Review article

Chronic environmental contamination: A narrative review of psychosocial health consequences, risk factors, and pathways to community resilience

Daniel Sullivan [a,*], Harrison J. Schmitt [a], Eric E. Calloway [b], Whitney Clausen [b], Pamela Tucker [c], Jamie Rayman [c], Ben Gerhardstein [c]

[a] Department of Psychology, University of Arizona, Tucson, AZ, USA
[b] Gretchen Swanson Center for Nutrition, Omaha, NE, USA
[c] Agency for Toxic Substances and Disease Registry, Atlanta, GA, USA

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ABSTRACT

A body of psychological and social scientific evidence suggests that the experience of technological disaster or long-term exposure to environmental contamination can be psychologically stressful. Addressing the psychosocial impact in communities living with chronic contamination is therefore a vital part of improving their resilience. Guided by a synthetic theoretical model of the unique psychosocial impact of chronic environmental contamination (in contrast to natural and technological disasters, and background pollution), we undertook a narrative review to assess the current research on this important social problem. Relevant qualitative peer-reviewed studies and grey literature were examined to derive a model identifying likely factors increasing risk for distress in chronic contamination experience and actions that may be taken by public health professionals and local leaders to enhance community resilience and take health-protective actions. Based on our initial theoretical model and the literature reviewed, we emphasize the importance of considering both the material and social dimensions of chronic environmental contamination experience. For instance, our review of the qualitative literature suggests that individuals who attribute material health impacts to contamination, and who have the social experience of their concerns being delegitimized by responsible institutions, are most at risk for psychological stress. Psychological stress in the context of chronic contamination is an important potential public health burden and a key area for additional research.

Chronic environmental contamination (CEC) is the experience of living in an area where hazardous substances are known or perceived to be present in air, water, or soil at elevated levels. This contamination may be chemical or radiological, and the result of prior or current industrial processes or a technological accident (Couch and Coles 2011). Environmental contamination can pose toxicological health risks if someone is exposed. The experience of long-term exposure to environmental contamination can also be psychologically stressful for some members of an affected community (Baum and Fleming 1993; Couch and Coles 2011; Havenaar and van den Brink 1997; Tucker 1998).

Social and environmental stressors are associated with higher allostatic load, a form of physiological wear measured as a composite of physical biomarkers (Mair et al., 2011; McEwen and Tucker 2011). Allostatic overload occurs when chronic stress leads to physiological changes via imbalances in stress mediators such as glucocorticoids, excitatory amino acids, and pro-inflammatory cytokines (McEwen 2008). Through such hypothesized processes, chronic stress can lead to several elevated health risks, including hypertension, coronary heart disease, and autoimmune disorders, which may also make individuals more susceptible to the effects of contaminants (Dhabhar, 2010). Chronic stress from CEC may interact with toxicant exposure to produce worse health outcomes, in part by amplifying the adverse effects of a toxicant (e.g., by compromising the immune system, especially if contaminants independently impair immune functioning; Gee and Payne-Sturges 2004).

Communities can therefore be stressed by prolonged CEC experience, with reductions in community-level resilience that have implications for individual psychological and physical health (Auyero and Swistun 2009; Cassano and Benz 2019). Addressing psychosocial impacts in communities living with CEC is thus vital for improving their health and resilience (Edelstein 2004; Hoover et al., 2015). It is crucial to consider both individual psychological effects as well as psychosocial effects –

community-level factors through which broader structural forces impact local residents (Martikainen et al., 2002).

Current gaps in the literature challenge the goal of addressing psychosocial consequences in CEC-impacted communities. While social scientists have made progress in differentiating technological from natural disasters (Gill and Ritchie 2018; Neria et al., 2008), most studies draw a binary distinction around whether a disaster is "human-made" without examining more fine-grained distinctions. Similarly, most theory and research on psychological (Bonanno et al., 2010) and community resilience (Norris et al., 2008) uses a set of assumptions most appropriate for the disaster relief context of an isolated, high-impact and rapid-onset crisis event. Yet a number of field studies (Auyero and Swistun 2009; Cline et al., 2010; Davidson 2018; Edelstein 2004; Kroll-Smith and Couch 1990) converge on the observation that life under conditions of CEC – such as a Superfund site, a hazardous waste site, or a community with a history of industrial exposures – has unique psychosocial characteristics.

We undertook a narrative review to inform public health practice and future research. We begin by presenting a theoretical model for understanding the unique psychosocial characteristics of CEC in comparison to other types of environmental hazards (e.g., natural disasters and background pollution). This theoretical model was initially developed based on prior reviews and conceptual approaches. After presenting the model, we turn to two central research questions: What are the risk factors (individual, social, and situational differences) that moderate the psychological impact of CEC? What can public health professionals and others do to increase community psychosocial resilience to this hazard? While these questions have been broached before in individual studies or review papers, they have not been addressed using a synthetic theoretical model of the unique psychosocial profile of CEC; nor have they been addressed in the context of a systematic review approach. Thus, to update the literature with regard to these questions, we drew on a simultaneous, separate systematic review project assessing the psychological impact of chronic contamination experience (Schmitt et al., 2021), which identified several relevant qualitative studies and grey literature. In a new narrative review of this material, we specify risk factors for CEC-induced stress as well as strategies for supporting community psychosocial resilience to CEC. In sum, the quantitative and meta-analytic findings from our systematic review are presented in Schmitt et al. (2021), whereas the current paper presents the background theoretical model that guided our review, as well as a narrative synthesis of the peer-reviewed qualitative literature and the grey literature.

1. Background: A theoretical model of the psychosocial profile of CEC

Beginning with research on events such as the Love Canal contamination (Fowlkes and Miller 1987; Gibbs and Levine 1982; Stone and Levine 1985), the Three Mile Island nuclear incident (Bromet 1989), and the *Exxon Valdez* oil spill (Palinkas et al., 1993; Picou et al., 1992), the 1980s and 1990s saw a steady stream of research on the psychological effects of contamination (for review, see Tucker 1998). Early studies used various comparative designs and a range of methods to determine that CEC experience was stressful for extended temporal periods, although not necessarily at levels indicative of clinical impairment (Baum and Fleming 1993; Bowler et al., 1994; Dayal et al., 1994; Havenaar and van den Brink 1997). Theoretical models suggested similarities between symptoms of CEC-induced chronic stress and post-traumatic stress disorder (PTSD), particularly in regard to the chronic ambiguity, invisibility, and subsequent hypervigilance associated with exposure and potential health effects (Edelstein 2004; Vyner 1988). Evidence was gathered for a lack of perceived control (Baum et al., 1983) and attributional processes (i.e., attributing an event to human intention as opposed to natural causes; Blocker and Sherkat 1992) as mediators of the psychological outcomes of technological disaster and CEC.

Natural versus technological disasters. One of the major areas of advance in this research area has been an emerging consensus on the different sociological attributes of natural and technological (or "human-made") disasters, as well as their psychological implications (Erikson 1994). The boundaries between these categories can be difficult to draw; both forms have increased in frequency in the last 50 years (Aldrich et al., 2014; Sandifer and Walker 2018), and there are increasing cases of "natech" disasters (Showalter and Meyers, 1994; Picou 2009) in which a natural catastrophe initiates a technological disaster (e.g., hurricanes or floods spreading contaminants across a wide area). Indeed, some social scientists (e.g., Davis and Seitz 1982) have long presented arguments that human and technological involvement in disaster is so ubiquitous that the concept of "natural" disaster is a misnomer. However, a generally accepted distinction is that "*if the triggering event could have taken place even if no humans were present* … then the disaster is most appropriately seen as [natural] … if the triggering event was one that inherently required human action … then the disaster is most appropriately seen as technological" (Freudenburg 1997, pp. 24–25). The major catastrophes at Bhopal and Chernobyl are prototypic technological disasters, in that they involved breakdowns and exposures from human-created facilities, caused by cumulative direct or indirect acts of human negligence (i.e., combinations of human-"engineered" and human-"operational" factors; Meshkati 1991; Perrow 1999).

The large body of relevant literature demonstrates that natural disasters differ from technological disasters in terms of *physical damages*, *disaster phases*, and *post-disaster community and individual reactions* (Gill and Ritchie 2018). Whereas natural disasters are characterized by highly visible damage (e.g., casualties, sudden destruction of property), the consequences of technological disasters may be less immediately visible (e.g., environmental degradation or "contested illnesses" attributed to contamination; Brown 2007). Whereas community experience of natural disaster consists of demarcated linear phases (preparedness, response, recovery, mitigation), community experience of technological disaster is more likely to occur in repeating cycles (warning, threat, impact, warning; Couch and Coles 2011). Natural disasters often evoke acute negative physical and mental health impacts, with which individuals can cope by drawing on community and institutional supports (government agencies, NGOs, etc.) as well as insurance mechanisms. By contrast, responses to technological disaster can involve protracted periods of litigation, community conflict over how to define and address the situation, the potential for chronic physical and psychological effects, and support stemming from environmental and community advocacy groups rather than larger institutions. Arguably as a result of these distinct characteristics, past meta-analytic reviews have revealed the severity of psychological responses to be often greater in the case of technological as opposed to natural disaster (particularly as indexed by PTSD; Neria et al., 2008), although this difference may be limited to communities in the "developed world" or Global North (Norris et al., 2002; Zaumseil et al., 2014).

Although the work distinguishing technological from natural disasters is important and robust, this binary categorical approach may be too coarse for understanding the unique psychosocial profile of CEC. Researchers have observed that placing all technological disasters into a single category has limited detailed investigation of "*slow-onset disasters of lengthy indeterminate duration*" (Cline et al., 2010, p. 2; cf. Glantz 1999; Robertson 1993). Whereas this is an accurate description of the experience of many communities undergoing CEC (e.g., on or around Superfund sites), the technological disasters that have been most widely studied in recent years tend to be characterized by "signal" triggering events (Picou 2009), and thus have more in common with natural disasters when it comes to speed of onset and duration (e.g., the Fukushima Daiichi Nuclear Power Plant disaster; the Deepwater Horizon oil spill). For some CEC communities, the announcement of contamination may act as a kind of triggering event (Edelstein 2004). However, the

different psychosocial experience of CEC of indeterminate duration as compared to that of more rapid-onset technological disasters likely has consequences for the nature and severity of psychological impact. For instance, a detailed comparison (Gill and Picou 1998) of two rapid-onset technological disasters with a Superfund site community revealed comparatively higher levels of PTSD symptoms in the latter sample.

CEC's unique psychosocial profile. A more fine-grained, dimensional theoretical model can situate the unique psychosocial profile of CEC in comparison to other kinds of environmental hazards. Analytic work in the area of disaster classification has argued for an *ecological-symbolic* approach that attends to "both the nature of the disruption in the human/environmental relations and the appraisals people make of those disruptions" (Kroll-Smith and Couch 1994, p. 28). For present purposes, we will situate CEC along a theoretical continuum that identifies the role of the *material dimension*, the *social dimension*, and their interrelationship in environmental hazards (Freudenburg et al., 1995; Kroll-Smith and Couch 1991; see Fig. 1). The *material dimension* represents a continuum ranging from the concentrated impact characteristic of natural disasters such as hurricanes and tornados (highly visible, rapid-onset "signal" triggering events with immediate life, health, and property impacts) to the extremely diffuse impact characteristic of background (air) pollution extending across regional, national, and global areas, or global climate change (lacking an identifiable triggering event, with "invisible" health and property impacts that occur over an extended duration). Climate change is the prototypic diffuse impact event – though it clearly affects human health (Balbus et al., 2016), there is no single triggering event causing it; climate change is the ultimate "unintended consequence" of billions of individual human acts as well as societal practices (Morton 2013).

This material dimension is correlated – albeit far from perfectly – with an associated *social dimension* representing individual, community, and institutional understanding of and response to environmental hazards. The social dimension ranges from the general consensus response characteristic of natural disasters (where causes and consequences are relatively clear and established institutional disaster relief procedures may be implemented) to responses of extreme social fragmentation (where community members, communities and institutions, or sociopolitical groups may be strongly opposed on how to define and respond to a contested hazard).

Our model suggests that, all else being equal, these dimensions will correlate – e.g., the relatively visible material effects of a natural disaster will be associated with relatively strong social consensus about how to define and respond to the hazard. However, it must be recognized that numerous factors may intervene to situate a hazard at various points along these continua (e.g., media may shape public perception in a way that either fosters consensus or fragmentation; Alexander 2012; Aronoff and Gunter 1992; Mazur 1989; or social and governmental responses to a natural disaster may be contested; Zaumseil et al., 2014). It is important to keep in mind that any kind of environmental hazard may sometimes blur into or co-occur with another, depending on how a given community's experience is uniquely situated along the material and social impact dimensions. For instance, a community frequently exposed to repeat natural disasters, such as wildfires or hurricanes, may experience the more diffuse material impact and social fragmentation typical of CEC-impacted communities (Tierney 2014). Our theoretical model is "ideal-typical" in the sense that it attempts to describe, via comparative analysis, a typical community experience of an isolated type of environmental hazard.

In particular, we propose this model helps situate the relatively unique psychosocial profile of CEC, which falls roughly in-between the material poles of diffuse and concentrated impact, and the social poles of fragmentation and consensus (see Fig. 1). On one hand, CEC shares many qualities with technological disaster, and is sometimes caused by technological or industrial accidents. Yet unlike in the case of "clean" (i. e., non-toxic) technological disasters, many cases of CEC lack a clear triggering event. CEC is often due to breakdowns in complex technological or industrial activities over extended time periods (Glantz 1999; Perrow 1999), and hence attributions of responsibility and impact are often more ambiguous and contested (Mazur 1998). And unlike in the case of background pollution (e.g., variation in airborne benzene across urban areas), CEC is often accompanied by sociopolitical efforts to define the boundaries of contamination, meaning that a delimited subset of the population is characterized as uniquely "contaminated," a process with major implications for community dynamics and resilience (Edelstein 2004; Reich 1991). At the same time, the health impacts of CEC can be uncertain, diffuse, subtle, and long-lasting, ensuring that such hazards have a cyclical, multigenerational timescale quite different from clean technological and natural disasters (Auyero and Swistun 2009; Couch and Coles 2011).

Thus, the type of slow-onset, long-enduring hazard that we designate CEC has several distinguishing properties (Havenaar 2002; Meluch et al., 2016), and aspects of the material (e.g., the nature and extent of exposure; the "risk personality" of the contaminants; Edelstein 2004) and social dimensions (e.g., whether the community adopts a "maximalist" or "minimalist" response to potential risks; Fowlkes and Miller 1987; Gunter et al., 1999) influence whether CEC evokes a social response more similar to background pollution or to disaster events. Uncertainties at both the individual and societal level regarding how to
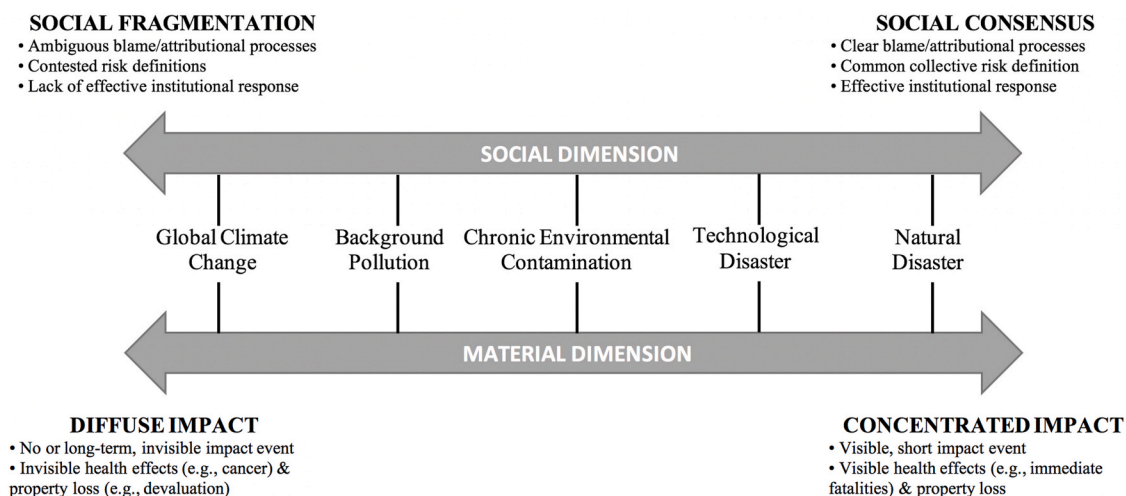

Fig. 1. A typology of environmental hazards on material and social dimensions.

respond to CEC – including the inability to fit these hazards into mental models used to understand other types of environmental hazards – play a prominent role in the psychological stress it evokes (Vyner 1988). Indeed, past case studies (Kroll-Smith and Couch 1990) suggest that CEC is characterized by two major stressors: the initial stress of contamination (the material dimension) and the secondary stress of subsequent social responses (the social dimension; also designated "primary and secondary impacts", Edelstein 2004; Hoover et al., 2015). The latter include: loss of trust vis-à-vis institutions; potential "community corrosion" (the breakdown of social networks from differing interpretations of and responses to CEC; Freudenburg and Jones 1991); and other community-level processes of stigma and fragmentation (e.g., property redlining; media siege; relocation efforts; Edelstein 2004; Green et al., 1994).

Having articulated a theoretical model of the unique psychosocial characteristics of CEC, we are in an enhanced position to investigate our primary research questions: What are the risk factors (individual, social, and situational differences) that moderate the psychological impact of this hazard? What can public health professionals and others do to increase community resilience to this hazard? Drawing in part on qualitative studies and grey literature collected in a separate systematic review project (Schmitt et al., 2021), we update the literature by addressing these questions in the remainder of this paper.

2. A narrative review of qualitative and grey literature on risk and resilience to the psychosocial stress of CEC

Since the first decades of research on psychological effects of CEC, progress has been made in understanding some of the factors that put communities at risk for negative psychological health outcomes. Ample evidence has accumulated for "environmental injustice," a broad concept originally developed by Bullard (1990), referring not only to disproportionate siting of and exposure to environmental hazards but to different experiences of and responses to exposure (Schweitzer and Stephenson 2007; Seamon 2013). Focusing on demographic trends, evidence that CEC exposure is stratified by race/ethnicity and socioeconomic status is provided in U.S. national-level longitudinal studies of siting of hazardous waste facilities (Mohai and Saha 2015), national- and state-level studies of Superfund site locations (Kramar et al., 2018; Maranville et al., 2009; Stretesky and Hogan 1998), and historical case studies of metropolitan areas (Bolin et al., 2013; Pulido 2000). Interactions between exposures to stress and environmental contaminants can lead to worse health risks than either type of exposure on its own (McEwen and Tucker 2011), presenting a "double jeopardy" for disadvantaged communities (Morello-Frosch and Shenassa 2006). Partly in response to this evidence, focus has shifted since the early phase of CEC research toward understanding macro-level psychosocial effects. There is a growing emphasis on understanding community-level resilience (Abramson et al., 2015; Norris et al., 2008), especially with regard to psychosocial consequences (Sandifer and Walker 2018). Concepts such as social capital and collective efficacy can explain the degree of clustering of resources in communities with implications for resilience to CEC (Couch and Coles 2011; Tierney 2014).

To summarize what is known from the existing literature, the experience of CEC can be stressful, with qualities that differentiate it from the experience of natural disaster, and members of disadvantaged social groups are disproportionately vulnerable to the negative psychological and physical health impacts of CEC. Using a systematic review approach, and guided by our theoretical model of the psychosocial impacts of CEC, we sought to update the literature on the topics of (1) the risk factors that predispose individuals to more severe psychological impact, and (2) the resilience factors that can be taken into consideration when intervening in a community to protect against psychosocial impact.

3. Narrative review methods

As a separate part of this project reported in another paper (Schmitt et al., 2021), we conducted a systematic review and exploratory meta-analysis of available quantitative findings on CEC and psychological stress from 1995 to 2019. This systematic review also yielded qualitative published studies and grey literature. Grey literature refers to major potential sources of evidence and information that would not appear in the peer-reviewed empirical literature, most prominently for our topic unpublished doctoral dissertations as well as manuals, toolkits, and presentations provided by agencies and experts in public health, government, and/or environmental science. There were accordingly three primary components to this overarching project: (1) the systematic review process, which yielded relevant quantitative and qualitative peer-reviewed papers as well as grey literature; (2) the meta-analysis of findings from quantitative peer-reviewed papers; and (3) the narrative review of qualitative peer-reviewed papers and grey literature.

A systematic review approach differs from a traditional literature review in that a protocol for literature searching is agreed upon by a team of authors prior to the search being conducted. In addition, several reviewers screen material for inclusion in the body of evidence based on the criteria pre-determined in the protocol. A meta-analysis is a statistical means of synthesizing quantitative findings; in our project, we attempted to determine the average impact of CEC experience on psychological health based on the available quantitative peer-reviewed literature. Both the details of the systematic review and accompanying meta-analysis are presented in a separate paper (Schmitt et al., 2021). Our primary findings from the database of relevant qualitative papers and grey literature that we accumulated through the systematic review are reported in narrative review form in the remainder of the present paper.

In conducting the systematic review, the research team decided to narrowly focus the operationalization of CEC, which resulted in excluding occupational exposures and major catastrophic events. Articles were screened at the title, abstract, and full-text level. Databases searched for peer-reviewed literature included Embase, Medline, PsycINFO, Scopus, TOXNET, and Web of Science. For grey literature, the databases included Deep Blue, WorldCat, WorldWide Science, and PROQUEST, as well as the ATSDR, CDC, and SAMHSA websites. Although the protocol was designed to target empirical quantitative studies, peer-reviewed qualitative studies were retained and used in the present paper to inform our discussion of risk pathways for stress in the CEC context. Table 1 presents an overview of the accumulated qualitative studies (26) and their findings. Table 2 presents an overview of accumulated grey literature, which consisted primarily of unpublished doctoral dissertations, as well as toolkits and manuals from ATSDR and other organizations that routinely intervene to assist communities dealing with CEC or other disasters. We do not claim that the materials accumulated specifically as part of the larger systematic review project are a comprehensive representation of the relevant qualitative or grey literature; nevertheless, in addition to the earlier studies and reviews discussed above, they provide a solid foundation for updating the literature on psychosocial impacts of CEC.

The process of distilling findings and extracting recommendations from this database of qualitative peer-reviewed studies and grey literature was as follows. The qualitative peer-reviewed studies were reviewed by the first author, who identified a risk pathway model from this evidence base (as well as the quantitative peer-reviewed studies reviewed in a separate paper; Schmitt et al., 2021). The first author presented this model to the co-authors and it was collectively discussed and refined. In order to extract recommendations for a framework to bolster community psychosocial resilience, the grey literature was reviewed and catalogued by multiple reviewers involved in the larger systematic review project, including the first three authors. Based on this information, the first author developed a resilience framework, which was presented to the co-authors and collectively refined. Throughout,

Table 1
Select qualitative studies of chronic environmental contamination and psychosocial impact, 1995–2019.

Authors/ Publication Date	Location and Nature of CEC	Summary of Relevant Findings
Adams et al. (2019)	Historic petrochemical exposure from oil refinery activities in Ponca City, OK	Responding to activism, oil company and local government used tactics to silence a community group
Banwell et al. (2019)	Military PFAS exposures in Williamtown, Oakey, & Katherine, Australia	Mental health concerns stemming from exposure-related uncertainty prominent
Barnes et al. (2002)	Industrial hexachlorobutadiene exposure in Weston Village, England	Loss of trust in responsible institutions and community conflict over appropriate response key sources of stress
Carroll et al. (2010)	Flooding and possible water contamination in Carlisle, England	Participants noted disputes with responsible institutions a key source of stress
Checker (2007)	Chemical contamination from wood-preserving factory in Hyde Park neighborhood, Augusta, GA	Mental health impacts, including depression, noted; racial minority participants express distrust of institutions and anger at victim-blaming
Clapp et al. (2016)	Historical asbestos contamination at waste sites in Ambler, PA	Participants concerned about uncertain health effects; acquiescence to expertise associated with mistrust in racial minority participants
Clarke and Gerlak (1998)	Superfund site (historic trichloroethylene) contamination from military and defense activities) in southside Tucson, AZ	Racial minority community expressed frustration over institutional denial and victim-blaming; public officials conflicted over how to define and respond to situation
Cline et al. (2010)	Amphibole asbestos exposures due to historic vermiculite mining in Libby, MT	Community conflict arose over appropriate response to exposures; participants with greater heath impacts perceived less social support
Cline et al. (2015)	Amphibole asbestos exposures due to historic vermiculite mining in Libby, MT	Participants with health impacts expressed stress and need for emotional support
Connon et al. (2018)	13 sites of historic contamination in New South Wales, Australia	Participants concerned about lack of control over contaminant exposure, particularly legacy contaminants perceived to be more "invisible"
Cutchin (2007)	Historic petrochemical contamination and technological disasters in Texas City, TX	Residents who are concerned about contamination feel powerless; exposure is clearly graded along historic demographic (racial) lines
Cuthbertson et al. (2016)	Lead contamination of water in Flint, MI	Rise in community levels of stress, anxiety, and depression partly attributed to distrust of public officials
Davidson (2018)	Agricultural consequences of fracking among rural farmers in southern Alberta, Canada	Community conflict due to varying perceptions of consequences; participants hyper-aroused and preoccupied by possible further drilling
Dory et al. (2017)	Historic pollution, dumping, and suspected water contamination in Ironbound neighborhood, Newark, NJ	Participants concerned about environmental degradation and possible health effects; frustrated at

Table 1 (*continued*)

Authors/ Publication Date	Location and Nature of CEC	Summary of Relevant Findings
		lack of appropriate official response
Gunter et al. (1999)	Superfund sites (polybrominated biphenyl and other chemicals) in St. Louis and Ionia City, lower MI	Participants do not observe major health effects and do not report stress, instead attributing an over-exaggerated, strategic response to officials
Jacobson (2016)	Cancer cluster with no identified environmental cause in The Acreage neighborhood, south FL	"Maximalist" residents sought environmental causes and expressed emotions of fear and anger; "minimalist" residents more reserved
Jacobson and Adams (2017)	Cancer cluster with no identified environmental cause in The Acreage neighborhood, south FL	Participants relied on values (of property vs. health) to engage in motivated reasoning about relative risks
Judge et al. (2016)	PFOA water contamination in Ohio River Valley	Biomonitoring feedback was given to participants, who positively responded and interpreted the information in light of preexisting attitudes
Malin and Petrzelka (2010)	Superfund sites (historic governmental uranium mining) in Monticello, UT	Activist participants distressed by perceived betrayal, powerlessness, and government "cover-ups" of information about exposure effects
Markstrom and Charley (2003)	Historic governmental uranium mining on the Navajo Nation	Impacted workers and their families expressed profound grief over bereavement, feelings of betrayal by government, anxiety and depression
Mix and Shriver (2007)	Superfund site (governmental nuclear facility and mercury releases) at Oak Ridge, TN	Community divided over perceived risk; shorter residence, lower place in facility hierarchy, and minority status associated with greater concern
Muhammad et al. (2018)	Lead contamination of water in Flint, MI	Racial minority high school students expressed belief that contamination occurred due to processes of either indirect or direct racial discrimination
Orom et al. (2012)	Amphibole asbestos exposures due to historic vermiculite mining in Libby, MT	Some participants expressed stressful conflict or hesitance to communicate about diseases within their families
Sarkar et al. (2015)	Water inaccessibility and poor quality in remote Inuit community in southern Labrador, CA	Participants report stress about maintaining water access during storms and the perceived need to rely on high-sugar, affordable alternatives
Shriver et al. (2008)	Superfund site (historic lead mining) at Picher, OK	Participants in the community divided over the extent and cause of health effects from lead exposure; EPA distrusted and their efforts criticized
Shriver and Kennedy (2005)	Superfund site (historic lead mining) at Picher, OK	Community formed two competing groups, one in favor of relocation and critical of EPA (composed of less attached residents), the other opposed to relocation and supportive of EPA (more attached residents)

Table 1 (*continued*)

Authors/ Publication Date	Location and Nature of CEC	Summary of Relevant Findings
Zhuang et al. (2016)	Water contamination (dioxin) due to industrial activity along Tittabawasee River in Michigan	Majority of participants had not changed outdoor activities or sought information about contamination, but also expressed concern and stress

the theoretical model of CEC's psychosocial profile guided the interpretations.

We will first discuss the factors that moderate risk of psychological stress within a CEC-impacted community, drawing primarily on the published qualitative studies presented in Table 1. We will then discuss factors that are likely to support community-level resilience, drawing primarily on the grey literature and past community intervention efforts in the context of CEC presented in Table 2.

4. Narrative review results I: Risk pathways identified in the peer-reviewed qualitative literature

The results of the quantitative component of our systematic review project are reported separately in Schmitt et al. (2021). We found in a meta-analysis of quantitative studies that people experiencing CEC suffered, on average, small-to-medium effects across a variety of psychological stress outcomes. Thus, CEC has the potential to be, and often is, psychologically stressful. However, studies have also consistently found that there are diverging psychological responses to CEC, with some community members evincing a "maximalist" reaction of distress, and others a "minimalist" reaction of little impact (Fowlkes and Miller 1987). There are likely several pathways that moderate the likelihood of psychological stress among community members.

Our review of the peer-reviewed qualitative literature identifies two primary risk pathways, presented in Fig. 2. Along the material dimension, the *presence (versus absence) of health effects and concerns* in the individual, family, or community appears as a strong moderator of psychological stress. Along the social dimension, an additional important moderator is the experience of various processes of *institutional delegitimization*: feeling that responsible or socially protective institutions have denied or misattributed one's concerns about CEC-related health effects.

The material dimension: Health effects and concerns. The assembled qualitative studies indicate that the presence of either concerns about possible health impacts or actual health impacts (attributed to contamination) on the individual or their family members is a robust risk factor for psychological stress in CEC (see especially Banwell et al., 2019; Clapp et al., 2016; Cline et al., 2010; Cline et al., 2015; Connon et al., 2018; Cutchin 2007; Dory et al., 2017; Zhuang et al., 2016; in Table 1). As prior studies have suggested (e.g., Lebovits et al., 1986), our review of the literature reinforces the notion that, within a community experiencing CEC, individuals and families with health problems that they attribute to contamination are the most likely to experience negative psychological outcomes. The presence or absence of health effects seems to influence psychosocial impact even at the community level: Case studies of neighborhoods with Superfund sites suggest less psychosocial impact in the absence of perceived "illness clusters" (Gunter et al., 1999), whereas impact is greater when a cluster is identified even in the absence of a clear environmental cause (Jacobson 2016; Jacobson and Adams 2017).

The social dimension: Institutional delegitimization. In now classic work, Vyner (1988) proposed that the social dimension of response to CEC was the most important factor for determining the risk of severe psychological outcomes. Specifically, he identified three social

Table 2

Select grey literature relating to chronic environmental contamination and psychosocial impact, 1995–2019. Excluding unpublished doctoral dissertations, further information about and access to these materials may be obtained at atsdr.cdc.gov/stress.

Resource Title	Resource Type	Description
Belle-Isle, L. (1996). Health and the environment: Risk perception survey in Cornwall. (University of Ottawa)	Dissertation	Investigates community perceptions of risks to health and quality of life from living near a contaminated river.
Bevc, C. A. (2004). Exposure matters: Examining the physical and psychological health impacts of toxic contamination using GIS and survey data. (University of Central Florida)	Dissertation	Investigates physical and mental health impacts of water contamination in a low-income minority community.
Bodenhamer, A. A. (2017). The Resurgence of Black Lung: A Critical Examination of Environmental Illness in Central Appalachia. (North Carolina State University)	Dissertation	Investigates the "culture of fear" surrounding reporting of job-related environmental health issues.
Brijbag, B. S. (2015). Southern Chivalry: Perception of Health & Environmental Justice in a Small Southern Neighborhood. (University of South Florida)	Dissertation	Investigates differences in perceptions of environmental health risk between community members and experts.
Choudhry, S.A. (2011). Predicting health perceptions with environmental hazards among African Americans on Chicago's south side. (University of Illinois at Chicago)	Dissertation	Investigates the connection between the presence of environmental hazards and health perceptions in a community.
Dorsey, J.W. (1999). Community-based Activism within an Environmental Justice Frame: The Siting of a Waste-to-Energy Facility in Flint-Genesee County. (University of Michigan)	Dissertation	Investigates factors that increase community involvement in environmental justice activism in context of contamination.
Farquhar, S. A. (2000). Effects of the Perceptions and Observations of Environmental Stressors on Health and Wellbeing in Residents of Eastside and Southwest Detroit, Michigan. (University of Michigan)	Dissertation	Investigates the relationships between environmental stressors, perceptions of those stressors, and physical and mental health outcomes.
Fields, K. (2015). Benefits and Burdens: The Advantages and Limitations of Race-Conscious and Race-Neutral Approaches to Environmental Justice. (University of Pennsylvania)	Dissertation	Investigates the consequences of framing environmental justice issues as either race-neutral or race-conscious in terms of outcomes for the impacted community.
Fuller, T. K. (2011). Environmental (In)Activism: Pollution, people, and politics in two Indianapolis neighborhoods. (University of Illinois at Urbana-Champaign)	Dissertation	Investigates the role of social capital in driving the extent and type of activism that a community engages in as a response to contamination.
Gagnon, V. S. (2016). Environmental Justice for Seven Generations: An Institutional Ethnography of Fish, Risk, and Health in the Lake Superior Toxic Riskscape. (Michigan Technological University)	Dissertation	Investigates differences in framing of environmental health issues between tribal and state/federal agencies.
Kennedy, D. K. (2008). Environmental degradation and disrupted social fabric in	Dissertation	Investigates how the objective presence of contamination and related

(continued on next page)

Table 2 (*continued*)

Resource Title	Resource Type	Description
the tar creek basin. (Oklahoma State University)		health issues can produce different responses and beliefs in the community.
Keyt, C. L. (2010). A place called home: Place, culture, and politics in three communities near superfund sites. (Arizona State University)	Dissertation	Investigates place attachment and identity in three communities located near Superfund sites across the US.
Lam, W. C. (1997). Local Victimization by Toxic Waste Exposure: A Contextual Constructionist Analysis. (Mississippi State University)	Dissertation	Investigates the psychological implications of living near a Superfund Site, as well as the conflicts that arise between the community and EPA officials.
Laurian, L. (2001). Cleaning up contaminated sites: Residents' perceptions and responses. (University of North Carolina at Chapel Hill)	Dissertation	Investigates factors that influence community mobilization around environmental contamination issues.
Lehigh, G. R. (2018). Capacity Building, Environmental Justice, and Brownfields Redevelopment: A Case Study of Harvest Hope Park, Tampa Bay, FL. (University of South Florida)	Dissertation	Investigates factors that contribute to a lack of community engagement in environmental health efforts in a community dealing with CEC.
Malin, S. A. (2007). Left in the dust: The victims of mill tailings exposure and uranium in Monticello, Utah. (Utah State University)	Dissertation	Investigates social interactions and well-being in a community impacted by uranium mining and milling.
Norton, B. L. (2006). Does community connectedness matter? Exploring the association between protective social factors and preventive health behaviors in a culturally diverse, environmentally stressed context. (University of Oklahoma)	Dissertation	Investigates the role of community connectedness in driving health behaviors and well-being in a community impacted by lead contamination.
Olsen, D. K. (2006). Contaminated communities: An examination of some psychological and social impacts of water contamination in two small communities. (State University of New York Empire State College)	Dissertation	Investigates loss of trust in two communities impacted by TCE contamination in drinking water.
Papadopoulos-Lane, C. (2010). Cognitive appraisals, stress, and emotion about environmental contamination in the Akwesasne mohawk nation. (State University of New York at Albany)	Dissertation	Investigates stress and post-traumatic stress symptoms in responses to toxic contamination in a Mohawk community.
Rainey, S. A. (2003). Assessing environmental concern, health and justice in Clarksville, Tennessee. (University of Tennessee)	Dissertation	Investigates public concern for contamination and environmental justice among black and white respondents.
Woods, B. R. (2010). Social well-being in the Appalachian coalfields. (Pennsylvania State University)	Dissertation	Investigates physical and social well-being in coalmining communities.
Addressing the Psychosocial Elements of Slow-Motion Technological Disasters (ATSDR)	Manual or guide	Comprehensive manual for those seeking to intervene to address psychosocial issues in a contaminated community.

Table 2 (*continued*)

Resource Title	Resource Type	Description
ATSDR Community Stress Team Logic Model & Instrument Potential Questions (ATSDR)	Manual or guide	Overviews short- and long-term objectives for community needs assessment.
CERC Crisis + Emergency Risk Communication: Community Engagement (CDC)	Manual or guide	Quick guide to planning and executing community engagement for before and during emergencies.
Planning for an Emergency: Strategies for Identifying and Engaging At-Risk Groups: A guidance document for Emergency Managers (CDC)	Manual or guide	Defines at-risk communities and offers ways to find and communicate with these groups using the CDC's Social Vulnerability Index.
Principles of Community Engagement, Second Edition (ATSDR)	Manual or guide	Tools for leading efforts to improve population health through community engagement.
Protocol for Assessing Community Excellence in Environmental Health (PACE EH): A guidebook for local health officials (ATSDR, CDC, NACCHO)	Manual or guide	Details the methodology for assessing a community's concern for, preparedness, and resource access to combat environmental health issues.
Public Health Assessment Guidance Manual (Update): Chapter 4: Involving and Communicating with the Community (ATSDR)	Manual or guide	Provides information on how to communicate and work with an impacted community.
Stronger Together: An In-Depth Look at Selected Community-Level Approaches to Disaster Behavioral Health (SAMHSA)	Manual or guide	Programs and approaches that can be used to help whole communities fare better during and after disasters in terms of behavioral health.
The Emotional Impact of Disaster on Children and Families (American Academy of Pediatrics)	Manual or guide	Discusses both immediate and chronic care needs following a disaster, particularly in resource-poor communities.
Community Stress Training for Environmental Health Professionals: Coping Skills for Health Assessors (ATSDR)	Presentation slides or transcript	Presentation for public health professionals concerning the stress they personally may experience intervening in a community with CEC.
Crisis and Emergency Risk Communication (CERC) Basic Principles (CDC)	Presentation slides or transcript	Covers the basics of CERC, the 6 principles and how to best utilize or implement each.
Disaster Behavioral Health: Tools and Resources (CDC, Washington State Dept. of Health)	Presentation slides or transcript	Online training course that educates public health and other professionals about disaster mental health.
Psychological Effects and Community Stress: Response Strategies to Chronic Exposures and Contamination (ATSDR)	Presentation slides or transcript	Presentation for public health professionals about psychosocial aspects of CEC.
Psychosocial Effects of Hazardous Substances (ATSDR)	Presentation slides or transcript	Presentation intended for public health professionals about psychosocial aspects of CEC.
Stress and Environmental Contamination: Tips and Tools from ATSDR (ATSDR)	Presentation slides or transcript	Overview of the stress response and application within toxicological disasters. Also includes ways for professionals to cope with job-related stress.
Stresses Associated with Dislocation After the Flood (ATSDR)	Presentation slides or transcript	Presentation for public health or medical/mental health professionals about stress resulting from relocation in a contamination event.
Understanding and Responding to Community Stress: A		

Table 2 (*continued*)

Resource Title	Resource Type	Description
Guide for Environmental Health Workers (ATSDR)	Presentation slides or transcript	Presentation for public health professionals about psychosocial aspects of CEC.
ATSDR Communication Toolkit (ATSDR)	Toolkit	Toolkit to aid ATSDR site teams in communication efforts with local communities for public health assessments.
CDC's Social Vulnerability Index (CDC)	Toolkit	Toolkit that provides data on state-, county-, and census-tract-level social vulnerability for the entire US.
Communities Advancing Resilience Toolkit (CART): The CART Integrated System© (Terrorism and Disaster Center)	Toolkit	Descriptions for several assessment tools for community resilience and vulnerability in the face of a disaster.
Community Assessment for Public Health Emergency Response (CASPER) Toolkit, Third Edition 3.1 (CDC)	Toolkit	64-page toolkit for rapid data collection and dissemination of household-level public health needs for actionable decision-making during disaster or non-emergency situations.
Environmental Health Project Medical Toolbox (Southwest Pennsylvania Environmental Health Project)	Toolkit	Contains information, case definitions, surveys, health education materials, and other resources intended to help healthcare providers understand environmental and exposure histories of patients.
Resilience Builder: Tools for Strengthening Disaster Resilience in Your Community (Los Angeles County Department of Public Health, Emergency Preparedness & Response Program)	Toolkit	Designed to help build upon existing community resources and build partnerships to address community strength and capacity.

Fig. 2. Risk pathways for experiencing psychological stress as a consequence of chronic environmental contamination.

risk factors, which we collectively designate here as processes of *institutional delegitimization*: (1) denial (or framing as a "non-issue"; Reich 1991) of the severity and potential impact of CEC by corporations, government, or public health professionals; (2) problematic relationships with healthcare providers who are unfamiliar with CEC and may attribute patient concerns to hypochondria; and (3) indirect or direct victim-blaming processes (e.g., attributing health effects to resident

"lifestyles" as opposed to CEC). Our updated review provides further evidence that each of these social processes may act as secondary impacts of CEC, and may in some instances have a greater influence on psychological stress than the material dimension of health concerns. In the qualitative literature, loss of trust in institutions previously assumed to be responsible for community safeguarding was identified by impacted residents as a major consequence of CEC and source of stress in several studies (Adams et al., 2019; Barnes et al., 2002; Carroll et al., 2010; Cutchin 2007; Cuthbertson et al., 2016; Davidson 2018; Dory et al., 2017; Malin and Petrzelka 2010; Markstrom and Charley 2003; see Table 1).

Disadvantaged group effects. As described, one of the major advances in the literature on psychosocial impacts of CEC has been the documentation of environmental injustice. Qualitative studies of racial/ethnic minority communities impacted by CEC often record perceived experiences of institutional delegitimization that are attributed to indirect or direct racism (Checker 2007; Clapp et al., 2016; Clarke and Gerlak 1998; Cutchin 2007; Markstrom and Charley 2003; Mix and Shriver 2007; Muhammad et al., 2018; see Table 1).

Intra-community conflict. Several of the qualitative studies (Adams et al., 2019; Barnes et al., 2002; Clarke and Gerlak 1998; Cline et al., 2010; Davidson 2018; Jacobson 2016; Mix and Shriver 2007; Orom et al., 2012; Shriver et al., 2008; Shriver and Kennedy 2005; see Table 1) re-affirmed earlier literature emphasizing the role of intra-community conflict over how to define and respond to CEC as a major stressor for residents. Intra-community conflict about CEC may occur as a function of occupation (i.e., families employed versus not employed by a responsible party; Adams et al., 2019; Barnes et al., 2002; Mix and Shriver 2007), race (Clarke and Gerlak 1998; Mix and Shriver 2007), litigation status (Davidson 2018), and feelings of attachment and belongingness to the community (Jacobson 2016; Mix and Shriver 2007; Shriver and Kennedy 2005). These factors can also contribute to intra-family conflict (Cline et al., 2010; Orom et al., 2012). These studies suggest that CEC experience can either create new community divisions, or amplify existing ones, with seriously deleterious potential impact on much-needed social capital.

5. Narrative review results II: Resilience pathways identified in the grey literature

The concepts of community resilience and social capital have been primarily applied and researched in the context of acute community crises (e.g., natural disasters and mass shootings). Communities are differentiated in the degree to which they possess resilience as a function of their level of social capital, primarily consisting of "bonding" forms (local resources such as social cohesion, strong ties between neighbors and community groups, and neighborhood social control) and "bridging" forms (resources and ties connecting community leaders and groups to larger, distal resources such as wealth, media mobilization, and state/federal government assistance; Aldrich 2012; Szreter and Woolcock, 2004). There are special considerations regarding these concepts when applied to CEC. Processes of environmental injustice ensure that communities impacted by CEC are disproportionately likely to be relatively low in bridging social capital; and residential mobility, ranging from complete relocation in extreme cases to steady out-migration by individual families, can erode bonding social capital (Ritchie and Gill 2007). Further, compared to other community stressors, social fragmentation in CEC is more likely to take the form of reduced institutional trust and/or community divisions (e.g., between supporters and opponents of local industry or litigation; Freudenburg 1997).

Recognizing these complexities, we present preliminary recommendations for supporting community psychosocial resilience to CEC. In developing our recommendations, we have primarily extracted initial lessons from the available grey literature (see Table 2); hence they should be interpreted with due scientific caution. These
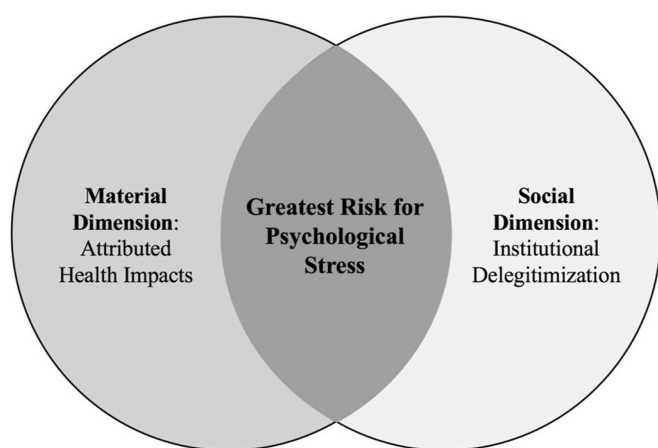
recommendations for supporting community resilience and addressing psychosocial impacts (summarized in Fig. 3) are intended especially for public health professionals or local leaders responding to health concerns in CEC-impacted communities. We propose that the tools and strategies most effective for enhancing psychosocial resilience to CEC are simultaneously facilitative of effective community response to the underlying environmental issue. It is not appropriate for responsible institutions and parties to simply adopt psychosocial interventions in the absence of dedicated environmental remediation and health protection efforts (indeed, such efforts would backfire when experienced as institutional delegitimization). However, the integration of a psychosocial component into a broader community response to CEC – including efforts to improve environmental conditions and reduce exposure-related health risks – will likely prove an efficient and holistic means of catalyzing resilience.

**Maintain perspective and prevent negative secondary impacts.** When intervening to assist communities impacted by CEC, it is imperative to remember that all actions (and inactions) become part of the community's "secondary impact" experience, for better or for worse (Becker 1997). Given that experiences of institutional delegitimization are a primary risk pathway for stress in this context, public health professionals and other representatives of intervening institutions should always bear in mind their power to either legitimate or de-legitimate the community's experience. A key tactic from the disaster mental health relief approach is to validate the stress experience as normative, reducing the likelihood of stigmatization (Ellis et al., 1992; Hernandez and Sedler 2003). Importantly, this process involves not only efforts to educate the public, but also other involved parties (e.g., public health professionals, environmental agency officials, primary care physicians and therapists) concerning the normative and unique nature of stress in the CEC context. All intervening individuals speaking in public settings must be familiar with basic principles of effective risk communication (e.g., the CDC's Crisis and Emergency Risk Communication approach), as well as the importance of cultural sensitivity in this domain (Lindell and Perry 2004; Ramirez-Andreotta et al., 2014). Utmost caution should be practiced to avoid language that might inadvertently convey victim-blaming (e.g., comparing involuntary to voluntary risks; Mullen 1989).

It should be acknowledged that some of the primary barriers to improving psychosocial resilience in the CEC context are the realities of scientific uncertainty and the limited capacities of protective and regulatory institutions in contemporary governments (Freudenburg 1997). It can be very difficult for intervening public health professionals to avoid having negative secondary impact on the contamination-impacted communities they serve, simply by virtue of the fact that they often must convey frustrating and potentially stressful information to the public. Nevertheless, maintaining empathic awareness of these issues can go a long way in minimizing the psychological effects of secondary impacts, and research suggests that residents are often receptive to uncertain information if conveyed in a collaborative spirit of full transparency (Judge et al., 2016).

Prepare for the unique impact and timecourse of CEC. Whereas much of the stress, resilience, and community intervention literatures has developed with a focus on acute community crises, professionals intervening in CEC-impacted communities need to understand – and communicate to the public – that they are dealing with a situation of chronic, potentially intergenerational stress. Chronic stress has unique aspects that should be understood by public health professionals, such as the lack of a clear endpoint to the stressor (e.g., Keller et al., 2007; Schetter and Dolbier 2011). As a result, many forms of intervention are not appropriate for chronic stress due to uncertain stressors. Although therapy may not be necessary or appropriate for the majority of CEC-impacted individuals, certain therapeutic approaches such as Acceptance and Commitment Therapy (ACT) have demonstrated preliminary potential in a case study of a patient impacted by CEC (Jourdain and Dulin 2009). Beyond understanding the unique psychological impacts of this situation, intervening individuals should undertake efforts to build sustainable interventions (Israel et al., 1998), given that communities may continue to experience stress for years as more people learn about local contamination, as new contaminants of concern are identified, or as (attributed) long-term health effects emerge. Doing so requires partnering with communities to build mechanisms and resources for the ongoing provision of services such as mental health support. In general, relationships should be cultivated and maintained with community leaders before and after concrete intervention efforts, to facilitate possible (re-)intervention in the event of later developments in the community. As noted in the qualitative literature we reviewed, it is essential to build such relationships with sensitivity to the ever-present potential for intra-community conflict over CEC.

Finally, intervening individuals should remain sensitive to the possibility of re-traumatization among affected community members, either as they experience (attributed) health effects or as new contaminating incidents occur or contaminants are revealed. At the individual level, lifetime experiences of potentially traumatic or stressful events have a complicated relationship to resilience, but among a subset of individuals repeated hardships may increase symptom severity (Morin et al., 2017; Seery et al., 2010). Possible re-traumatization is an issue that needs to be considered especially carefully in the context of implementing resilience interventions for CEC, because the very act of preparing for potential future exposures in vulnerable communities could be stressful for some
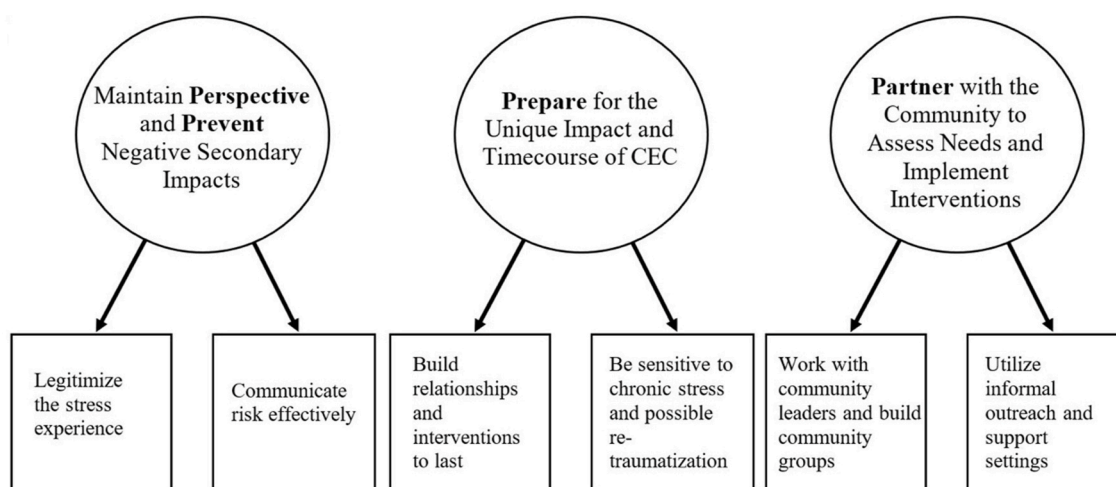
Fig. 3. Strategies for intervening to increase psychosocial resilience in a community impacted by CEC.

community members who have already been impacted in the past.

Partner with the community to assess needs and implement interventions. Interventions to increase community resilience cannot succeed unless intervening individuals understand and engage the community with an awareness of the likely psychosocial impact of CEC. Prior to conducting any intensive work, it is important to assess the community in basic ways (e.g., following ATSDR's Principles of Community Engagement), including learning how people in the community receive health information and identifying important centers of cohesion or support (e.g., leaders, prominent organizations, and resources such as church halls, public centers, and extant mental health or disaster relief services). Case studies suggest that leveraging such resources can be essential in building resilience to CEC, especially when it comes to securing requisite funding (Rogge 1998). Traditional media and social media are typically important sources and factors in shaping a community's awareness of and attitude towards CEC (Aronoff and Gunter 1992; Mazur 1989). Accordingly, community assessments should include identification of what residents consider sources of credible information, including the media (McComas and Trumbo 2001). Generally, a very important initial step should be to ascertain the community's view(s) on the issue of stress; the qualitative literature reviewed here clearly demonstrates the potential for divisiveness and variation within communities where psychological reactions to CEC are concerned, and factors such as culture or litigation status can play a significant role. Some communities – or substantial portions of their members – may be resistant to the very idea of addressing stress in this context, in which case an intervention may do more harm than good (Ellis et al., 1992).

If community members are interested in confronting the issue of psychosocial consequences related to CEC, then they should be empowered as much as possible to collaborate in intervention efforts and inform environmental risk management decisions (Ramirez-Andreotta et al., 2014). Such empowerment efforts are vital for at least two reasons: (1) given the long-lasting nature of most CEC, community leadership groups and local service providers will necessarily be required to sustain resilience-building activities in the wake of initial intervention procedures (Hernandez and Sedler 2003); and (2) environmental and community advocacy in the CEC context can restore a threatened sense of agency in community members and thereby facilitate recovery from negative psychological effects (Brown 2007; Ellis et al., 1992; Stone and Levine 1985). Dissertation comparative case studies have shown that communities with stronger social ties and attachment to place are more resilient in the face of CEC (Fuller, 2011), and that in some cases it may be advantageous to directly address issues of environmental racism in attempts to mobilize community involvement (Fields, 2015). Another key way to involve community leadership groups is by working with them to establish informal outreach and support settings and resources, which case studies show can be far more effective than formalized public meetings overseen by agency representatives. For instance, health fairs or "teach-ins" in prominent public locations can further health educational goals; and support groups have addressed mental health needs in the CEC context (Ellis et al., 1992; Hernandez and Sedler 2003).

The resilience framework in practice: Intervention efforts in Libby, MT. Our framework of recommendations for improving community psychosocial resilience to CEC has not yet been empirically tested in its entirety. However, one prior case study which contributed substantially to the development of our framework can be considered an example of its potential. Specifically, the principles we have identified in the present paper were implemented earlier as part of an intervention in Libby, MT carried out by ATSDR's Community Stress Team (which operated from 1996 until the early 2000s) in collaboration with partnering institutions such as EPA, Public Health Service, SAMHSA and the American Lung Association.

For decades, a vermiculite mine and processing plants operated in the rural town of Libby, MT, exposing miners and plant workers, as well as residents and families, to amphibole asbestos (Cline et al., 2014). An

ATSDR assessment determined asbestosis and lung cancer mortality rates in Libby to be statistically significantly higher than expected and in 2002 EPA declared it a Superfund site (Kuntz et al., 2018). As part of the federal government's public health response, the ATSDR Community Stress Team and EPA's Community Involvement Coordinators intervened in the Libby community with the express aim of addressing psychosocial needs.

This intervention implemented the recommendation of *Maintaining perspective and preventing negative secondary impacts* by first discussing the possibility of addressing psychosocial stressors with EPA's Libby Community Advisory Group as well as conducting an EPA community needs assessment that included psychosocial issues, and then taking several steps to legitimize the community's stress. These steps included informal outreach efforts through local radio messages as well as hosting a community health far to address all physical and psychosocial effects of the asbestos exposure. In addition, the ATSDR Community Stress Team recommended that psychosocial services be made available to impacted community members, particularly those suffering from asbestos-related disease. Subsequent research in fact documented that, out of a sample of individuals seeking screening and treatment at the local clinic for asbestos-related disease, one-third exhibited significant psychological stress (Weinert et al., 2011). Social workers were hired to address this need, and it was integrated into a more comprehensive program of disaster response and healthcare provision. As noted by two of the professionals involved (Hernandez and Sedler 2003), the fact that psychosocial care was provided in a routine way alongside standard healthcare legitimized the stress experience and increased utilization of these services.

The recommendation of *Partnering with the community* was implemented through the creation of medical support groups to offer informational and social support to community members with asbestos-related diagnoses. Finally, the recommendation of *Preparing for the unique impact and timecourse* was implemented by supporting the efforts of the local social workers as well as University of Montana researchers, who were able to continue to provide psychosocial and other forms of support to the community after the ATSDR Community Stress Team concluded its formal operations. In addition, SAMHSA gave these local professionals a grant to develop a training manual for addressing the psychosocial effects of CEC (Hernandez and Sedler 2003). The stated desire of the community advisory group to have Libby house a center for research on asbestos-related diseases also resulted in an extended program of community-based participatory research that yielded considerable valuable information (Kuntz et al., 2018).

The work of ATSDR and partnering institutions in Libby offers many valuable lessons relevant to our model, despite an absence of specific evaluation of the stress mitigation efforts by the ATSDR Community Stress Team. For instance, an analysis of EPA community advisory group meetings in Libby between the years 2001–2008 indicated that community members reacted positively to ATSDR involvement in their community as well as the use of face-to-face meetings and radio to communicate health and exposure information (Blata-Pennock 2010). However, research also indicated considerable community division over priorities in the contamination response (Cline et al. 2010, 2014). Perhaps reflecting this division, ATSDR Community Stress Team participants recall that not all community members were willing to treat psychosocial consequences as a key issue, and that recognition of the importance of addressing stress developed only slowly in some community members.

This prior case study was not conducted as a specific test of the present resilience framework; rather, we drew on the case study (particularly the comprehensive intervention manual developed by Hernandez and Sedler, 2003) as one source for developing the framework. The case study can be considered a preliminary demonstration that some communities are amenable to the approach recommended in the framework, and that enacting these principles can lead to at least some important deliverables (such as integrating psychosocial needs

into the delivery of healthcare and the development of long-lasting community-centered research programs).

6. Limitations

It should be born in mind that the qualitative studies we drew on for identifying risk pathways were collected as a supplementary aspect of a parallel quantitative systematic review (Schmitt et al., 2021). Accordingly, we may not have attained as comprehensive a view of the available literature as would be the case if we had conducted a systematic review specifically targeting qualitative studies. We recommend a systematic review of the qualitative literature on stress in CEC as a project for future research. Even from our somewhat limited review, it is clear that further qualitative research in this area would also be beneficial, especially comparative studies with data on CEC experience from multiple communities, or neighborhoods within a community.

It should also be reiterated that our framework for intervening in a community while fostering psychosocial resilience is based primarily on grey literature reports, such as unpublished dissertations and toolkits or presentations made by government agencies and personnel. In general, a plethora of tools and frameworks for assessing community resilience have developed in recent years, but it is difficult to evaluate across them and there is a relative dearth of evidence on the effectiveness of interventions (Cutter 2016; Villalonga-Olives et al., 2018). In particular, frameworks and tools for assessing community resilience are often especially lacking when it comes to a focus on environmental issues such as coping with contamination (Sharifi 2016). Given the general state of this literature, it is perhaps not surprising that the models and frameworks for intervening specifically to increase psychosocial resilience in the context of CEC have for the most part not been rigorously graded according to a high standard of evidence. At the same time, however, some of the toolkits that we drew on in constructing the present framework (e.g., the CART or CDC's CASPER) have been rigorously tested or applied in multiple community events. Our framework also draws heavily on the past work of ATSDR's Community Stress Team, which drew on contemporary standards for evidence-based practice in natural disaster mental health relief established by SAMHSA. Ideally, utilization of the present framework in specific CEC events should be subjected to empirical evaluation in the future.

7. Conclusions

Evidence suggests that experiencing CEC is psychologically stressful. Our theoretical model suggests that this elevated stress is due in large part to the unique position CEC occupies along the material and social dimensions of environmental hazard, which undermines efforts on the part of impacted community members and responsible institutions to fit this particular hazard to their extant mental models.

Our review of accumulated qualitative published studies suggests that individuals who attribute physical health effects to exposure and also feel that their concerns are being de-legitimized by culpable or responsible institutions are most at risk for psychological stress as a consequence of CEC. By identifying the important risk factors for stress in CEC of material health impacts and the social experience of institutional delegitimization, our review builds upon and largely corroborates earlier research on the topic. This fact, combined with the observation that these findings match those of our separate quantitative review and meta-analysis (Schmitt et al., 2021), attests to the likely robustness of these conclusions.

Beyond understanding the factors that put certain individuals within a community at elevated risk for psychological impact, it is also essential to examine the community-level characteristics that might enhance psychosocial resilience to CEC. Based primarily on a review of the available grey literature, we derived three principles of a framework that public health professionals or local leaders might employ when working with communities to maintain psychosocial resilience to CEC.

First, it is important to understand that all public efforts become part of the community's "secondary impact" experience, and to prevent negative secondary impacts. This can be addressed by taking care to legitimize and recognize the community's potential stress, and make effective risk communications. Second, it is important to prepare for the unique ways in which CEC can impact a community. This can be addressed by planning for the timecourse of CEC by staying in contact with the community and learning about the unique nature of CEC-related psychosocial stress. Third, it is important to partner with the community to assess needs and develop, implement, and maintain long-term interventions and resilience mechanisms. This can be done by enabling community ownership of collaborative solutions, leveraging existing strengths while listening to and investing in the community's needs.

Among many implications, our updated risk pathways model has implications for research and advocacy on environmental racism and justice. There are well-documented health disparities as a consequence of both race/ethnicity and lower socioeconomic status, and recent evidence that the effect of socioeconomic status on mental health is environmental in origin (Garrison and Rodgers 2019; Nuru-Jeter et al., 2018). Given these findings, our risk pathways model (Fig. 2) suggests the risk of psychological stress is elevated for disadvantaged group members (racial/ethnic minorities and lower socioeconomic status) in part due to: (1) increased likelihood of experiencing CEC; (2) increased likelihood of adverse health effects that may be attributed to CEC; and (3) increased likelihood of experiencing (perceived) institutional delegitimization.

It has long been recognized that communities that are either currently or likely to be impacted by CEC (e.g., due to high levels of industrial activity or background pollution) often need an integrated emergency management system, but face significant barriers to the implementation of such systems by local agencies and leaders (Faupel and Bailey 1989). In a catch-22, communities affected by CEC, and the public health agencies responsible for their protection, often may not develop contingency plans prior to an acute event. This lack of preparedness stems in part from the technical and scientific complexity involved (Zavestoski et al., 2002), but also because community members may be unlikely to weigh exposure risks as very significant until they have been personally impacted (Gunter et al., 1999; Greenberg and Schneider 1996). Despite governmental provisions such as the Emergency Planning and Community Right-to-Know Act (EPCRA) and the existence of Local Emergency Planning Committees, the complexity of the industrial and technological systems that produce CEC, as well as the sheer number of potential contaminants, means that many communities remain underprepared for a variety of hazardous events (Macey 2016). Coupled with the fact that CEC-impacted communities are often relatively resource-poor, prioritization of interventions to increase resilience to CEC may be difficult to justify until serious consequences have already occurred. Such barriers notwithstanding, development of community resilience-enhancing pathways will be especially prudent given rising concern over recently identified contaminants (e.g., PFAS; Guelfo et al., 2018).

As our resilience framework details, intervening public health professionals and local leaders can adopt a number of strategies to build bridging and bonding social capital, and hence community resilience, in CEC-affected communities. In this regard, the goals of the resilience framework must again be emphasized. We are proposing, based on the available grey literature, toolkits, and prior case studies, a set of principles for intervening in CEC-impacted communities in a way that is sensitive to the added public health burden of negative psychosocial impact. The framework is not designed to guide an intervention that seeks to exclusively address psychological stress in the absence of a dedicated effort to address the contamination itself and associated physical health outcomes. Instead, it is a set of recommended practices for carrying out these important goals while recognizing psychological stress as an important potential aspect of the community's experience and endeavoring to minimize it.

Especially important is the need to validate and normalize the experience of psychological stress in this context, and to re-build potentially damaged trust in institutions. This means that it is important for professionals interfacing with the community to keep two facts consistently in mind. The first is that community members' experience of the social dimension of CEC has tangible psychological effects (and therefore potential consequences for physical health). Appropriate respect must be paid to people's experiences. In some situations, a public health professional or exposure scientist may have a responsibility to communicate to the public information suggesting that there is little or no evidence for a link between a certain illness and contaminant of concern. It must be recognized that this information can be experienced as institutional delegitimization by some community members, particularly if it is presented in a way that is not sensitive to the legitimacy of the concerns the public has and the stress they may be feeling, or to the reality of differences in representation and resource access between social groups. The second critical and related fact is that community members seem to value transparent and consistent communication in the maintenance of trust (e.g., Judge et al., 2016). Even in situations where an intervening professional needs to present information that is uncertain, or might violate the expectations of the community, it is ultimately most effective to communicate in an honest and direct way if seeking to avoid institutional delegitimization. Ultimately a combination of transparency and empathy – an approach that validates community concerns and responds to them in a straightforward manner – is the best approach to minimizing negative secondary impacts. By acting in ways that re-build community trust, intervening representatives of responsible institutions can work toward developing psychosocial resilience through bridging social capital.

Disclaimer

Declaration of competing interest

None to declare.

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