid but "emotionally dry" facts (Krause et al., 2020).

4 Managing the channels to counter the spread of misinformation

The challenge for risk communication is to select the most effective channels for their given public(s) and to overcome the domination of sensational and false information, notably via social media. Unfortunately, as described above, sensational and fake news can travel much more quickly and widely than verified facts.

5 The resources, capacity and skills needed for risk communication

Institutions responsible for communicating on risk struggle to dedicate the resources and develop the capacity and skills needed for risk communication for EH. Many institutions have both scientific and communication expertise but not necessarily skills in risk communication and the cross-disciplinary methods needed. This is even more the case when it comes to applying two-way or multidirectional communication, which by its very nature is resource-intensive given the dialogue and relationship-building needed.

6 Reframing information so that it is understood by the public

Linked to the first challenge are the difficulties for risk communication in reframing information so that it is understood and ultimately supports desired behaviour changes. This has been further complicated by crises such as the COVID-19 pandemic, in which information on (for instance) social distancing or confinement may be clearly understood but does not lead to desired behaviour change—and possibly even the reverse—because of polarization and politicization of such behaviour. This leads to the necessity to go further and address the causes or sources of such polarization (see section 1.3, good practice no. 3).

1.3 Good practices for effective risk communication for EH

Based on the analysis of 25 sources (Annex 1), 10 good practices for risk communication for EH were identified, ranked here in order of their consensus in the sources.

1 Messaging that reflects the concerns of the public and recognizes their diversity

The strongest good practice identified is the necessity to recognize and integrate the concerns of the public in risk communication, in addition to understanding that the public is made up of diverse groups with differing concerns and needs. This practice is illustrated by the three case studies below (sections 2–4) and is supported by past research which found that messaging is more effective when it integrates factors known to influence risk attitudes and behaviours: experiential, social, cultural, political, linguistic, etc. The limitations of messaging have to be recognized if the targeted public is overwhelmingly opposed to the source (see good practice no. 3).

2 Selecting and managing the appropriate channels to reach and reassure the public

Selection of the most appropriate channels to reach the public(s) is a given in all forms of communication. Communicating on heat risks in Europe has evolved in the

past 15 years from issuing passive warnings through mass media to use of multiple and interactive channels, including the internet, mobile applications and social media (WHO, 2021b) (see also case study 3 on heat health action in Austria; section 4 below). The rapid spread of misinformation over social media is a challenge for all communication, including risk communication for EH. However, when used correctly for risk communication, social media can be used to effectively communicate verified information to the public through dialogue and exchange, particularly when unease concerning communicating uncertainty has been overcome and health experts become "first movers", as Malecki, Keating & Safdar (2021) propose (p. 4): "Clinicians and public health experts can get ahead of the public in shaping messages, social media offers an almost immediate opportunity to spread information, become a trusted source, and to build relationships with the public."

3 Understanding who has influence on the public and optimizing it

Today the health expert has to compete with other influencers for attention and, unfortunately, the two may not always be aligned. The COVID-19 pandemic has shown the power of elites such as politicians, media personalities and celebrities to influence and mobilize the public. Where possible, risk communicators need to work with other influencers to encourage consistent and accurate messaging that is communicated compassionately and amplified by their own (ideally) exemplary behaviour. Case study 1 on promoting indoor air quality in schools in Hungary illustrates how influencers can be used effectively (see section 2 below). For some publics polarized by partisan beliefs and conspiracy theories, the health expert will never be a reference. In these cases, the risk communication strategy must try to identify and influence the relevant elites, as difficult as that may be, but as Uscinski et al. (2020) highlight (p. 3):

> If cues from partisan elites are capable of inflaming conspiracy beliefs among likeminded supporters, they may also be capable of reducing conspiracy beliefs and limiting their pernicious effects. In these instances, the distrust at the center of conspiracy thinking and denialism may be overridden by embracing the power of partisanship and conveying corrective information using likeminded political elites.

Good examples were also seen in communicating heat risk in Europe, where key "relays" for conveying information, such as nursing home managers, pharmacists, hospital managers and schools, were included in communication plans (WHO, 2021b).

4 Involving the public and stakeholders early and adopting two-way and multidirectional communication

The importance of involving the public and stakeholders early in risk assessment and management is well recognized in the literature and practice and goes a long

way to narrowing the perception divide between experts and the public (section 1.2, challenge no. 1). Such engagement needs to be further reinforced, as does the adoption of two-way and multidirectional communication (as illustrated in case study 2 on water contamination in Italy; section 3 below). Even in crisis situations, communication need not be one-directional; constant feedback and direct interaction should be integrated. This approach also builds trust with the public, as Renn (2010) states (p. 91): "Information alone will never suffice to build or sustain trust. Without systematic feedback and dialogue there will be no atmosphere in which trust can grow."

5 Measuring risk communication to understand progress

The importance of research and measurement to inform risk communication is stressed at all phases of the communication process in order to understand the risk perception(s) of the public(s); to determine the influencers on the public(s); to pre-test messages and materials; to monitor the reach and uptake of messages and desired behaviours; to monitor competing messages and mistruths; and to evaluate communication sources, channels and activities. Without research and measurement, it cannot be known whether risk communication efforts are effective and, if they are not, how to adapt and adjust them. Case study 3 on heat health action in Austria illustrates the effective use of evaluation to adapt subsequent communication (section 4 below). Evaluation need not be expensive or complicated; critical is message testing, as Fischhoff (quoted in Balog-Way, McComas & Besley, 2020; p. 2249) cautions: "One should no more release untested communications than untested pharmaceuticals." As an example, efforts should be made to test the associations that messages may trigger: the language used in heat warning messages may in fact evoke positive feelings towards dangerous heat (WHO, 2021b).

6 Risk communication requires a multidisciplinary approach

Risk communication can benefit from a multidisciplinary approach that encompasses different models and methods, including public health, health education, health promotion, sociology, mass media, emergency and crisis communication, digital media, communication for behaviour change, networking and influencing. To be effective in the challenging contexts it faces, risk communication should not only present information that is factually correct but also capitalize and draw on a broad range of approaches. Case study 2 on water contamination in Italy (section 3 below) illustrates the complexity and range of skills needed to respond to what was an acute crisis in 2013 (discovery of contaminated water) that evolved into a chronic risk (the long-term impact of contaminated water).

7 Risk communication requires capacity-building

A challenge identified above (section 1.2, no. 5) was the lack of resources, capacity and skills in risk communication. In-house capacity within institutions that communicate and manage risk for EH is key; it has also been shown to be important to support early communication on risks, as was seen in the COVID-19 pandemic. As stressed above, capacity simply to produce clear and factually correct information is insufficient today; capacity across multiple disciplines and skill sets is needed.

8 Messaging needs emotions and compassion to counter outrage

Valid health facts need to be communicated clearly and widely. At the same time, emotions and outrage may be at the core of competing and often dominating messages, as was the case in the COVID-19 pandemic. Good practice suggests that risk communication can "flip" this by making greater use of emotions and compassion in its messaging and storytelling and by integrating the concerns of the public, recognizing that the level of outrage can distort the public's perception of risk (good practice no. 1).

9 Recognizing that uncertainty is manageable for risk communication

Risk communication can manage uncertainty, knowing that its presence in messaging will not diminish the trust of the public in the communicator or the institution. While uncertainty is accepted for acute risks much more than for chronic ones, publics understand that there is rarely full certainty in any area. At the same time, risk communication needs to recognize that there will always be people who will exploit any uncertainty for their own purposes—for example, to cast doubt on the health advice recommended. But publics are able to assess and judge uncertainty, even if their own predispositions will limit their ability to do so in some ways.

10 Risk communication should be embedded within scientific studies from the outset

Risk communication is often insufficiently integrated within scientific studies—it should be embedded in them from conception through to dissemination of findings. Good practice suggests that elements of risk communication should be integrated within research and scientific studies, considering that most will have an eventual input into the policy area. Such integration also provides an early opportunity for researchers to reflect and assess how their research will be positioned in the competitive external environment. Case study 1 on promoting indoor air quality in schools in Hungary provides a good example of embedding communication within research (section 2 below).

2. Case study 1
Promoting indoor air quality in schools, Hungary

2.1 Background

The quality of air in schools plays an important role in providing a comfortable and healthy environment for children to study in. The issue is a significant one because of the amount of time (6–8 hours per day) that children spend in school and the potential risks to their health and well-being. Children are more vulnerable to the risk of air pollution than adults. Not only does a combination of physiological, biochemical, behavioural and social characteristics make them more susceptible to the effects of pollution, but they are also less able to defend themselves as their immune and blood–brain systems are less mature (WHO, 2020a). For instance, they breathe faster than adults, increasing the intake of dangerous pollutants (WHO, 2020a: module 2). Consequently, children are at risk of various short- and long-term effects, ranging from headaches, coughing and nausea to allergies, asthma, respiratory diseases and cancer (WHO, 2020a: module 3). Indoor and outdoor air pollution is one of the regional priority goals of WHO's Children's Environment and Health Action Plan for Europe.

Indoor air quality depends on the levels of a wide range of pollutants including biological contaminants such as mould, dust mites and bacteria, carbon dioxide and carbon monoxide. The sources of these pollutants may be internal (by-products from heating systems, cleaning products, paint and floor coverings) or external (proximity to a car park, bus stop or designated outdoor smoking area) (ICE, 2018). In Hungary, the need for action in this area was underlined by the results of a monitoring campaign which found that, of 16 participating primary schools, 15 were rated either unhealthy or very unhealthy on the Indoor Health Index and 11 were rated unhealthy for comfort (NPHC, 2018). In Hungary, children aged 6–14 attend primary school, meaning that improvements in air quality in school could benefit around 741 000 children, as well as 74 000 teachers (ICE, 2018).

2.2 Communication campaign on indoor air quality in primary schools

In Hungary, the National Public Health Center (NPHC) is responsible for investigating the health risk associated with indoor and outdoor air pollution, as well as for communicating the risks to the public. In some instances, this can happen on a relatively small scale—the NPHC intervenes if a problem is flagged up and it needs to engage in risk communication with the actors directly involved. The NPHC also works on a much bigger national scale.

Between 2017 and 2019, the NPHC undertook a major nationwide campaign to raise awareness and change behaviour to improve the indoor air quality for children in primary schools. This awareness-raising campaign took place as part of the InAirQ project, funded by Interreg Central Europe, for which the NPHC is the lead partner. The overall aim was to raise awareness of air pollution, indoors and outdoors, in order to protect children's health. Its objective was (ICE, n.d.):

> to inform and raise awareness about the issue of indoor air quality, especially in environments frequented by children, and to change behavioral attitudes in a way that pays attention to health needs when relating to indoor environments.

An overall communication strategy was developed by a communication manager in collaboration with all the InAirQ project partners. However, the national campaign was led by the lead communication expert of the NPHC. The campaign drew on research that had been carried out on how to improve the air quality in primary school classrooms. Sixteen primary schools in Hungary were involved in the InAirQ project. The air quality in classrooms in these schools was investigated and, in addition, a test was conducted that attempted to improve the indoor air quality in one selected primary school building.

2.3 Communication campaign

2.3.1 Objectives and key messages

The overall objective of the campaign was to instigate changes that would lead to improvements in the air quality in classrooms in primary schools and improved health for children. The main goal was to achieve behaviour change leading to cleaner indoor air, in order to prevent the health risk and associated negative consequences. To achieve this, the campaign sought to increase awareness of the issue, to suggest achievable behaviour changes and to target policy-makers to instigate policy change. This work was part of a collaboration with the InAirQ project in which partners worked together to design ways of reaching out to pupils, parents, school managers, maintenance staff, decision-makers and others (ICE, n.d.).

The messages for the campaign were identified on the basis of preparatory work that had previously been carried out, such as the monitoring campaign. The key messages were then formulated by means of a dialogue between the scientific researchers and the communications team, who helped to translate them into a language the public would readily understand. The focus was on communicating the main risks associated with poor indoor air quality and clearly explaining how to reduce them through simple, achievable actions such as ventilating the room more frequently and children having separate shoes for indoor and outdoor use to avoid dust. The possible health outcomes were also described, such as the increased risk of developing asthma. The messaging was made tangible for the audience; for instance, poor indoor air quality was linked to certain

respiratory symptoms in the classroom, enabling people to make a connection between the problem and how they felt.

Results from the monitoring campaign conducted in 2017/2018 in the five countries participating in the InAirQ project were used to refine messages for the campaign. One of the key issues identified was low air exchange rate; this was translated into a key message for teachers that included simple actions that could create a healthier environment at school, such as regularly ventilating classrooms. This led to an awareness-raising campaign that focused on behaviour change for teachers in schools, featuring posters on the theme "Learning is easier in clean air" that were distributed to all primary schools.

2.3.2 Target publics

An issue identified by the project team was that addressing indoor air quality in schools required collaboration between a wide range of actors who do not usually meet or communicate (researchers, school caretakers, policy-makers, parents, teachers, headteachers). One goal of the project was to bring these groups together to encourage them to work towards this common goal. As a result, the campaign targeted specific audiences as well as the general public—policy-makers in the Hungarian government (notably in the Ministry of Human Capacities, which is responsible for health and education), teachers, school management, those responsible for school maintenance, architects who design school buildings and the children themselves.

Decision-makers

The lack of national guidelines or regulations on indoor air pollution, despite the existence of international guidelines, had been identified as a key area for improvement (ICE, 2018). Consequently, a strong focus was placed on decision-makers, such as those within the key ministries, including the Ministry of Human Capacities, which covers health and education. This was considered to be the most challenging group to convince and the hardest to engage. The campaign set out to inspire policy changes that would make a lasting difference to the quality of air in classrooms, with the objective of leading to national strategies on the issue. After the campaign, WHO support was requested to produce further policy documents and recommendations that could be used to communicate the issue to policy-makers.

Schoolchildren

The campaign sought to engage children aged 6–14, sensitizing them early to EH issues and encouraging them to pay more attention to actions that could improve indoor and outdoor air quality.

Stakeholders with roles related to schools

This group included teachers, school managers, and those engaged in school maintenance, including churches and the Klebelsberg Institute Maintenance Centre, which is responsible

for maintaining 78% of schools (ICE, 2018). The goal here was to ensure a healthy school environment by raising awareness of factors that have a detrimental impact on air quality.

Although the campaign did not start with any specific audience analysis, a questionnaire had been included as part of the monitoring campaign to be completed by children with help from their parents. It was completed by approximately 300 parents in Hungary. It included questions about air quality, as well as families' perceptions of air quality in classrooms, with the aim of understanding the distinction between air quality as perceived and as shown to be in reality through monitoring.

2.3.3 Perception of risk

Despite the risks to children's health outlined above, the research team described a low level of awareness and interest in the issue of indoor air quality prior to the communication campaign. According to the NPHC, the overall awareness of indoor air pollution and its negative impact on health was low; it was not a "top of mind" issue when people thought about health concerns. The general public do not tend to associate health issues with air pollution, as the impact is often not directly and visibly linked with health consequences, and this can lead to a perception that risks are low: if people fall ill, they do not link their health problem with air pollution. The NPHC suggests that there was a low perception of risk and a lack of public outrage to inspire action or to stimulate policies on the issue to be elaborated in Hungary.

Despite international projects and recommendations on indoor air quality, policy-makers remained largely unaware of the issue and did not see it as a priority; consequently, little action was taken. Teachers also lacked awareness and knowledge of the topic. The perception among parents was described as varied. The leader of the project highlighted children's awareness and their openness to learning about the issue, based on his interactions with children at school talks in the course of another project. A key public to target, therefore, was perceived to be children themselves, as a key to instigating durable change that would be carried across generations. For these reasons, it was important for the communication campaign to raise awareness of the negative health consequences that result from indoor air pollution, in order to sensitize the public and decision-makers to the need to take concrete actions.

2.4 Channels

The communication campaign made use of a wide range of mass and interpersonal communication channels tailored to the needs of each target public. The campaign did not rely on paid-for media, which meant that it could be conducted with minimal cost, based on owned media (social media pages, website) and traditional media.

2.4.1 Schools and children

Printed communication materials were developed as part of the InAirQ campaign and translated into Hungarian. Colourful posters were designed and distributed to primary schools; these drew on international recommendations on best practices to support good air quality, such as the need for frequent ventilation and measures to reduce the particulate matter concentration.

2.4.2 Competition for children

In March 2019, a competition called "Journey towards clean air" was launched in order to engage primary schoolchildren, who were invited to produce artwork or short videos to show what they thought about air pollution and air quality.[2] It also sought children's thoughts about how air quality could be improved. This also engaged the teachers who were involved. The competition was promoted via the NPHC's website and the Facebook page of InAirQ Hungary by means of a poster, a short video and a series of social media posts. It was also circulated to all primary schools and featured on various radio and TV channels. The competition culminated in a prize ceremony at the International Conference on Problem-Solving Approaches to Ensure Schoolchildren's Health, where Hungary's chief medical officer, among others, gave prizes to the children; the children's artwork was also displayed at the conference. In total, 458 children took part and entered the competition.

2.4.3 Mainstream media and influencers

Traditional media played a key role in the campaign. The media are generally interested in the work of the NPHC and the topics they present, so it was not difficult to attract media attention and to gain coverage for the issue in newspapers and on radio and television. Public figures and two celebrities who had an interest in the issue and were involved in the campaign helped to attract media attention by taking part in television interviews and sharing the campaign through their personal social media profiles.

Press conferences took place, including one that was held in a primary school with the participation of children and attended by three TV channels and two newspapers. This proved to be an exciting opportunity to engage the children who took part. The deputy chief medical officer, the head of the NPHC's Air Hygiene Laboratory (also the leader of the InAirQ project), a medical doctor and a broadcast meteorologist participated in this event.

The lead scientists for the project took part in live TV and radio interviews in which they outlined the main risks of indoor air pollution and informed the public how to reduce these risks with simple actions such as regularly opening windows.

2 The competition entries can be viewed on the project's Facebook page: https://www.facebook.com/InAirQMagyarorszag.

2.4.4 Events and conferences

The campaign organized regular fora that brought together school management, teachers and maintenance personnel; these formed part of a bottom-up approach that sought to engage the key stakeholders and to enable them to share their ideas. These events highlighted the importance of indoor air quality, as well as focusing on concrete actions that could be taken by the different actors. Training materials were created for the different target groups (teachers, architects who design school buildings, etc.) and capacity-building courses were organized in Hungary for these groups too. Initially, engagement with these events may not have been as high as had been hoped, given the many other pressures already faced by teachers and the perception that air quality was not a priority issue. At each forum, participants had an opportunity to provide feedback. Their input on the problems that mattered most to them was used to develop subsequent events, thereby creating a dialogue with the audience and motivating them to continue their participation. For instance, at early events, teachers expressed concern about the food children were eating, showing their awareness of the importance of children's health. Later events included a broader range of topics related to EH in the classroom, alongside air quality, in order to appeal to the audience and reflect their concerns. The fora reached 200 stakeholders.

An international conference on integrated problem-solving approaches to improve the health of primary schoolchildren, encompassing indoor air quality alongside other topics, was organized in Budapest. The conference aimed to attract scientists, researchers and doctors, as well as school managers, teachers, architects and engineers. A key public for this event was policy-makers and decision-makers, who were invited to highlight the importance of the topic. The international conference involved WHO, as well as international partners who were collaborating with the NHPC in the InAirQ project. The campaign was linked to these broader efforts of the InAirQ project; each of the five participating countries produced a national action plan on indoor air quality improvements.

Public events such as European Mobility Week—an event held in September each year that promotes the use of clean mobility and sustainable urban transport—were also used to raise awareness. The NPHC had a stand at this event, which attracted 200 000 visitors, and the NPHC experts showed visitors (including children and their parents) how to use scientific equipment to measure air quality. Research nights were also held at the NPHC, which children were invited to visit with their parents to learn about different kinds of air pollution.

2.4.5 Using research as outreach

The monitoring campaign itself was used as an opportunity to engage stakeholders. It contributed to raising the awareness and changing the behaviour of the teachers whose

classrooms were being monitored during the project, as they became more aware of the importance of opening windows. In addition, the headteacher of each school was invited to sign a commitment to undertake specific measures to improve indoor air quality at the end of the project.

2.4.6 Website and social media

The InAirQ project included a "massive and continuous social media campaign" in each partner country (ICE, n.d.). The InAirQ website included information relevant to decision-makers in Hungary and the four other countries in central Europe participating in the project.

In Hungary, the NPHC was able to use its Facebook page, as well as that of the chief medical officer, which had a high number of followers. A Facebook page for InAirQ Hungary was created in October 2017; by June 2019, 67 posts had been created in Hungarian and English, attracting 225 followers. These pages were used to share a diverse range of content, including the poster that had been made for schools, short videos, the artwork produced by the children for the competition, updates on the project and press interviews. As previously mentioned, the celebrities who were involved in the project also amplified the message by sharing the campaign materials on their own social media accounts.

2.4.7 Partners and allies

As mentioned above, the campaign was closely linked to regional and international partners collaborating in the InAirQ project and to WHO; there was also national and local collaboration between the different actors involved in primary schooling. Private partners were also engaged; companies contributed by donating gifts that were used to reward competition winners and also as gestures of gratitude to the celebrities who helped with the campaign.

2.5 Results

While there has been no specific evaluation carried out to assess the impact of this campaign, it can be linked with a number of achievements.

Children and teachers were sensitized to the issue

- The poster reached 85 000 people on Facebook via the NPHC's and the chief medical officer's accounts.
- Nearly 500 children took part in the art competition, suggesting that they (and potentially their parents and teachers) had become more aware of the issue and the

action that needed to be taken. The nature of the competition meant that they were also involved in thinking of solutions and were able to provide their input.

- Anecdotal evidence suggests that awareness was raised in the schools that took part in the monitoring campaign and that teachers changed their behaviour as a result.

Decision-makers were sensitized and concrete steps taken towards greater national regulation

- More than 100 policy-makers, public health professionals, researchers and architects from all over Europe attended the international conference in June 2019 (NPHC, 2019).
- After the conference, a deputy state secretary welcomed the development of a protocol to determine how a school can diagnose air quality issues and decide on actions to be taken. This document has been prepared and is awaiting approval; if approved, it will become compulsory for schools in Hungary to follow these procedures. The document will also be made publicly available on the NPHC's website.
- The InAirQ project website states that it resulted in five national action plans being produced, one for each of the participating project countries (including Hungary).

A presence in the national media would have reached the general public

- National coverage on radio and television and in the press suggests that the public would have been sensitized to the issue, not least because of the involvement of celebrities who helped promote the cause.

2.6 Lessons learned

2.6.1 Messaging

- Communication tools contained preventive messages on how to avoid the risks and were communicated to stakeholders in a timely, clear and understandable way.
- Messaging aimed to achieve behaviour change leading to cleaner indoor air and included actions that were easy to take and tailored to each target audience (children, teachers, architects, etc.).
- The risk communication campaign sought to communicate the risks involved by making them visible and tangible to the audience in a way that would overcome their prior lack of awareness. It also sought to raise the profile of the risks associated with indoor air pollution by positioning them alongside general issues surrounding children's health at school that were of concern to the audience.

2.6.2 Channels

- The use of influencers (such as celebrities and public figures) helped to amplify the campaign and attract greater media attention both in the mainstream media, whose representatives were willing to attend press conferences and host interviews, and on social media platforms, as celebrities used their own accounts to share the campaign materials.
- Diverse communication channels were used to reach different audiences, including in-person meetings that allowed for interpersonal communication. As part of the campaign's advocacy efforts, it created opportunities for various stakeholders to come together to promote collaboration between the wide network of stakeholders (private sector partners, media, scientists, the communications team, schools, government agencies, WHO, international partners).
- Creative strategies were used to engage the audience and create a feedback loop including in-person and interpersonal communication (for instance, the art competition for children that also engaged teachers and presumably parents; fora that united diverse stakeholders). This feedback was then used to refine the message and increase engagement by connecting the issue with topics that were of concern to stakeholders (for instance, a general concern for children's health).

2.6.3 Linking research, analysis and risk communication

- The communication campaign benefited from strong links with the scientific researchers, who were heavily committed to communication work. The lead experts collaborated closely with the communications team, as the head of the NPHC's Air Hygiene Laboratory and leader of the InAirQ project commented: "having scientific research is not enough in itself, it is really important to communicate the results. If you really want to change something, you have to communicate."
- Clear definition of key messages (key risks, actions most urgently needed to avoid the risks, the need for policy change) and target groups was made possible by prior analysis of the issues using the method developed as part of the InAirQ project.
- Risk communication is a continuous process and requires patience and time in order to achieve lasting, long-term change.

2.6.4 Assessing impact

- While the campaign led to some tangible results, future risk communication campaigns would benefit from systematic evaluation, including prior to communicating, to inform their efforts.

3. Case study 2
Water contamination in the Veneto region, Italy

3.1 Background

Millions of people in European and central Asian countries drink contaminated water, often without knowing it. WHO estimates that, every day, 14 people across the WHO European Region die of diarrhoeal disease due to inadequate water, sanitation and hygiene. Contamination can come from naturally occurring substances such as arsenic and fluoride but also from substances introduced by humans, such as lead, nitrate and industrially derived chemicals (WHO, 2017c and 2018c).

Although many Europeans do not think of access to water as an issue, for some populations, such as those in rural areas, clean and safe drinking-water is frequently unavailable. In the Region, 21 million people still lack access to basic drinking-water services and 57 million people do not have piped water at home. These people use water from unprotected dug wells or springs or directly consume surface water. Climate change also has an impact on the quality and availability of clean and safe drinking-water (WHO, 2017c and 2018c).

Industrial chemicals contaminating water in Europe and central Asia include poly- and perfluoroalkyl substances (PFAS), which are a group of widely used synthetic organic chemical substances. These substances repel oil and grease and are used to protect the surfaces of textiles and packaging materials, in addition to being used in a wide range of products including firefighting foams, semiconductors, medical devices, biocides, feed additives, pharmaceuticals and paints (European Commission, 2020b; WHO, 2017b). PFAS find their way into the environment from wastewater treatment plants, landfills, recycling and incineration installations, and reuse of contaminated sewage sludge. The number of sites potentially emitting PFAS has been estimated to be approximately 100 000 in Europe (European Commission, 2020b).

PFAS are also persistent and mobile, with negative consequences for human health. The main risks of PFAS to human health include increased cholesterol levels, effects on reproduction and fertility, immunotoxicity, thyroid disease, liver damage, and kidney and testicular cancer (European Commission, 2020b; WHO, 2017b).

3.2 Water contamination in the Veneto region

The Veneto region in north-east Italy is known globally for its historic capital, Venice, but is also one of Italy's leading industrial regions, producing furniture, leather and footwear,

textiles, clothing, and also chemicals, electronics and metals. Agriculture is also important, with wine production accounting for approximately 20% of Italy's total production (WHO, 2017b).

In spring 2013, the regional authorities were alerted by an extensive study to the presence of PFAS in the groundwater, surface water and drinking-water in some parts of the Veneto region, in an area extending over some 200 km^2 and affecting up to 350 000 people.[3] The source of the contamination was found to be wastewater entering the waterways from an industrial plant producing chemicals for crop production, herbicides and pharmaceutical products. Water pollution was not new to the Veneto region; since at least the 1970s, instances had been reported, reflecting the important industrial and agricultural production of the region (Region of Veneto, 2017a).

In response, an emergency task force was set up comprising representatives of relevant authorities: the Regional Prevention Directorate, the Regional Environment Directorate, the Regional Environmental Protection Agency and the regional health-care trusts (local bodies responsible for public health). The aim of the task force was to oversee the situation with a view to protecting population health, coordinating activities, collecting and sharing data, and managing risk communication.

3.3 Communication approach

The Regional Prevention Directorate coordinated closely with the local health-care trusts to formulate plans and communicate messages on the water contamination, as the trusts had direct contact with the affected populations. A wide range of stakeholders was involved in the communications and response to the water contamination; these included national health research institutes, the relevant national and regional authorities (agriculture, health, environment, food safety, veterinary services), local authorities (including mayors, administrators and health trusts), water service providers, civil society and the affected populations. The WHO Regional Office for Europe also provided technical assistance and support.

3.3.1 Objectives and key messages

When the crisis hit in 2013, the immediate objective was to communicate about the water contamination, the potential risk to the population, and the measures being undertaken to remedy the situation. The assessment provided by the National Health Institute (Istituto Superiore di Sanità) to the Ministry of Health in June 2013 stated that, although there was no immediate risk to the exposed population in drinking the contaminated water, urgent mitigation and prevention measures should be adopted (Region of Veneto, 2017a).

3 A two-year study conducted by the National Research Centre of the Institute of Water Research, commissioned by the Ministry for the Environment, Land and Sea (IRSA–CNR, 2013).

Furthermore, in 2013 there was considerable scientific uncertainty about the dangers of PFAS and no regulations were in place in Europe or Italy on safe thresholds for PFAS in drinking-water (two of the most extensively used PFAS were already globally regulated; perfluorooctane sulfonic acid and its derivatives had been restricted in the EU for more than a decade under the Persistent Organic Pollutants Regulation (ECHA, 2020)). The health authorities also had to be conscious of the potential long-term risks of PFAS, considering that they could have been in the waterways for decades prior to 2013.

Communications focused on informing the population about the water contamination, while stressing that—although the longer-term risks had not yet been determined – the immediate risks were low. It was also important to communicate the measures being taken by the regional and local authorities, including urgent installation of carbon filters by the water service providers to clean the water; identifying the area of contamination and the main source responsible; increased monitoring of drinking-water and the waterways of the region; assessing the effects on the exposed population; and studying the effects on food production in the region (Region of Veneto, 2017a). By September 2013, all water treatment plants had been equipped with activated carbon filters and were then able to meet the thresholds for PFAS concentrations in drinking-water established by the Ministry of Health in January 2014 (see below). For this reason, the regional health authorities did not recommend that the population should stop drinking tap water.

3.3.2 Perception of risk

The challenge facing the regional and local health authorities was the uncertainty of the science surrounding PFAS in 2013 and, consequently, communicating the potential risk of PFAS. When informed about the water contamination, the public's perception of the risk was high and they judged it to be more dangerous than it was considered to be by the health authorities. The public's risk perception was also heightened by other factors, including the time needed to carry out the studies and assessments necessary to gain a better understanding of the water contamination and its effects on the population and the environment, and the fact that the polluting industrial plant did not take responsibility for the water contamination; these factors combined with the media coverage to increase public anxiety and even create a degree of panic (WHO, 2017b).

3.3.3 Channels

The Regional Prevention Directorate, in conjunction with its national and local partners, used a range of communication channels and relays to communicate about the PFAS contamination.

- Tools and materials were prepared with key messages for the affected publics, including flyers, a list of frequently asked questions, monthly e-bulletins on the situation, and other web-based materials. Any results of water treatment monitoring were also

published and shared. The information was made available on the Region of Veneto's website and to media outlets used by the public.

- Mayors and local authorities were briefed on the situation as early as July 2013 and provided with information to use in their communication with the public. A series of "town hall" meetings were held with the public to explain and discuss the situation.
- The health-care trusts, water service providers and main health-care providers (such as general practitioners) were also important relays and were briefed and given guidance on how to communicate the risk of PFAS contamination to the public.
- Given the important role of the media in reaching the public, a series of trainings and briefings for journalists in the Veneto region was organized by the health authorities and Viveraqua, the consortium of water service providers.

The communication was ongoing, with stakeholders and publics updated regularly as measures were taken to remedy the PFAS contamination, and the results of the various health, environmental and food safety studies were published from mid-2013 onwards.

3.4 Post-crisis and ongoing actions

By August 2013, with many of the technical measures in place, the water contamination was reduced and the crisis phase was over. However, it was only the start of addressing PFAS in the environment of the Veneto region over the long term.

In January 2014, thresholds for PFAS were set nationally in Italy, providing a benchmark for safe drinking-water (WHO, 2017b). Research continued into 2015/2016 in the Veneto region and biomonitoring studies showed up to 40 times higher concentrations of PFAS in exposed populations compared to those that had not been exposed (Ingelido et al., 2018). For those exposed, analysis found a higher risk of mortality, diabetes, cerebrovascular diseases, myocardial infarction and Alzheimer's disease (Mastrantonio et al., 2018). In 2017 a health surveillance plan was launched for the residents of highly affected areas (Pitter et al., 2020). On 21 March 2018 a state of emergency for the Veneto region in relation to PFAS contamination was declared by the national Council of Ministers, and up to €56 million of additional funding was allocated for its mitigation and resolution (Region of Veneto, 2020).

Medical and social research continued in Italy, Europe and beyond, highlighting a growing number of health effects linked to PFAS (Goldenman et al., 2019). In 2015 more than 200 scientists signed the Madrid Statement, urging a limitation on the production and use of PFAS (Blum et al., 2015). The EU's 2020 Chemicals Strategy, recognizing the health, societal and economic costs of PFAS, called for their phasing-out in Europe (European Commission, 2020a).

Growing awareness and concern about PFAS and their potential impact on health triggered the creation of grassroots movements in the Veneto region. Since 2017 the advocacy group Mamme No PFAS ("mums against PFAS") has led a range of campaign and advocacy actions calling for the reduction of PFAS in drinking-water, raising awareness among the population, facilitating a better understanding of the health effects of PFAS, and seeking to bring the polluting industrial plant to justice (the issue remained legally unresolved as of October 2021).[4]

3.5 Results

The discovery of PFAS contamination in 2013 led to a joint and collaborative effort from the regional and local authorities to communicate the risks directly to the public and through key relays such as the local authorities, health trusts, media, general practitioners and water service providers. This in turn resulted in more cohesive communication, such as that of the 12 water service providers, who communicated jointly through their consortium Viveraqua.

The communication encouraged dialogue and an exchange, where possible, between the affected populations and the health authorities. The communication also aimed to be transparent by sharing the results of scientific studies as they became available and making public any results of water treatment monitoring.

Raised awareness of PFAS contamination had an impact at national and European levels; what occurred in the Veneto region contributed to setting thresholds for PFAS in drinking-water in Italy and led to heightened visibility and attention to PFAS across Europe, as was seen in the EU's 2020 Chemicals Strategy. Learning and understanding the risks of PFAS mobilized the citizens of the affected areas to call for more action to combat PFAS, not only in the Veneto region but also at the EU level and globally.

3.6 Lessons learned

3.6.1 Communication approach

- A collaborative and consultative way of working facilitated a common and joint approach to communicating on the PFAS contamination in 2013.
- More systematic and ongoing dialogue between the health authorities and the affected publics could have been beneficial, especially as the 2013 crisis subsided and the longer-term effects of PFAS became evident.

4 The group's website can be seen at www.mammenopfas.org.

- The evolving situation from 2013, with more and more scientific results on the dangers of PFAS becoming available, implied that the risk communication needed to adapt and integrate these new results in its messaging.

3.6.2 Messages

- The messages in 2013 gave a balanced view of the risk of water contamination, together with the actions to remedy the situation.
- The uncertainty of the science surrounding PFAS in 2013 made it challenging to communicate the risk to the public; it also took time to carry out the necessary studies on the effects of PFAS contamination on affected publics and food production; this in turn led to some mistrust among the public.
- The polluting industrial plant did not take responsibility for the PFAS contamination and has not, to date, been brought to justice, further exacerbating the mistrust of the affected publics.

3.6.3 Channels

- The use of a range of channels and relays to communicate with both stakeholders and the public supported widespread building of awareness of the PFAS contamination in 2013.
- The continued work with the media was important to ensure that they had accurate factual information and understood the science and where there was uncertainty in the findings.

3.6.4 Linking research, analysis and risk communication

- Risk communication had to cope with translating numerous scientific studies from a range of areas (agriculture, health, environment, food safety, veterinary services) for public consumption and needed the support of specialists in this regard.
- The scientific studies did not always produce findings that could be translated into concrete results and guidelines, such as specific advice on risk-reduction behaviour, for the local authorities and affected publics; further support was needed from specialists in this regard.

3.6.5 Assessing impact

- The communication efforts could have benefited from more systematic approaches to understanding the results of its activities and the attitudes and behaviours of affected publics, in order to inform future efforts.

4. Case study 3
Heat health action in Styria, Austria

4.1 Background

Climate change and the resulting extreme weather have been described as an "urgent health threat for humans" (Shumake-Guillemot, 2020a). Heatwaves and hotter temperatures are becoming more prevalent as the world is warming and lead to increased health risks (Matties et al., 2008). Europe is no exception and has experienced "an unprecedented rate of warming in recent decades" (WHO, 2021d). According to WHO, "heat-waves and hot weather kill and can aggravate existing health conditions" (Matties et al., 2008). Untreated heat stroke has a 65–80% fatality rate and high temperatures can lead to "severe dehydration, blood clotting, stroke and organ damage" (Shumake-Guillemot, 2020a).[5] Existing health conditions affecting the kidneys, heart and lungs may also be aggravated, as may mental health conditions (Shumake-Guillemot, 2020a). As the weather continues to become more extreme and heatwaves intensify and lengthen as a result of climate change, mortality rates are expected to increase (WHO, 2021c).

Austria is no exception. Average temperatures rose by 1.3 °C between 1988 and 2017,[6] and the 2003 heatwave in Europe intensified fears about the impacts of heat stress on health. In Austria heatwaves are expected to become more frequent, with particularly negative effects in urban areas (WHO, 2018b: p. 111). Longer heatwaves have a stronger impact on mortality rates, and their effects on health can be aggravated if combined with increased air pollution (WHO, 2021c), while heat simultaneously exacerbates urban air pollution (Shumake-Guillemot, 2020a). Despite these effects, and the ability of heat to exacerbate other disasters such as droughts and cyclones, it may not be considered an emergency in itself and health systems may not be well equipped to cope with the health impacts of extreme heat (Shumake-Guillemot, 2020a; WHO, 2021c).

Vulnerability to heat stress varies according to age, occupation, housing and socioeconomic status. Those most at risk of heat stress include people suffering from chronic medical conditions or social isolation, and those working in certain occupations—in particular, those who work outdoors (Shumake-Guillemot, 2020a; WHO, 2021c). Homeless people

5 According to Shumake-Guillemot (2020a), heat stroke is defined as exposure to temperatures over 40 °C leading to throbbing headaches, an absence of sweating, high fever above 39.5 °C, nausea or vomiting, and potential loss of consciousness. This contrasts with heat exhaustion, which results from exposure to temperatures between 37–40 °C and leads to fainting or dizziness, excessive sweating, cool, pale, clammy skin, nausea or vomiting, a rapid weak pulse, and muscle cramps.

6 Figures from the Zentralanstalt für Meteorologie und Geodynamik (ZAMG) (www.zamg.ac.at).

are also at risk. Heat stress can be linked with a loss of productivity and income, as well as reduced quality of life for those working in affected professions (including health workers using personal protective equipment (PPE) in the context of the COVID-19 pandemic). The urban elderly are also an at-risk group; as WHO (2021c) states, "in European cities, the elderly suffered the greatest effects of heat-waves, with women bearing a higher burden of mortality than men". Globally, this means that Europe and the eastern Mediterranean "are particularly at risk … due to ageing populations living in cities" (Shumake-Guillemot, 2020a).

Although the considerable risks may be underestimated, these harmful effects are mostly preventable. The Global Heat Health Information Network has called for urgent action to be taken to mitigate the considerable risks to health. Alongside WHO, they advocate for effective communication to form part of heat health planning and summer heatwave prevention strategies, and in particular to reach out to vulnerable and high-risk populations (Matties et al., 2008). They also specifically call for "a better understanding of heat risks and a push to drive evidence and risk information into policy and action" (Shumake-Guillemot, 2020a).

Mitigating heat stress is all the more urgent in the context of the COVID-19 pandemic, as the same vulnerable populations are doubly at risk, health systems are under greater strain, and public health interventions are harder to implement effectively as a result of the pandemic (Shumake-Guillemot, 2020b).

4.2 Heat health protection in Austria

Like many European countries, Austria has developed national climate change vulnerability, impact and adaptation assessments, including a health assessment of heat risks that was carried out as part of Austria's national adaptation strategy on public health and climate change (WHO, 2018b: p. 27). Established in 2017, the Austrian National Heat Protection Plan coordinates efforts to protect against the negative health effects of heatwaves and to reduce mortality. A heat warning system runs between May and September, looking out for heatwaves and triggering communication if needed.

The Austrian National Heat Protection Plan involves close cooperation between national and regional authorities, together with health professionals, hospitals and emergency staff (WHO, 2018b: p. 42). Two of Austria's provinces, as well as the city of Vienna, have put special measures in place to communicate with citizens about heat health and to provide heat warnings (Climate-ADAPT, 2017). A heat health action plan was first created in the Styrian province of Austria in 2011, drawing on WHO recommendations; Styria was one of the first provinces to create a plan, followed by Carinthia in 2013.[7] These two regions

7 The website of the Styrian Heat Protection Plan can be found at https://www.gesundheit.steiermark.at/cms/beitrag/11685019/72561200.

are now used to inspire developments elsewhere in the country. Styria, situated in the south-east of Austria, has a population of 1.24 million; of these, 270 000 live in the main city, Graz, which suffers from bad ventilation due to its topography, as well as high levels of air pollution (Pollhammer, n.d.). Devising heat health action plans will become all the more crucial as the population ages and there is an increase in the number of vulnerable people, including those over 65, those with restricted mobility, and those endangered by poverty and less able to access health prevention (Pollhammer, n.d.).

4.3 Communication campaign

4.3.1 Objectives and key messages

Communication plays a key role in Austria's Heat Protection Plan. Usually, before each summer, the national working group, overseen by the Ministry for Health and Women's Affairs, meets to put a communication plan in place in the event of a heatwave. Strains on resources caused by the COVID-19 pandemic meant that the group was unable to meet in 2020. As Austria's seven regions have different weather, the provinces are responsible for communicating on heat risk and issuing warnings in the case of a heatwave, and the province of Styria runs its own heat health protection plan. This work is part of broader efforts to make the province healthier and more resilient.

Each year, communication begins in April, before the first heatwave is likely to occur, to introduce the heat warning system in case it is needed. This is crucial as the first heatwave can present the greatest risk, as the population has not yet become acclimatized to rising temperatures and the effects are felt more strongly. It is also important to enable people to sign up to the newsletter, in compliance with data protection regulations.

In 2020 the summer was very warm, but no heatwaves occurred in Austria and it was not necessary to trigger the heat warning system that had been put in place in Stryia; this situation was deemed auspicious given the context of the COVID-19 pandemic and its domination of public communication and the strain already placed on the health system. Depending on conditions during the year, the system may be activated multiple times; in 2015 it was activated 8–10 times. It would usually be triggered by the national weather service announcing a pending heatwave (with temperatures forecast to exceed 35 °C (PET—physiological equivalent temperature)) in order to provide as much notice as possible to those responsible for taking action. A clear, traffic light warning system is used to indicate the level of threat and response needed: none (green), heightened (yellow), strong (amber) or extreme (red).

Communication takes place at two levels. At the national level, the Ministry for Health and Women's Affairs "sets out information about heat warnings on its website and provides and promotes precautionary measures for the citizens" (WHO, 2018b: pp. 42–3). At the regional

level, the provincial authorities are responsible for communication on heat health with key publics under the guidance of the national plan, communicating specific information to institutions that work with vulnerable groups, such as general practitioners, nursing homes, hospitals and kindergartens (WHO, 2018b: p. 43).

An evaluation of the Styrian Heat Protection Plan, including its heat warning system, was carried out in 2017 to assess the impact of the heat health action plan and its related communication strategy. Key stakeholders were surveyed and interviewed, notably those working in childcare, care for the elderly and hospitals.

The COVID-19 pandemic brought up further challenges for communicating on heat health (Box 2).

Box 2. Heat health and COVID-19

Communicating on heat health faced further challenges with the onset of the COVID-19 pandemic and the consequent torrent of information available on health and COVID-19. One interviewee described the overwhelming amount of information available to the public as "white noise" making it difficult to be heard, especially in the public, mainstream media. It is also challenging to stay up to date on conditions on the ground affecting family doctors and other sites where communication on heat health usually occurs. People, especially those most at risk, may be reluctant to visit their family doctor during the pandemic and may miss out on opportunities to see posters and other communications concerning heat health that are displayed and distributed there.

Information distributed on heat health was adapted to take the pandemic into account, drawing on WHO recommendations and experience from the previous year. Some general COVID-19 information, such as social distancing and use of masks, was included in the newsletter on heat health, and there were also some specific considerations such as using ventilation for those working indoors in offices or nurseries and use of air conditioning before people enter a room.

The materials were also adapted to flag up the potential danger of confusing heat stress symptoms, such as headaches, with COVID-19 symptoms, which could make early diagnosis difficult. Also highlighted was the danger that fear of infection would make people at risk less willing to use health services.

The Styrian Heat Protection Plan was also informed by an earlier evaluation of the German Information System on Climate Change and Health, which found that people at risk who were exposed to the information system did not protect themselves any better than those who had no exposure and that the relevant newsletter contained few if any instructions

(Pollhammer, 2016: p. 71). The public were more likely to use information that was clear and easy to translate into actions. It also showed that people responsible for taking care of those at risk (for instance, nursery workers) do not tend to research which actions they need to take; however, when clear, easily actionable information is provided, they will act. Consequently, Styria sought to provide clear and concrete recommendations, through posters available on their website and other methods, with the goal of achieving behaviour change. These steps contributed to the overall goal, which is to inspire active engagement and behaviour change to mitigate the potential heat health risks.

4.3.2 Target publics

The Styrian Heat Protection Plan acknowledges that those most at risk are likely to be those who are hardest to communicate with rapidly and effectively via email, as they may lack internet connectivity or face other socioeconomic or physical and mental health challenges (Pollhammer, 2016: p. 74). In addition, "heat warnings alone are no guarantee of action being taken. The most important trigger for action, in addition to personal experience, is direct discussion with doctors, nurses or other people of trust" (Pollhammer, 2020, translated from the original German). This is all the more crucial given the low perception of risk and the crowded communication environment.

Consequently, the key publics are the intermediaries who work with and care for vulnerable groups and can reach them. These include family doctors and those involved in hospitals, retirement homes, rescue organizations, childcare (crèches, schools, nurseries), mobile care organizations, local authorities and contact points for homeless people.

The Styrian Heat Protection Plan also stresses the need for civic engagement to protect extremely vulnerable people who may be living alone and less apt to provide for their own needs. Relatives, caregivers and neighbours are also encouraged to regularly contact and help care for elderly people, especially those living alone. These trusted people can also impress upon them the need for self-care to prevent the risks associated both with heat and with COVID-19. This kind of dialogue with trusted people was deemed more important than messaging in the mainstream media.

4.3.3 Perception of risk

In Austria, the perception of risk associated with heat was considered to be low, including among key actors such as family doctors and within vulnerable groups themselves. This low level of perceived risk has also been observed across Europe (WHO, 2021b). Awareness of the health risks associated with heat is also low among policy-makers; this may change as heatwaves become more frequent. Heat health is considered and discussed as part of the Austrian and Styrian political dialogues related to climate strategy, including climate protection and adaptation.

According to the 2017 evaluation of the Styrian Heat Protection Plan, compared to the general population, the perception of risk is higher among professionals who work directly with vulnerable groups—in particular, those caring for elderly people—who may have witnessed the risks first-hand (Pollhammer & Gössinger-Wieser, 2019: p. 18). For instance, 86% of interviewees who work in care for the elderly estimated that the risk associated with heatwaves was high or medium. In the survey, those in caring professions also felt a stronger need for measures and planning to mitigate heat health risks (Pollhammer & Gössinger-Wieser, 2019: p. 19).

The greatest concern was expressed for those who do not live in an institution and may live alone and be insufficiently aware of the risks of heat. These groups may only be irregularly in touch with a health professional such as a family doctor, underlining the key role played by doctors as intermediaries bringing key information to those at risk.

4.3.4 Channels

The communication channels selected were validated by the 2017 evaluation. Respondents stated that they were happy with the channels used (email newsletter) and did not request the use of alternative channels such as SMS messaging or a smartphone application.

Email newsletters

A first email newsletter is sent out in advance of the summer season in April to introduce the heat warning system and to explain what defines a heatwave and when further communication can be expected. The person in charge of the local government heat health response also receives the email newsletter.

If the national weather service announces a heatwave, a cascade of communication is triggered that is implemented at the provincial level. The Styrian authorities responsible for this work maintain an email list of the key publics to facilitate communication. In Styria, the mailing list contains some 4000 email addresses and includes nurseries, care homes, family doctors, hospitals and local authorities. The same list is used for the newsletter and, if relevant, messaging from the heat warning system. According to the evaluation, 98% of those surveyed received the emails and the majority were strongly satisfied with the content.

The heat warning newsletter includes a map indicating the level of risk. It contains information about symptoms and simple preventive measures, as well as emergency numbers and quick response (QR) codes linking to the website. The inclusion of QR codes was motivated by the evaluation, which found that only 44% of respondents used the weblinks in the newsletter (Pollhammer, n.d.).

Online resources

At the national level, information is available on the website of the Ministry for Health and Women's Affairs. The regional health authorities also have their own websites. The

email newsletters direct recipients to the Styrian Heat Protection Plan website, where further information is available, including brochures, emergency phone numbers and a map indicating the level of risk; the website and materials were adapted to the COVID-19 context, as mentioned above (Box 2). The evaluation found that a majority of respondents (70%) found the content of the internet portal helpful (Pollhammer, n.d.). Internet users have rated the Styrian Heat Protection Plan website 4.3 out of 5 (based on 66 responses, as of August 2021).

Posters and leaflets

The Styrian website provides PDFs of posters that can be printed out and displayed in relevant sites, such as doctors' examination and waiting rooms. These posters include QR codes that can be used with smart phones to access further information online. Some general materials are available, including a leaflet with behavioural tips and measures and information on the effects of extreme heat on drugs and medicine, and a brochure on symptoms and measures. A few more specific materials are also available on the website, including a brochure on care for the elderly, a leaflet for family members of vulnerable people that includes behavioural tips, and a brochure for workplaces that covers legal regulations and also gives behavioural tips.

National heat hotline

A telephone hotline is provided nationally which is activated during a heatwave; citizens can turn to this service for advice.

National media

Austria has approximately 4–5 key newspapers that receive information from the Austrian Press Association. The Austrian Centre for Disease Control, which manages the Austrian National Heat Protection Plan, can provide health messaging to the Press Association, which is then disseminated in the national press. The national weather service (ZAMG) releases information about risk levels and pending heatwaves, which are likewise relayed by the national mainstream media.

Events

A congress was held for hospital managers, which included a session on climate change and heat and how to prevent issues for patients.

4.4 Results

The evaluation of the Styrian Heat Protection Plan conducted in 2017 suggests that the plan and its related communications are appreciated and having a positive impact; 96% of respondents were rather or very satisfied with the plan and 73% of those working in care homes for the elderly felt that the heat warning service had helped to reduce the

health burden in their institution and negative health outcomes among their clients (Pollhammer, n.d.; Pollhammer & Gössinger-Wieser, 2019: p. 17). A further evaluation is envisaged in the coming years.

4.5 Future actions

The provincial health authorities are currently considering further actions to improve their communications on heat health.

Role of family doctors as vital intermediaries and advocates

There should be increased focus on family doctors as intermediaries providing a vital connection with those at risk who may otherwise be isolated. Potential future actions could include dedicated training for family doctors on the topic of heat health. The importance of communication between doctors and nursing homes was also a finding in the evaluation. Research highlighted the benefits of doctors carrying out risk assessments and health checks on nursing home residents, where resources make this possible.

Seeking further intermediaries to reach isolated, vulnerable groups

Those who provide services such as food delivery to vulnerable populations should be integrated into the heat health action plan and could serve as useful intermediaries to reach groups at risk.

Heat register of vulnerable people

Inspired by work carried out in France and Italy, a register of vulnerable people who should be visited regularly by authorities in the event of a heatwave to provide care and health checks could be created.

Differentiated communications

The provincial authorities have plans to create differentiated versions of the email newsletter tailored to the needs of different publics (nursing homes, doctors, vulnerable groups, etc.). Further actions are being considered to reach out to groups that are currently not directly addressed, such as outdoor workers. Trade unions, which are already part of the heat health working group, or the chamber of commerce could be potential intermediaries to reach this public.

Lobbying and politics

There should be greater awareness among politicians of the need for climate protection to prevent worsening heat health risks and of the social and economic benefits of implementing heat protection plans.

4.6 Lessons learned

- The presence of national and provincial heat health action plans with a strong communication component outlining the key publics, communication channels and emergency health warning procedures can play a key role in the event of a heatwave. The need to communicate proactively is underlined by a finding in the 2017 evaluation of the Styrian plan that 88% of those surveyed rarely or never searched online for heat warnings or information related to heat protection (Pollhammer, n.d.).
- People are willing to act and will do so if provided with easy access to information. The communication on heat health drew on the findings of the 2017 evaluation; by including QR codes on posters, the goal was to encourage the public to follow up and explore further information on heat health.
- Information must be clear and limited to the most relevant content for the different publics.
- Timing of communication is crucial to anticipate the first potential heatwave, which is the riskiest time, and to give the authorities sufficient lead time to follow up on the information provided (WHO, 2018b: p. 113).
- Evaluations can lead to better understanding of the impact of heat health communications and provide more nuanced information about their potential impact to complement quantitative indicators such as the number of clicks on the relevant websites.

5. Conclusions

This report set out to provide a strategic overview of effective risk communication for EH globally, with a focus on Europe. An overview was provided of the latest trends, theories and concepts of risk communication for EH, and key challenges and good practices were identified. This was complemented by three cases studies.

Drawing on the good practices identified, the report provides guidance on adopting effective risk communication for EH in face of the considerable challenges that confront us. These challenges have been further accelerated and brought into focus by the COVID-19 pandemic. Nevertheless, as described in the case studies and other examples cited, risk communication for EH has a key role in encouraging informed decision-making and contributing to positive behaviour change. Increasingly, health professionals and communicators are building up their know-how on "what works" through research and practical experience based on solid theoretical foundations.

Health researchers need to be aware of the implications of risk communication for the dissemination and uptake of health research outcomes. Today, researchers are faced with a challenging scenario in which their scientific findings alone are not sufficient to influence policy-makers and the public. They therefore have to consider the competitive environment in which their findings will be used, anticipate dialogue, and proactively involve stakeholders in their research.

As risk communication becomes increasingly integrated in responses to both acute and chronic health hazards, the availability of data, information and research on communication practices is also likely to increase. It is to be hoped that this rich resource will provide many insights to further improve the effectiveness of risk communication and contribute to improving health and saving lives.

References

Abrams EM, Greenhawt M (2020). Risk communication during COVID-19. J Allergy Clin Immunol Pract. 8(6):1791–4. doi:10.1016/j.jaip.2020.04.012

Ataguba OA, Ataguba JE (2020). Social determinants of health: the role of effective communication in the COVID-19 pandemic in developing countries. Glob Health Action. 13(1):1788263. doi:10.1080/16549716.2020.1788263

Baines D, Elliott RJ (2020). Defining misinformation, disinformation and malinformation: an urgent need for clarity during the COVID-19 infodemic. Discussion Papers 20-06. Birmingham: University of Birmingham (https://ideas.repec.org/p/bir/birmec/20-06.html, accessed 3 August 2021)

Balog-Way D, McComas K, Besley J (2020). The evolving field of risk communication. Risk Anal. 40(S1):2240–62. doi:10.1111/risa.13615

Bauer MW (2018). Trust in science after the BREXIT. In: deMarec J, Schiele B, editors. Culture of science. Montreal: Acfas:95–102

Bauer MW, Pansegrau P, Shukla S, editors (2019). The cultural authority of science: comparing across Europe, Asia, Africa and the Americas. Routledge Studies of Science, Technology and Society, Vol. 40. London: Routledge

Berry D (2007). Health communication: theory and practice. Maidenhead: Open University Press

Blum A, Balan SA, Scheringer M, Trier X, Goldenman G, Cousins IT et al. (2015). The Madrid Statement on poly- and perfluoroalkyl substances (PFASs). Environ Health Perspect. 123(5):A107–11. doi:10.1289/ehp.1509934

Brownlie J (2008). Conceptualizing trust and health. In: Howson A, Green A, Brownlie J, editors. Researching trust and health. New York (NY): Routledge:17–32

Buchanan M (2020). Managing the infodemic. Nat Phys. 16:894. doi:10.1038/s41567-020-01039-5

Cairney P, Wellstead A (2021). COVID-19: effective policymaking depends on trust in experts, politicians, and the public. Pol Des Pract. 4(1):1–14. doi:10.1080/25741292.2020.1837466

Climate-ADAPT (2017). Operation of the Austrian Heat Protection Plan. Case studies. [n.p.]: Climate-ADAPT (https://climate-adapt.eea.europa.eu/metadata/case-studies/operation-of-the-austrian-heat-protection-plan, accessed 12 August 2021)

Coombs WT, Holladay SJ, editors (2011). The handbook of crisis communication. Chichester: John Wiley & Sons

Covello VT, Slovic P, von Winterfeldt D (1986). Risk communication: a review of the literature. Risk Abstr. 3(4):172–82

Dieckmann NF, Johnson BB, Gregory R, Mayorga M, Han PK, Slovic P (2017). Public perceptions of expert disagreement: bias and incompetence or a complex and random world? Public Underst Sci. 26(3):325–38. doi:10.1177/0963662515603271

Dora C, editor (2006). Health, hazards and public debate: lessons for risk communication from the BSE/CJD saga. Copenhagen: WHO Regional Office for Europe (https://www.euro.who.int/en/publications/abstracts/health,-hazards-and-public-debate.-lessons-for-risk-communication-from-the-bsecjd-saga, accessed 3 August 2021)

Dowler E, Green J, Bauer M, Gasperoni G (2006). Assessing public perception: issues and methods. In: Dora C, editor. Health, hazards and public debate: lessons for risk communication from the BSE/CJD saga. Copenhagen: WHO Regional Office for Europe (https://www.euro.who.int/en/publications/abstracts/health,-hazards-and-public-debate.-lessons-for-risk-communication-from-the-bsecjd-saga, accessed 3 August 2021)

Dryhurst S, Schneider CR, Kerr J, Freeman ALJ, Recchia G, van der Bles AM et al. (2020). Risk perceptions of COVID-19 around the world. J Risk Res. 23:994–1006. doi:10.1080/13669877.2020.1758193

ECHA (2020). PFAS—convenience but at what cost? ECHA Newsletter, May 2020. Helsinki: European Chemical Agency (https://newsletter.echa.europa.eu/home/-/newsletter/entry/pfas-convenience-but-at-what-cost-, accessed 3 August 2021)

Edelman (2021). 2021 Edelman Trust Barometer. New York and Chicago: Edelman (https://www.edelman.com/trust/2021-trust-barometer, accessed 3 August 2021)

Eurobarometer (2018). Media use in the European Union. Standard Eurobarometer 88. Autumn 2017. Luxembourg: Publications Office of the European Union (https://op.europa.eu/en/publication-detail/-/publication/a575c1c9-58b6-11e8-ab41-01aa75ed71a1, accessed 3 August 2021)

European Commission (2020a). Chemicals strategy for sustainability: towards a toxic-free environment. COM(2020) 667. Brussels: European Commission (https://ec.europa.eu/environment/pdf/chemicals/2020/10/Strategy.pdf, accessed 3 August 2021)

European Commission (2020b). Poly- and perfluoroalkyl substances (PFAS). Commission Staff Working Document 249. Brussels: European Commission (https://ec.europa.eu/environment/pdf/chemicals/2020/10/SWD_PFAS.pdf, accessed 3 August 2021)

Fancourt D, Steptoe A, Wright L (2020). The Cummings effect: politics, trust, and behaviours during the COVID-19 pandemic. Lancet. 396(10249):464–5. doi:10.1016/S0140-6736(20)31690-1

Fischhoff B (1995). Risk perception and communication unplugged: twenty years of process. Risk Anal. 15(2):137–45. doi:10.1111/j.1539-6924.1995.tb00308.x

Gamhewage G (2014). An introduction to risk communication. Geneva: World Health Organization (https://www.who.int/risk-communication/introduction-to-risk-communication.pdf, accessed 3 August 2021)

Gellman MD, Turner JR, editors (2013). Encyclopedia of behavioral medicine. New York (NY): Springer-Verlag

Glik DC (2007). Risk communication for public health emergencies. Annu Rev Public Health. 28:33–54. doi:10.1146/annurev.publhealth.28.021406

Goldenman G, Fernandes M, Holland M, Tugran T, Nordin A, Schoumacher C et al. (2019). The cost of inaction: a socioeconomic analysis of environmental and health impacts linked to exposure to PFAS. Copenhagen: Nordic Council of Ministers/Publications Unit (http://norden.diva-portal.org/smash/get/diva2:1295959/FULLTEXT01.pdf, accessed 3 August 2021)

Green J, Edgerton J, Naftel D, Shoub K, Cranmer SJ (2020). Elusive consensus: polarization in elite communication on the COVID-19 pandemic. Sci Adv. 6(28):eabc2717. doi:10.1126/sciadv.abc2717

Heath RL, O'Hair HD, editors (2010). Handbook of risk and crisis communication. New York (NY): Routledge

Ho SS, Leong AD, Looi J, Chen L, Pang N, Tandoc Jr E (2019). Science literacy or value predisposition? A meta-analysis of factors predicting public perceptions of benefits, risks, and acceptance of nuclear energy. Environ Commun. 13(4):457–71. doi:10.1080/17524032.2017.1394891

Hosking G (2019). The decline of trust in government. In: Sasaki M, editor. Trust in contemporary society. Leiden/Boston: Brill:77–103

ICE (2018). National Indoor Air Quality Action Plan: Hungary. Version 1. InAirQ project. Vienna: Interreg Central Europe (https://www.interreg-central.eu/Content.Node/InAirQ/National-IAQ-Action-Plan-Hungary.pdf, accessed 12 August 2021)

ICE (n.d.). Output factsheet: pilot actions. Version 1. InAirQ project. Vienna: Interreg Central Europe (https://www.interreg-central.eu/Content.Node/InAirQ/Output-fact-sheet-pilot-1-awareness-raising.pdf, accessed 12 August 2021)

Infield T (2020). Americans who get news mainly on social media are less knowledgeable and less engaged [news article]. Trust Magazine. 16 November 2020. Washington (DC): Pew Charitable Trusts (https://www.pewtrusts.org/en/trust/archive/fall-2020/americans-who-get-news-mainly-on-social-media-are-less-knowledgeable-and-less-engaged, accessed 3 August 2021)

Ingelido AM, Abballe A, Gemma S, Dellatte E, Iacovella N, De Angelis G et al. (2018). Biomonitoring of perfluorinated compounds in adults exposed to contaminated drinking water in the Veneto Region, Italy. Environ Int. 110:149–59. doi:10.1016/j.envint.2017.10.026

IRSA–CNR (2013). Rischio associato alla presenza di sostanze perfluoroalchiliche (PFAS) nelle acque potabili e nei corpi idrici recettori di aree industriali nella Provincia di Vicenza e aree limitrofe [Risk associated with the presence of perfluoroalkylated substances (PFAS) in drinking-water and other recipient water bodies in industrial areas in the province of Vicenza and surrounding areas]. Venice: Institute of Water Research–National Research Centre

Jakab Z (2017). Better health. Better environment. Sustainable choices. Public Health Panorama. 3(2):147–51 (https://apps.who.int/iris/handle/10665/325291, accessed 3 August 2021)

Jensen EA, Kennedy EB, Greenwood E (2021). Pandemic: public feeling more positive about science. Nature. 591(7848):34. doi:10.1038/d41586-021-00542-w

Krause NM, Freiling I, Beets B, Brossard D (2020). Fact-checking as risk communication: the multi-layered risk of misinformation in times of COVID-19. J Risk Res. 23:1052–9. doi:10.1080/13669877.2020.1756385

Leiss W (2004). Effective risk communication practice. Toxicol Lett. 149(1–3):399–404. doi:10.1016/j.toxlet.2003.12.050

Macnamara JR (2016). Organizational listening: the missing essential in public communication. New York (NY): Peter Lang Publishing

Malecki KMC, Keating JA, Safdar N (2021). Crisis communication and public perception of COVID-19 risk in the era of social media. Clin Infect Dis. 72(4):697–702. doi:10.1093/cid/ciaa758

Martuzzi M, Tickner JA, editors (2004). The precautionary principle: protecting public health, the environment and the future of our children. Copenhagen: WHO Regional Office for Europe (https://www.euro.who.int/en/publications/abstracts/precautionary-principle-the-protecting-public-health,-the-environment-and-the-future-of-our-children, accessed 3 August 2021)

Mastrantonio M, Bai E, Uccelli R, Cordiano V, Screpanti A, Crosignani P (2018). Drinking water contamination from perfluoroalkyl substances (PFAS): an ecological mortality study in the Veneto Region, Italy. Eur J Public Health. 28(1):180–5. doi:10.1093/eurpub/ckx066

Matties F, Bickler G, Cardeñosa M, Hales S, editors (2008). Heat-health action plans. Copenhagen: WHO Regional Office for Europe (https://www.euro.who.int/en/publications/abstracts/heathealth-action-plans, accessed 3 August 2021)

NPHC (2018). Virtual Health Repository (VHR): Hungary. InAirQ project. Budapest: National Public Health Center (https://www.nnk.gov.hu/index.php/c-h-r/vhr-hungary, accessed 12 August 2021)

NPHC (2019). International Conference on Problem-Solving Approaches to Ensure Schoolchildren's Health [note to participants]. June 2019. Virtual Health Repository

(VHR). InAirQ project. Budapest: National Public Health Center (https://www.nnk.gov.hu/index.php/international-conference-inairq-vhr, accessed 12 August 2021)

Osuagwu UL, Miner CA, Bhattarai D, Mashige KP, Oloruntoba R, Abu EK et al. (2021). Misinformation about COVID-19 in sub-Saharan Africa: evidence from a cross-sectional survey. Health Secur. 19(1):44–56. doi:10.1089/HS.2020.0202

Pitter G, Da Re F, Canova C, Barbieri G, Zare Jeddi M, Daprà F et al. (2020). Serum levels of perfluoroalkyl substances (PFAS) in adolescents and young adults exposed to contaminated drinking water in the Veneto Region, Italy: a cross-sectional study based on a health surveillance program. Environ Health Perspect. 128(2):27007. doi:10.1289/EHP5337

Pollhammer C (2016). Hitzeschutzplan Steiermark, Landessanitätsdirektion [Heat Protection Plan Styria, State Medical Directorate]. Graz: Gesundheit Steiermark (in German) (https://www.gesundheit.steiermark.at/cms/dokumente/11685019_72561200/a3c97659/HSPl_Stmk.pdf, accessed 3 August 2021)

Pollhammer C (2020). Hitzeschutzplan Steiermark/Österreich—Klimawandelanpassung in der Praxis [Heat Protection Plan Styria/Austria—climate change adaptation in practice]. Pub Health Forum. 28(1):43–5 (in German). doi:10.1515/pubhef-2019-0112

Pollhammer C (n.d.). Hitzeschutzplan Steiermark, Landessanitätsdirektion [Heat Protection Plan Styria, State Medical Directorate]. Graz: Gesundheit Steiermark (in German) [internal document]

Pollhammer C, Gössinger-Wieser A (2019). Steirischer Hitzeschutzplan und Evaluation des Hitzewarnsystems [Styrian Heat Protection Plan and evaluation of the heat warning system]. Graz: Gesundheit Steiermark (in German) (https://www.gesundheit.steiermark.at/cms/dokumente/11685019_72561200/aa438f42/Evaluierung_Hitzewarnsystem_Steiermark.pdf, accessed 3 August 2021)

Region of Veneto (2017a). Domande frequenti sulle sostanze perfluoroalchiliche (PFAS) [Frequently asked questions on perfluoroalkyl substances (PFAS)]. Venice: Regione del Veneto (in Italian) (https://www.regione.veneto.it/web/sanita/informazione-e-comunicazione, accessed 14 August 2021)

Region of Veneto (2017b). Sostanze perfluoro alchiliche (PFAS) [Perfluoroalkyl substances (PFAS)]. Venice: Regione del Veneto (in Italian) (https://www.regione.veneto.it/web/ambiente-e-territorio/pfas, accessed 14 August 2021)

Region of Veneto (2020). Contaminazione da sostanze perfluoro-alchiliche (PFAS) delle falde idriche nei territori delle province di Vicenza, Verona e Padova [Contamination by perfluoro-alkyl substances (PFAS) of water tables in the territories of the provinces of Vicenza, Verona and Padua]. Venice: Regione del Veneto (in Italian) (https://www.regione.veneto.it/web/gestioni-commissariali-e-post-emergenze/stati-di-emergenza-al-31-gennaio-2020, accessed 14 August 2021)

Renn O (2010). Risk communication: insights and requirements for designing successful communication programs on health and environmental hazards. In: Heath RL, O'Hair HD, editors. Handbook of risk and crisis communication. New York (NY): Routledge:80–98

Renn O, Levine D (1991). Credibility and trust in risk communication. In: Kasperson R, Stallen PJ, editors. Communicating risk to the public. Dordrecht: Kluwer Academic Publishers:175–218

Romer D, Jamieson KH (2020). Conspiracy theories as barriers to controlling the spread of COVID-19 in the US. Soc Sci Med. 263:113356. doi:10.1016/j.socscimed.2020.113356

Sandman PM (1989). Hazard versus outrage in the public perception of risk. In: Covello VT, McCallum DB, Pavlova MT, editors. Effective risk communication. Boston (MA): Springer:45–9

Scheufele DA, Krause NM (2019). Science audiences, misinformation, and fake news. Proc Natl Acad Sci USA. 116(16):7662–9. doi:10.1073/pnas.1805871115

Shumake-Guillemot J (2020a). Linking global and local approaches to extreme heat protection. [n.p.]: Global Heat Health Information Network (https://ghhin.org/wp-content/uploads/SHUMAKE-GHHIN-Overview-Global-Perspectives.pdf, accessed 3 August 2021)

Shumake-Guillemot J (2020b). Risk management of extreme heat during the COVID19 pandemic. [n.p.]: Global Heat Health Information Network (https://ghhin.org/wp-content/uploads/WMO_WHO_Joy-Shumake-Guillemot.pdf, accessed 3 August 2021)

Siegrist M, Cvetkovich G (2000). Perception of hazards: the role of social trust and knowledge. Risk Anal. 20(5):713–9. doi:10.1111/0272-4332.205064

Uscinski JE, Enders AM, Klofstad C, Seelig M, Funchion J, Everett C et al. (2020). Why do people believe COVID-19 conspiracy theories? Harv Kennedy Sch Misinfor Rev. 1(3) (https://misinforeview.hks.harvard.edu/article/why-do-people-believe-covid-19-conspiracy-theories, accessed 3 August 2021)

van der Bles AM, van der Linden S, Freeman ALJ, Spiegelhalter DJ (2020). The effects of communicating uncertainty on public trust in facts and numbers. Proc Natl Acad Sci USA. 117(14):7672–83. doi:10.1073/pnas.1913678117

van Zwanenberg P, Millstone E (2006). Risk communication strategies in public policy-making. In: Dora C, editor. Health, hazards and public debate: lessons for risk communication from the BSE/CJD saga. Copenhagen: WHO Regional Office for Europe (https://www.euro.who.int/en/publications/abstracts/health,-hazards-and-public-debate.-lessons-for-risk-communication-from-the-bsecjd-saga, accessed 3 August 2021)

Vosoughi S, Roy D, Aral S (2018). The spread of true and false news online. Science. 359(6380):1146–51. doi:10.1126/science.aap9559

WHO (2013). Health and environment: communicating the risks. Copenhagen: WHO Regional Office for Europe (https://www.euro.who.int/en/publications/abstracts/health-and-environment-communicating-the-risks-2013, accessed 3 August 2021)

WHO (2017a). Communicating risk in public health emergencies: a WHO guideline for emergency risk communication (ERC) policy and practice. Geneva: World Health Organization (https://apps.who.int/iris/handle/10665/259807, accessed 3 August 2021)

WHO (2017b). Keeping our water clean: the case of water contamination in the Veneto Region, Italy. Copenhagen: WHO Regional Office for Europe (https://www.euro.who.int/en/publications/abstracts/keeping-our-water-clean-the-case-of-water-contamination-in-the-veneto-region,-italy-2017, accessed 3 August 2021)

WHO (2017c). Water, sanitation and hygiene. Transforming the regional agenda towards equitable access to safe and sustainable services. Fact sheet 7. Copenhagen: WHO Regional Office for Europe (https://www.euro.who.int/en/media-centre/sections/fact-sheets/2017/fact-sheets-on-environment-and-health-priorities/fact-sheet-7-water,-sanitation-and-hygiene.-transforming-the-regional-agenda-towards-equitable-access-to-safe-and-sustainable-services-2017, accessed 3 August 2021)

WHO (2018a). Heat and health [fact sheet]. 1 June 2018. Geneva: World Health Organization (https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health, accessed 3 August 2021)

WHO (2018b). Public health and climate change adaptation policies in the European Union. Final report. Copenhagen: WHO Regional Office for Europe (https://www.euro.who.int/en/health-topics/environment-and-health/Climate-change/publications/2018/public-health-and-climate-change-adaptation-policies-in-the-european-union-2018, accessed 3 August 2021)

WHO (2018c). Safe drinking-water in Europe? Copenhagen: WHO Regional Office for Europe (https://www.euro.who.int/en/health-topics/environment-and-health/water-and-sanitation/news/news/2018/3/safe-drinking-water-in-europe, accessed 3 August 2021)

WHO (2020a). WHO global strategy on health, environment and climate change: the transformation needed to improve lives and wellbeing sustainably through healthy environments. Geneva: World Health Organization (https://apps.who.int/iris/handle/10665/331959, accessed 3 August 2021)

WHO (2020b). World health statistics 2020: monitoring health for the SDGs, sustainable development goals. Geneva: World Health Organization (https://apps.who.int/iris/handle/10665/332070, accessed 3 August 2021)

WHO (2021a). Chemical pollution of indoor air and its risk for children's health: educational course: supplementary publication to the screening tool for assessment of health risks from combined exposure to multiple chemicals in indoor air in public settings for children. Copenhagen: WHO Regional Office for Europe (https://apps.who.int/iris/handle/10665/341984, accessed 3 August 2021)

WHO (2021b). Heat and health in the WHO European Region: updated evidence for effective prevention. Copenhagen: WHO Regional Office for Europe (https://www.euro.who.int/en/health-topics/environment-and-health/Climate-change/publications/2021/heat-and-health-in-the-who-european-region-updated-evidence-for-effective-prevention-2021, accessed 3 August 2021)

WHO (2021c). Heat threatens health: key figures for Europe. Copenhagen: WHO Regional Office for Europe (https://www.euro.who.int/en/health-topics/environment-and-health/Climate-change/archive/heat-threatens-health-key-figures-for-europe, accessed 13 August 2021)

WHO (2021d). Heat–health action planning. Copenhagen: WHO Regional Office for Europe (https://www.euro.who.int/en/health-topics/environment-and-health/Climate-change/activities/public-health-responses-to-weather-extremes2/heathealth-action-plans, accessed 13 August 2021)

WHO (2021e). WHO public health research agenda for managing infodemics. Geneva: World Health Organization (https://www.who.int/publications/i/item/9789240019508, accessed 3 August 2021)

WHO (n.d.). Risk communication: frequently asked questions. Geneva: World Health Organization (https://www.who.int/risk-communication/faq/en, accessed XX August 2021)

Annex 1.
Analysis of challenges and good practices

Table A1.1. Challenges for risk communication for environment and health, based on analysis of 25 articles, studies and reports

Six key challenges (for detailed analysis, see section 1.2 above)

1. Difficulties in closing the gap between expert and public risk perceptions
2. Dealing with uncertainty and changing scientific evidence
3. Shift in who is considered a trusted source
4. Managing the channels to counter the spread of misinformation
5. Resources, capacity and skills needed for risk communication
6. Reframing information so that it is understood by the public

Article, study or report	Challenge number (see list above)						Score
	1	2	3	4	5	6	
	(✓ = present in article)						
Malecki KMC, Keating JA, Safdar N (2021). Crisis communication and public perception of COVID-19 risk in the era of social media. Clin Infect Dis. 72(4):697–702. doi:10.1093/cid/ciaa758	✓	✓	✓	✓	✓	✓	6
Scheufele DA, Krause NM (2019). Science audiences, misinformation, and fake news. Proc Natl Acad Sci USA. 116(16):7662–9. doi:10.1073/pnas.1805871115	✓	✓	✓	✓		✓	5
WHO (2013). Health and environment: communicating the risks. Copenhagen: WHO Regional Office for Europe (https://www.euro.who.int/en/publications/abstracts/health-and-environment-communicating-the-risks-2013)	✓	✓		✓	✓	✓	5

Article, study or report	Challenge number (see list above)						Score
	1	2	3	4	5	6	
	(✓ = present in article)						
Dora C, editor (2006). Health, hazards and public debate: lessons for risk communication from the BSE/CJD saga. Copenhagen: WHO Regional Office for Europe (https://www.euro.who.int/en/publications/abstracts/health,-hazards-and-public-debate.-lessons-for-risk-communication-from-the-bsecjd-saga)	✓	✓		✓	✓	✓	5
Orso D, Federici N, Copetti R, Vetrugno L, Bove T (2020). Infodemic and the spread of fake news in the COVID-19-era. Eur J Emerg Med. 27(5):327–8. doi:10.1097/MEJ.0000000000000713	✓		✓	✓		✓	4
WHO (2005). Outbreak communication: best practices for communicating with the public during an outbreak. Report of the WHO Expert Consultation on Outbreak Communications held in Singapore, 21–23 September 2004. Geneva: World Health Organization (https://apps.who.int/iris/handle/10665/69138)	✓	✓			✓	✓	4
Zhang L, Li H, Chen K (2020). Effective risk communication for public health emergency: reflection on the COVID-19 (2019-nCoV) outbreak in Wuhan, China. Healthcare (Basel). 8(1):64. doi:10.3390/healthcare8010064	✓	✓			✓	✓	4
Ataguba OA, Ataguba JE (2020). Social determinants of health: the role of effective communication in the COVID-19 pandemic in developing countries. Glob Health Action. 13(1):1788263. doi:10.1080/16549716.2020.1788263	✓		✓	✓			3
Krause NM, Freiling I, Beets B, Brossard D (2020). Fact-checking as risk communication: the multi-layered risk of misinformation in times of COVID-19. J Risk Res. 23:1052–9. doi:10.1080/13669877.2020.1756385	✓	✓	✓				3

Article, study or report	Challenge number (see list above)						Score
	1	2	3	4	5	6	
	(✓ = present in article)						
Mheidly N, Fares J (2020). Leveraging media and health communication strategies to overcome the COVID-19 infodemic. J Public Health Policy. 41(4):410–20. doi:10.1057/s41271-020-00247-w			✓	✓	✓		3
Balog-Way DH, McComas KA (2020). COVID-19: reflections on trust, tradeoffs, and preparedness. J Risk Res. 23(7–8):1–11. doi:10.1080/13669877.2020.1758192		✓			✓		2
Renn O (2010). Risk communication: insights and requirements for designing successful communication programs on health and environmental hazards. In: Heath RL, O'Hair HD, editors. Handbook of risk and crisis communication. New York (NY): Routledge	✓	✓			✓		3
Abrams EM, Greenhawt M (2020). Risk communication during COVID-19. J Allergy Clin Immunol Pract. 8(6):1791–4. doi:10.1016/j.jaip.2020.04.012	✓	✓		✓			3
Leiss W (2004). Effective risk communication practice. Toxicol Lett. 149(1–3):399–404. doi:10.1016/j.toxlet.2003.12.050	✓				✓		2
Abraham T (2009). Risk and outbreak communication: lessons from alternative paradigms. Bull World Health Organ. 87(8):6047. doi:10.2471/blt.08.058149	✓				✓		2
Vosoughi S, Roy D, Aral S (2018). The spread of true and false news online. Science. 359(6380):1146–51. doi:10.1126/science.aap9559				✓			1
Buchanan M (2020). Managing the infodemic. Nat Phys. 16:894. doi:10.1038/s41567-020-01039-5				✓			1
Obregón R, Chitnis K, Morry C, Feek W, Bates J, Galway M et al. (2009). Achieving polio eradication: a review of health communication evidence and lessons learned in India and Pakistan. Bull World Health Organ. 87(8):624–30. doi:10.2471/blt.08.060863			✓	✓			2

Article, study or report	Challenge number (see list above)						Score
	1	2	3	4	5	6	
	(✓ = present in article)						
Cairney P, Wellstead A (2021). COVID-19: effective policymaking depends on trust in experts, politicians, and the public. Pol Des Pract. 4(1):1–14. doi:10.1080/25741292.2020.1837466		✓	✓				2
Dryhurst S, Schneider CR, Kerr J, Freeman ALJ, Recchia G, van der Bles AM et al. (2020). Risk perceptions of COVID-19 around the world. J Risk Res. 23:994–1006. doi:10.1080/13669877.2020.1758193	✓	✓					2
Gamhewage G (2014). An introduction to risk communication. Geneva: World Health Organization (https://www.who.int/risk-communication/introduction-to-risk-communication.pdf)			✓				1
Green J, Edgerton J, Naftel D, Shoub K, Cranmer SJ (2020). Elusive consensus: polarization in elite communication on the COVID-19 pandemic. Sci Adv. 6(28):eabc2717. doi:10.1126/sciadv.abc2717			✓				1
Uscinski JE, Enders AM, Klofstad C, Seelig M, Funchion J, Everett C et al. (2020). Why do people believe COVID-19 conspiracy theories? Harv Kennedy Sch Misinfor Rev. 1(3) (https://misinforeview.hks.harvard.edu/article/why-do-people-believe-covid-19-conspiracy-theories)			✓				1
Glik DC (2007). Risk communication for public health emergencies. Annu Rev Public Health. 28:33–54. doi:10.1146/annurev.publhealth.28.021406	✓						1
Covello VT (2003). Best practices in public health risk and crisis communication. J Health Commun. 8 Suppl 1:5–8; discussion 148–51. doi:10.1080/713851971							0
	15	12	11	11	10	7	

Table A1.2. Good practices for risk communication for environment and health, based on analysis of 25 articles, studies and reports

Ten good practices (for detailed analysis, see section 1.3 above)

1. Messaging that reflects the concerns of the public and recognizes their diversity
2. Selecting and managing the appropriate channels to reach and reassure the public
3. Understanding who has influence on the public and optimizing it
4. Involving the public and stakeholders early and adopting two-way and multidirectional communication
5. Measuring risk communication to understand progress
6. Risk communication requires a multidisciplinary approach
7. Risk communication requires capacity-building
8. Messaging needs emotions and compassion to counter outrage
9. Recognizing that uncertainty is manageable for risk communication
10. Risk communication should be embedded within scientific studies from the outset

Article, study or report	Good practice number (see list above)										Score
	1	2	3	4	5	6	7	8	9	10	
	(✓ = present in article)										
WHO (2013). Health and environment: communicating the risks. Copenhagen: WHO Regional Office for Europe (https://apps.who.int/iris/handle/10665/108629)	✓	✓		✓		✓	✓	✓	✓	✓	8
Malecki KMC, Keating JA, Safdar N (2021). Crisis communication and public perception of COVID-19 risk in the era of social media. Clin Infect Dis. 72(4):697–702. doi:10.1093/cid/ciaa758	✓	✓	✓	✓	✓		✓	✓	✓		8
Dora C, editor (2006). Health, hazards and public debate: lessons for risk communication from the BSE/CJD saga. Copenhagen: WHO Regional Office for Europe (https://apps.who.int/iris/handle/10665/328036)	✓			✓	✓	✓	✓	✓	✓	✓	8

Article, study or report	Good practice number (see list above)										Score
	1	2	3	4	5	6	7	8	9	10	
	(✓ = present in article)										
Renn O (2010). Risk communication: insights and requirements for designing successful communication programs on health and environmental hazards. In: Heath RL, O'Hair HD, editors. Handbook of risk and crisis communication. New York (NY): Routledge:80–98	✓	✓		✓		✓	✓	✓	✓		7
Balog-Way DH, McComas KA (2020). COVID-19: reflections on trust, tradeoffs, and preparedness. J Risk Res. 23(7–8):1–11. doi:10.1080/13669877.2020.1758192	✓		✓	✓	✓		✓			✓	6
Obregón R, Chitnis K, Morry C, Feek W, Bates J, Galway M et al. (2009). Achieving polio eradication: a review of health communication evidence and lessons learned in India and Pakistan. Bull World Health Organ. 87(8):624–30. doi:10.2471/blt.08.060863	✓	✓	✓	✓	✓	✓					6
Leiss W (2004). Effective risk communication practice. Toxicol Lett. 149(1–3):399–404. doi:10.1016/j.toxlet.2003.12.050	✓			✓			✓	✓		✓	5
Glik DC (2007). Risk communication for public health emergencies. Annu Rev Public Health. 28:33–54. doi:10.1146/annurev.publhealth.28.021406	✓	✓	✓		✓			✓			5
Covello VT (2003). Best practices in public health risk and crisis communication. JHealthCommun.8Suppl1:5–8;discussion 148–51. doi:10.1080/713851971		✓	✓	✓	✓				✓		5
Gamhewage G (2014). An introduction to risk communication. Geneva: World Health Organization (https://www.who.int/risk-communication/introduction-to-risk-communication.pdf)	✓	✓			✓	✓					4
Krause NM, Freiling I, Beets B, Brossard D (2020). Fact-checking as risk communication: the multi-layered risk of misinformation in times of COVID-19. J Risk Res. 23:1052–9. doi:10.1080/13669877.2020.1756385	✓		✓					✓	✓		4

Article, study or report	Good practice number (see list above)										Score
	1	2	3	4	5	6	7	8	9	10	
	(✓ = present in article)										
Abraham T (2009). Risk and outbreak communication: lessons from alternative paradigms. Bull World Health Organ. 87(8):6047. doi:10.2471/blt.08.058149	✓	✓	✓			✓					4
Zhang L, Li H, Chen K (2020). Effective risk communication for public health emergency: reflection on the COVID-19 (2019-nCoV) outbreak in Wuhan, China. Healthcare (Basel). 8(1):64. doi:10.3390/healthcare8010064	✓		✓						✓	✓	4
Mheidly N, Fares J (2020). Leveraging media and health communication strategies to overcome the COVID-19 infodemic. J Public Health Policy. 41(4):410–20. doi:10.1057/s41271-020-00247-w			✓	✓	✓		✓				4
Orso D, Federici N, Copetti R, Vetrugno L, Bove T (2020). Infodemic and the spread of fake news in the COVID-19-era. Eur J Emerg Med. 27(5):327–8. doi:10.1097/MEJ.0000000000000713	✓	✓				✓					3
Uscinski JE, Enders AM, Klofstad C, Seelig M, Funchion J, Everett C et al. (2020). Why do people believe COVID-19 conspiracy theories? Harv Kennedy Sch Misinfor Rev. 1(3) (https://misinforeview.hks.harvard.edu/article/why-do-people-believe-covid-19-conspiracy-theories)	✓		✓	✓							3
Abrams EM, Greenhawt M (2020). Risk communication during COVID-19. J Allergy Clin Immunol Pract. 8(6):1791–4. doi:10.1016/j.jaip.2020.04.012	✓	✓		✓							3
Green J, Edgerton J, Naftel D, Shoub K, Cranmer SJ (2020). Elusive consensus: polarization in elite communication on the COVID-19 pandemic. Sci Adv. 6(28):eabc2717. doi:10.1126/sciadv.abc2717	✓		✓								2

Article, study or report	Good practice number (see list above)										Score
	1	2	3	4	5	6	7	8	9	10	
	(✓ = present in article)										
Cairney P, Wellstead A (2021). COVID-19: effective policymaking depends on trust in experts, politicians, and the public. Pol Des Pract. 4(1):1–14. doi:10.1080/25741292.2020.1837466	✓		✓								2
Scheufele DA, Krause NM (2019). Science audiences, misinformation, and fake news. Proc Natl Acad Sci USA. 116(16):7662–9. doi:10.1073/pnas.1805871115	✓					✓					2
Vosoughi S, Roy D, Aral S (2018). The spread of true and false news online. Science. 359(6380):1146–51. doi:10.1126/science.aap9559		✓									1
Buchanan M (2020). Managing the infodemic. Nat Phys. 16:894. doi:10.1038/s41567-020-01039-5		✓									1
Ataguba OA, Ataguba JE (2020). Social determinants of health: the role of effective communication in the COVID-19 pandemic in developing countries. Glob Health Action. 13(1):1788263. doi:10.1080/16549716.2020.1788263	✓										1
Dryhurst S, Schneider CR, Kerr J, Freeman ALJ, Recchia G, van der Bles AM et al. (2020). Risk perceptions of COVID-19 around the world. J Risk Res. 23:994–1006. doi:10.1080/13669877.2020.1758193	✓										1
WHO (2005). Outbreak communication: best practices for communicating with the public during an outbreak. Report of the WHO Expert Consultation on Outbreak Communications held in Singapore, 21–23 September 2004. Geneva: World Health Organization (https://apps.who.int/iris/handle/10665/69138)	✓										1
	21	12	12	11	8	8	7	7	7	5	

The WHO Regional Office for Europe

The World Health Organization (WHO) is a specialized agency of the United Nations created in 1948 with the primary responsibility for international health matters and public health. The WHO Regional Office for Europe is one of six regional offices throughout the world, each with its own programme geared to the particular health conditions of the countries it serves.

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WHO European Centre for Environment and Health

Platz der Vereinten Nationen 1
D-53113 Bonn, Germany
Tel.: +49 228 815 0400
Email: euroeceh@who.int
Website: www.euro.who.int