The relations between mental health and psychological wellbeing and living with environmental contamination: A systematic review and conceptual framework

Rupert Legg[1]*, *Jason Prior*[1], *Jon Adams*[2] *and Erica McIntyre*[1]

[1] *Institute for Sustainable Futures, University of Technology Sydney, NSW, Australia*

[2] *Faculty of Health, University of Technology Sydney, NSW, Australia*

*Rupert.legg@uts.edu.au
Level 10, UTS Building 10
235 Jones Street
Ultimo NSW 2007, Australia

Other emails: Jason.Prior@uts.edu.au; Erica.McIntyre@uts.edu.au; Jon.Adams@uts.edu.au

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Abstract

This review explores how the experience of living with environmental contamination is related to residents' mental health and psychological wellbeing. MEDLINE, PsycINFO, Scopus and Web of Science were searched for peer-reviewed literature reporting relevant original empirical data published before 1 April 2021. The search identified 40 papers for full review. Of these, 25 articles examined how living with environmental contamination influenced pre-clinical mental health symptoms, including depression, anxiety and schizophrenia, 17 reported on emotions, such as worry and concern, and seven reported on associations with clinical mental health disorders, such as major depressive disorder. Most articles (n = 38) identified some statistically significant or anecdotal evidence of an association between mental health and the experience of living with environmental contamination. Through the critical interpretive synthesis of our review, the factors associated with mental health and wellbeing outcomes in the included papers were thematically organised into five categories: intrinsic, extrinsic (sociodemographic and personal), social, environmental, and regulatory. The conceptual framework contributes to our understanding of how environmental contamination impacts mental health and wellbeing, which may assist in preventing poor mental health outcomes in contaminated neighbourhoods.

Keywords: environmental contamination; mental health; psychological wellbeing; emotions; environmental psychology; socioecological framework.

1. Introduction

Globally, decades of unabated industrial activity have resulted in widespread environmental contamination with various chemicals (Panagos, Van Liedekerke, Yigini, & Montanarella, 2013). An awareness of the extent and number of such contaminated sites has grown in recent years while the land is steadily becoming more contaminated, as economies and populations grow, and the presence of industry expands faster than regulation can keep up (Dowling et al., 2016). Estimates suggest at least 61 million people worldwide are now exposed to environmental contamination (Landrigan et al., 2018). These estimates do not account for a range of contaminants still currently emerging as hazardous (Barroso, Santos, Martín, Aparicio, & Alonso, 2019). The full extent of environmental contamination has yet to be fully understood (Landrigan et al., 2018).

A number of systematic reviews and meta-analyses have examined the direct impact of contaminants, such as mercury, lead and asbestos, on physical health and disease (Bourdès, Boffetta, & Pisani, 2000; Chowdhury et al., 2018; Xu, Barg, Emmett, Wiebe, & Hwang, 2018), establishing a connection between the extent to which an individual is physically exposed to a contaminant and a specific illness—critical for determining the toxicity of the contaminant. Such reviews have also included examinations of the neurobiological changes caused by exposure to contaminants, which have been observed to directly affect mental health, such as the relation between heavy metal exposure and schizophrenia (Attademo, Bernardini, Garinella and Compton, 2017). However, it is also becoming apparent that health effects from contamination can occur in the absence of physical exposure—subjective, indirect effects resulting from living with environmental contamination can detrimentally affect mental health and psychological wellbeing (Schmitt et al., 2021; Sullivan et al., 2021). In some cases, these effects may even have a larger burden on health and wellbeing than those resulting from actual exposure (Couch and Coles, 2011; Matthies et al., 2000). As such,

it is unsurprising that investigations of mental health and wellbeing have recently started to increase in prevalence.

Notably, there have been several systematic reviews conducted recently examining the connection between the experience of living with environmental contamination and mental health. Early reviews examining this connection were limited in scope or used non-systematic and non-rigorous methodology (Couch and Coles, 2011; Palinkas, 2012). For instance, Brinkel, Khan and Kraemer (2009) focused their review solely on the mental health effects of arsenic contamination in Bangladesh. In contrast, a recent meta-analysis was broader in scope in assessing the effect of contamination on anxiety, depression, trauma and stress (Schmitt et al., 2021). In examining literature from 1995 to 2019, Schmitt et al. (2021) determined that living with environmental contamination has a small to moderate effect on these psychological symptoms. Extending this, along with an accompanying narrative review published elsewhere (Sullivan et al., 2021), the researchers also developed a conceptual model of the risk factors most significantly associated with these adverse mental health effects. The model had two dimensions: material (consisting of actual health impacts and concern of possible health effects) and social (referring to the possibility of institutional delegitimisation). While this model is a helpful start for determining how mental health is connected to the experience of living with environmental contamination, there is a need to expand and update this considering there are several important factors excluded from their two-dimensional model and more papers have been published reporting on the topic in the past two years.

There are several risk factors beyond the material and social dimensions identified by Sullivan et al. (2021) that impact the mental health and wellbeing of residents living with environmental contamination. Previous literature suggests that adverse mental health effects are more likely to occur among those who perceive that they have been exposed to the

contaminant or that the contaminant poses a high risk to their physical health (Couch & Coles, 2011; Cuthbertson, Newkirk, Ilardo, Loveridge, & Skidmore, 2016; Edelstein, 2002; 2018; Matthies, Höger, & Guski, 2000). However, the literature also indicates that other intrinsic differences, such as residents' knowledge of the contaminant, their sense of uncertainty surrounding the future, and their sense of place, also influence their mental health and wellbeing (Albrecht et al., 2007; Askland & Bunn, 2018; McIntyre, Prior, Connon, Adams, & Madden, 2018; Prior et al., 2019).

A range of sociodemographic factors, such as age, gender, and socioeconomic status, have been associated with the likelihood of residents experiencing specific psychological symptoms (Kruger et al., 2017; McIntyre et al., 2018; Prior et al., 2019). Further, the contamination may also be accompanied by extrinsic personal impacts that differ between people, affecting their mental health in varying ways. For instance, property blight, financial impacts, and forced relocation have been observed to exacerbate worry and distress (Niitsu et al., 2014; Prior et al., 2019).

Social and environmental characteristics have also been observed to play a role in shaping the mental health of those living with environmental contamination. For instance, community cohesion or disputes have been found to predict residents' level of concern about the contamination (Messer, Adams, & Shriver, 2019). Environmental factors such as the type of contaminant or extent of damage to nature have also been found to correlate with adverse psychological effects (McIntyre et al., 2018; O'Leary and Covell, 2002; Prior et al., 2019). Finally, regulatory factors, such as the institutional delegitimisation identified by Schmitt et al. (2021), the presence of litigation and access to mental health services have been found to predict mental health outcomes (Calloway et al., 2020; Dunn, Taylor, Elliott, & Walter, 1994; Picou, Marshall, & Gill, 2004).

We propose these five categories of factors affect mental health and wellbeing through the associated stress that may arise from living with contamination: intrinsic, personal (sociodemographic and extrinsic), social, environmental, and regulatory. That is, becoming aware of being potentially exposed to a harmful chemical and continued exposure are stressful experiences that can disrupt an individual's everyday life (Couch & Coles, 2011; Cuthbertson et al., 2016; Edelstein, 2002; 2018; Matthies et al., 2000). The stress resulting from this disruption could lead to chronic mental health concerns through the proliferation of dysfunctional cognitions (Brosschot, Gerin, & Thayer, 2006; Hirsch & Mathews, 2012; Kemeny, 2003; Martin & Dahlen, 2005). For example, worry, a form of negative thinking about future internal and external threats, has been associated with depression and anxiety (Newman, Llera, Erickson, Przeworski, & Castonguay, 2013). Likewise, rumination has been linked to depression and stress (Hirsch & Mathews, 2012; Vanderhasselt & De Raedt, 2012) and catastrophising to anger (Martin & Dahlen, 2005). These symptoms can then manifest pathologically as specific mental disorders, such as generalised anxiety disorder (GAD) or major depressive disorder (MDD) (Hirsch & Mathews, 2012), or physiologically, with chronic stress being associated with increased inflammation and immune responses that increase the risk of certain illnesses, such as heart disease (Brosschot et al., 2006).

This paper expands the conceptual framework proposed by Schmitt et al. (2021) and Sullivan et al. (2021) by constructing a cohesive and extensive framework that connects the various ways living with environmental contamination affects mental health and wellbeing. Our proposed conceptual framework is informed by findings from a systematic review of the indirect effects on mental health from living near contamination. Specifically, the paper addresses the following questions:

- What is the relation between mental health and psychological wellbeing and living with environmental contamination?

- What psychological and socioecological factors influence the mental health and psychological wellbeing of residents living with environmental contamination?
- How is mental health and psychological wellbeing measured in the context of this literature/sub-topic?

2. Method

The systematic review methodology reported in this paper has been registered with PROSPERO [CRD42020168128] and follows PRISMA guidelines (Moher, Liberati, Tetzlaff, Altman & PRISMA, 2009).

2.1 Eligibility criteria

Peer-reviewed papers that reported relevant original empirical data relating predominantly to the mental health of residents living with contamination caused by industrial uses, and written in English, were eligible for the review. We define mental health as diagnosed mental disorders and subclinical symptoms of mental illness, such as dysfunctional cognitions and anticipatory and reactive affective responses (emotions) including worry, rumination, shame, and fear. While this definition focuses on negative components of mental health, the environmental contamination literature is largely framed this way (McIntyre et al., 2018; Prior et al., 2019); consequently, we will remain consistent with this framing. Beyond this, we align our definition of psychological wellbeing with earlier research, encompassing notions of human flourishing and unimpeded psychological functioning (Prior et al., 2019). Examples of the contaminant types include, but are not limited to, heavy metals (such as lead, mercury, arsenic), hazardous waste (such as asbestos and plastics), chemicals (such as fuels and polychlorinated biphenyl [PCB]) and nuclear radiation (such as at Chernobyl). Types of contamination where a risk of exposure to the studied population may not be present (such as

oil spills), were not included, as many of the characteristics of the contamination event that may shape mental health are not present in such cases (Shultz et al., 2015).

Literature reporting research focused on physical, community or somatic health, non-human animal health and contamination caused by non-industrial uses was also excluded. This includes papers solely reporting on the mental health effects experienced by those suffering from physical illness as a result of exposure to contaminants, such as arsenicosis or asbestosis. The reason behind excluding studies that focused predominantly on the mental health repercussions of physical health effects was to allow greater appraisal of the subjective, psychological impacts of living with contamination, disconnected from the mental health effects associated with the experience of living with physical illness. As Braithwaite et al. (2019) note, "physical comorbidities may both confound and/or mediate the associations [between pollution and mental health] observed, for example, through inflammation . . . or psychological effects of physical symptoms" (p. 20). We propose that, to accurately appreciate the extent to which the subjective experience of living with contamination is impacting mental health and wellbeing, it is necessary to distinguish between the different subjective psychological and objective physical causes, the best way to do which is to exclude studies focusing solely on the mental health effects of physical exposure to contamination. Finally, non-empirical papers such as review articles, editorials and commentaries were excluded from the review and no date restrictions to the review were set.

2.2 Literature search

The following databases were searched on 1 April 2021: MEDLINE, PsycINFO, Scopus and Web of Science. Following this, there was also a hand-search for literature that included inspecting the citations of eligible articles.

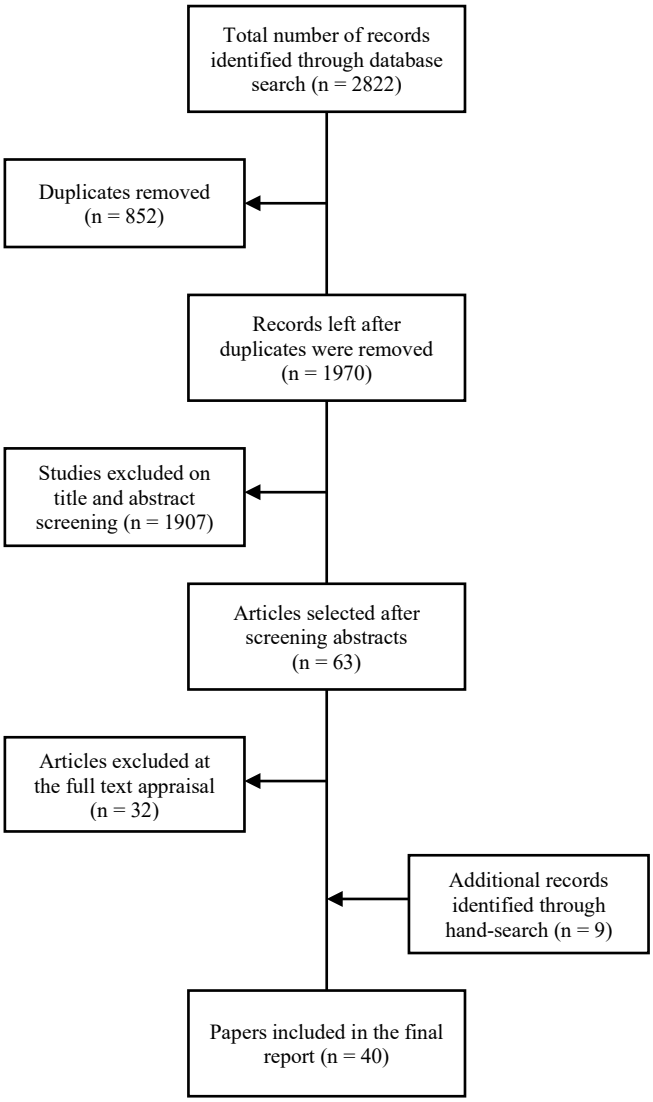
2.3 Search strategy

The following three groups of terms were used for the search of titles and abstracts:

- “contamination” or “contaminated” or “hazardous waste*” or “environmental hazard*” or “environmental toxicity” or “environmental disaster*” or “industrial pollution” or “waste incinerator*” or “toxic site*”
- AND “psychological well*being” or “mental health” or “psychological stress” or “psychosocial stress” or “psychological adjustment” or “psychological harm” or “psychological impact” or “psychosocial impact” or “psychosocial effect*” or “psychosocial health” or “emotional concern*” or “psychological symptom*” or “worry” or “anxiety”
- NOT “animal*” OR “rat*” OR “fish*” OR “noise” OR “bird*” OR “mice” OR “obsessive” OR “disgust”.

2.4 Screening and study selection

Figure 1. Flow diagram of preferred reporting items for systematic reviews and meta-analyses (PRISMA).



2.5 Data extraction

After data screening, RL examined the full text of the included articles and extracted the following data, which were checked for accuracy by EM:

- Article title, authors, year published, type of study (qualitative or quantitative);
- Study population/participants (age, gender, country);
- Design and methods (including the type of mental health/wellbeing measure);
- Type of contaminant;
- Mental health outcomes (including comparisons between those living with contamination and control or other population group);

- Independent variables that were either statistically significantly related to mental health (quantitative studies) or described as impacting mental health (qualitative studies).

2.6 Quality assessment

Quality assessment was conducted by RL. For quantitative studies, quality was assessed using the checklist of items provided by the NIH's National Heart, Lung, and Blood Institute's Quality Assessment Tools for observational cohort, cross-sectional and case-control studies (National Heart, Lung and Blood Institute, 2013). This included assessing the study design, setting, participants, variables, data sources, bias, study size, quantitative variables, and statistical methods. For qualitative studies, the protocol and critical appraisal tool developed by Hawker, Payne, Kerr, Hardey and Powell (2002) for assessing qualitative research was used. It involved appraising the abstract, aims, methods, sampling, data analysis, bias, results, transferability, and usefulness.

2.7 Analytical approach

A critical interpretive synthesis, as defined by Gough, Thomas, and Oliver (2012) as seeking to generate theory from the conceptual literature, was applied to the extracted data. Similar to Flemming (2010), the qualitative and quantitative data were thematically organised through the critical interpretive synthesis, so a conceptual model for understanding the likely mental health effects of living in an area affected by contamination could be developed. This process involved the collaboration of the entire review team.

3. Results

Forty articles were included in the review (see Appendix A).

3.1 Study characteristics

3.1.1 Study design

Of the 40 articles included, 30 were quantitative: case-control (n = 15), cross-sectional (n = 12) and longitudinal (n = 3), five were mixed methods, and five were qualitative. The mixed-methods articles all took the form of a predominantly cross-sectional study with qualitative data such as open-ended survey questions or interviews used as supporting evidence.

3.1.2 Sample location

The articles included in this review contained samples located in several countries. These included the United States (n = 17), Australia (n = 5), Japan (n = 3), China (n = 3), Ukraine (n = 3), Belarus (n = 2), Belgium (n = 2), Canada (n = 1), England (n = 1), Germany (n = 1), Russia (n = 1) and Switzerland (n = 1).

3.1.3 Sample characteristics

Most papers had samples consisting of adult residents (men and women) living with environmental contamination (n = 26) and either compared participants to a control or others within the sample. In some cases, specific categories of residents were reported on, including mothers (n = 5), evacuees (n = 2), litigants (n = 1), people with disability (n = 1), and school students (n = 1). Four papers had samples taken from a state- or country-wide pool and estimated individual exposure to environmental contamination by asking participants to what extend they perceived they had been exposed.

3.1.4 Characteristics of environmental contamination

A wide range of contaminant types were included in the reviewed papers. Nuclear radiation was the most common (n = 14), followed by sites containing heavy metals such as copper, cadmium, lead and zinc (n = 7). Less common were per- and poly-fluoroalkyl substances (PFAS; n = 2), pesticides (n = 2), chlorinated solvents (n = 2), coal fly ash (n = 2), solid

waste (n = 1), and asbestos (n = 1). Finally, 13 articles reported on sites containing a group of the above contaminants, described as a toxic waste mixture. This sums to a total of 46 different contaminant types, which is larger than the number of papers examined in this review, because some studies specifically compared two different contaminated sites.

3.1.5 Quality assessment

Five articles were rated as good quality, 31 as fair, and four as poor (see quality appraisal in supplementary material). The quantitative studies that were rated as poor tended to inadequately describe their methods, such as how mental health or the independent variables were measured.

3.2 Mental health effects of living with environmental contamination

Several different types of mental health effects were observed across the reviewed papers, which we have categorised as follows: clinical conditions meeting a diagnostic criteria such as GAD, pre-clinical symptoms such as depressive symptoms, and emotions such as worry or fear.

3.2.1 Clinical conditions

A minority of the papers examined, all quantitative, conducted clinical examinations of residents living with environmental contamination in order to determine the rates of MDD (n = 4), GAD (n = 3), and post-traumatic stress disorder (PTSD; n = 3). Across these studies, living with environmental contamination was found to have an increased risk of GAD, MDD and PTSD. For instance, Bowler, Mergler, Huel, and Cone (1994) found that clinical depression and schizophrenia were significantly more common among residents of a contaminated site compared to a control group. Similarly, residents evacuated from their homes due to radiation exposure were significantly more likely to experience MDD compared to those who had not been evacuated (Adams et al., 2002; Adams, Guey, Gluzman,

& Bromet, 2011). A longitudinal study found that the rates of MDD and GAD among residents of Three Mile Island who were exposed to radiation were considerably higher than a control population, and this persisted for the 42 months it was measured (Bromet, Parkinson, & Dunn, 1990). Another paper reported a significantly higher prevalence of GAD among residents of contaminated sites (Fortenberry et al., 2018). Finally, for PTSD, significantly higher levels for residents of contaminated sites compared to control groups were also observed (Adams et al., 2011; Kruger et al., 2017). It is important to emphasise that in both studies looking at PTSD (Adams et al., 2011; Kruger et al., 2017), actual clinical diagnoses of PTSD were not recorded. Instead, probable cases of PTSD were used as a proxy based on whether or not participants met a checklist for the clinical condition in the Diagnostic and Statistical Manual of Mental Disorders (DSM).

3.2.2 Pre-clinical mental health symptoms

Schmitt et al. (2021) in their meta-analysis of the mental health effects of living with environmental contamination observed a small-to-moderate on symptoms of depression, anxiety, general stress and PTSD. The results of our review largely align with this. For instance, depression symptoms were often observed to be of significantly higher prevalence in residents living with environmental contamination when compared to a control or similar population, or among residents who had perceived they had been exposed to contamination (Bowler et al., 1994; Bromet et al., 1990; Chen, Chen, & Landry, 2013; Collins, Baum, & Singer, 1983; Fleming, O'Keeffe, & Baum, 1991; Fleming, Baum, Gisriel, & Gatchel, 1982; Fortenberry et al., 2018; Goto, Bromet, & Fujimori, 2015; Goto et al., 2017), or among residents involved in litigation (Greve, Bianchini, Doane, Love, & Stickle, 2005). For anxiety, residents of contaminated sites experienced moderate or intense levels of anxiety, or had significantly worse anxiety than a comparison group (Banwell et al., 2021; Bowler et al., 1994; Bromet et al., 1990; Collins et al., 1983; Fleming et al., 1991; Fleming et al., 1982;

Greve et al., 2005; Tang et al., 2016). Stress symptoms were also significantly higher levels among residents of contaminated sites (Banwell et al., 2021; Barnes, Baxter, Litva, & Staples, 2002; Calloway et al., 2020; Cuthbertson et al., 2016; Gill & Picou, 1998; Matthies et al., 2000; Messer et al., 2019; Vandermoere, 2006; Whiteman, Dunne, & Burnett, 1995).

There are some differences to the Schmitt et al. (2021) review worth emphasising. Symptoms of schizophrenia were not accounted for, whereas our review observed two papers that found significantly higher levels of schizophrenia among residents of contaminated sites (Bowler et al., 1994) and contaminated residents involved in litigation (Greve et al., 2005) when compared to controls. Similarly, one longitudinal study determined that contaminated residents' levels of depression became significantly lower between one and three years after the contamination event (Sneed, Dotson, Brewer, Pugh, & Johnson-Lawrence, 2020).

3.2.3 Emotions

The following emotions were assessed across the articles: distress, worry, fear, anger, concern, fatigue, confusion, helplessness, frustration, and happiness and sadness. While it was more common for these papers to be quantitative, there were also some qualitative and mixed-methods approaches. For qualitative studies, we considered there to be an association between the examined emotion and living with environmental contamination if the participants in those studies described experiencing emotions because of the contamination.

The articles examining distress tended to observe a significantly higher level of distress among residents of contaminated sites when compared to a control group or group living with lower levels of environmental contamination, real or perceived (Adams et al., 2002; Adams et al., 2011; Baum et al., 1983; Greve et al., 2005; Havenaar et al., 1996; Niitsu et al., 2014; Vandermoere, 2008; Viinamäki et al., 1995). One longitudinal study found that the levels of

distress among residents living with contamination reduced significantly from between one year to three years after the occurrence of the contamination (Sneed et al., 2020).

Likewise, for worry, quantitative papers found that residents of contaminated sites were significantly more likely to worry about contamination when compared to a control group or less contaminated region (McIntyre et al., 2018; Prior et al., 2019; Zierold, Sears, & Brock, 2016). Having a disability (Connon, Prior, McIntyre, Adams, & Madden, 2019), having moved away from the contamination (Whiteman et al., 1995), and being a student of a school near contaminated sites (O'Leary & Covell, 2002) also significantly predicted higher levels of worry. Of the two quantitative papers that measured concern, one cross-sectional study found a significant positive correlation between levels of concern and residents living in high-exposure contaminated areas when compared to low-exposure areas (Grasmück & Scholz, 2005), while Koscheyev, Leon, Gourine, and Gourine (1997) did not conduct an analysis of difference between groups.

Finally, several articles considered other emotions including sadness, fear, anger, fatigue, confusion, helplessness, frustration, happiness, and sadness. First, Bowler et al. (1994) found that, compared to a control, residents living with contamination had significantly higher levels of anger, fatigue and confusion. Qualitative research also supported this, as studies reporting on interviews with residents described how they indicated experiencing a wide range of emotions associated with living with environmental contamination, namely fear, anger, and frustration (Calloway et al., 2020; Cuthbertson et al., 2016). Messer et al. (2019) noted that residents of contaminated sites described experiencing fear and helplessness, while Li and Zhou (2020) found that those who perceived the health risk of the environmental contamination around them as high experienced sadness more frequently and less happiness than those who rated it as low. In a longitudinal study, Sneed et al. (2020) observed that

residents' levels of fear remained high throughout the period of contamination, with no significant decrease in symptoms between one and three years after its occurrence.

3.3 Environmental contamination related factors affecting mental health

Several factors related to living with environmental contamination and their influence on participants' mental health and wellbeing were investigated across the different articles reported in the reviewed literature. Statistically significant associations between a psychological or socioecological factor and participants' mental health (for quantitative studies), and anecdotal evidence of a relationship between a factor and mental health outcomes (for qualitative studies) were found for 51 different factors across the 40 papers reviewed. These factors are categorised into the following domains: intrinsic, personal (sociodemographic and extrinsic), social, environmental, and regulation (see Table 1 for definitions).

Table 1. Domains reflecting environmental contamination related factors and their definitions.

Domain	**Definition**	**Factors Associated**
Intrinsic	Factors relating to an individual's perspective on some aspect of their life or the contamination itself.	Contextual: • Sense of place • General environmental concern • Perceived negative life events • Self-regard • Marital dissatisfaction. Impact: • Perceived risk of adverse health effects • Trust in government officials • Uncertainty

		• Self-rated physical health • Concern about family members' health • Perceived knowledge of the contaminant • Perceived need for remediation • Sense of control • Feeling involved in management • Perceived severity of the contamination • Perceived risk of future contamination • Coping behaviours implemented • Performance on cognitive tasks • Having heard of the contaminant.
Personal (socio-demographic and extrinsic)	Factors that manifest at the level of the individual. These include sociodemographic factors that are characteristics of an individual, and extrinsic factors that reflect external impacts of the contamination that manifest at the individual level.	Sociodemographic (Context): • Age • Gender • Level of education • Socioeconomic status • Employment status • Marital status • Having children • Housing tenure • Ethnicity • History of psychological illness • Being a first-time mother • Experiencing birth complications • Disability status • Body mass index • History of serious illness

		• Language spoken at home. Extrinsic (Impact): • Financial impacts • Displacement • Exposure period • Disrupted work • Damage to participant's home.
Social	Those factors that relate to the broader community living with the contamination and how they interact.	Contextual: • Social support • Familial support. Impact: • Media coverage • Community disagreements • Neighbours moving away • Social stigma.
Environmental	Factors that manifest across or near the whole contaminated site and are connected to nature, the earth's systems, and the contamination itself.	Contextual: • Urban or rural. Impact: • Type and severity of contamination • Remediation phase • Proximity to site.
Regulation	Those factors that consist of the governmental and institutional actions that shape the contaminated site and community.	Impact: • Governmental involvement • Litigation • Mental health services.

These domains are further categorised by whether the factor existed and could be measured before the contamination (i.e., context) or whether it occurred due to the contamination (i.e., impact). For instance, socioeconomic status would be considered a context-specific factor, whereas the financial implications of the contamination would be impact related.

3.3.1 Intrinsic

Seven different intrinsic *contextual* factors were examined for an association with mental health and wellbeing. These included sense of place, general environmental concern, perceived negative life events, maternal confidence, self-regard, sense of optimism, and marital dissatisfaction. Across the reviewed articles, environmental concern (Grasmück & Scholz, 2005; O'Leary & Covell, 2002), self-regard (Adams et al., 2002; Adams et al., 2011), sense of place (McIntyre et al., 2018) and marital dissatisfaction (Adams et al., 2002) were all observed to predict mental health and wellbeing. There was little evidence of sense of optimism or level of maternal confidence after birth playing a role in predicting mental health outcomes (Tang et al., 2016).

For the intrinsic factors relating to the *impact* of the contamination, 17 separate constructs were considered in regard to their relationship with participants' mental health or wellbeing. Several of these factors related to residents' perceptions of particular elements of the contamination, such as perceived risk of adverse health effects, trust in government officials, uncertainty, self-rated physical health, concern about family members' health, perceived knowledge of the contaminant, perceived need for remediation, perceived environmental impact, sense of control, feeling involved in management, perceived severity of the contamination, perceived exposure, and perceived risk of future contamination. Other factors involved residents' responses to the contamination, such as coping behaviours implemented, actual knowledge of the contaminant, performance on cognitive tasks, and having heard of the contaminant.

Residents' perceptions of the risk the contamination poses to their health was a common measure. Most quantitative studies found the factor significantly predicated poor mental health outcomes (Adams et al., 2002; Adams et al., 2011; Bromet et al., 1990; Grasmück &

Scholz, 2005; Matthies et al., 2000; O'Leary & Covell, 2002; Zierold et al., 2016), while qualitative evidence also noted that residents reported that the risk of adverse health effects was affecting their mental health (Banwell et al., 2021; Barnes et al., 2002; Calloway et al., 2020; Cuthbertson et al., 2016; Messer et al., 2019). For participants' self-ratings of their physical health, evidence also supported the proposal that those who perceived their physical health was poor were more likely to experience adverse mental health outcomes (Chen et al., 2013; Li & Zhou, 2020; Rehner et al., 2000; Viinamäki et al., 1995; Zierold et al., 2016).

Similarly, quantitative articles exploring trust in government officials observed that the factor correlated with mental health (Matthies et al., 2000; Tang et al., 2016), while qualitative articles reported anecdotal evidence of worse mental health outcomes for those who had low levels of trust (Banwell et al., 2021; Barnes et al., 2002; Calloway et al., 2020; Messer et al., 2019). Being uncertain about certain aspects of the contamination (Fleming et al., 1991; Viinamäki et al., 1995) and worrying about the health of family members (Dunn et al., 1994; Goto et al., 2017) were also observed to significantly correlated with mental health. Qualitative articles provided anecdotal evidence that uncertainty about the contamination exacerbated mental health (Banwell et al., 2021; Barnes et al., 2002; Calloway et al., 2020; Messer et al., 2019), while (Banwell et al., 2021) also observed that residents reported that worrying about family members' health impeded their psychological wellbeing.

Sense of control (Beehler et al., 2008; Connon et al., 2019) and a perceived lack of knowledge about the contamination (Grasmück & Scholz, 2005; Vandermoere, 2006) significantly correlated with poor mental health. Cuthbertson et al. (2016) also observed in their qualitative study that residents reported that a lack of knowledge about the contamination exacerbated their stress.

Performance in a cognitive task (Baum et al., 1983), perceived severity of the contamination (Kruger et al., 2017), having heard of the contamination (McIntyre et al., 2018), perceived participation in management (Fleming et al., 1991) and a perceived need for decontamination (Grasmück & Scholz, 2005) were found to significantly predict mental health. Likewise, certain behaviours, such as implementing dissonance reducing heuristics (Grasmück & Scholz, 2005) and exposure-reducing behaviours (Zierold et al., 2016), were found to alleviate adverse mental health effects. Finally, there was little evidence that actual knowledge about the contamination, perceived environmental impacts and perceived exposure affected mental health and wellbeing.

3.3.2 Sociodemographic and Personal Extrinsic

There were 15 separate sociodemographic factors considered for their association with mental health and wellbeing across the papers included in this review: age, gender, level of education, socioeconomic status, employment status, marital status, having children, housing tenure, ethnicity, history of psychological illness, being a first-time mother, experiencing birth complications, disability status, body mass index, history of serious illness, and language spoken at home.

There was conflicting evidence around the role of age in predicting mental health and wellbeing outcomes. Some articles observed a correlation between young age and adverse mental health effects for residents of contaminated sites (Beehler et al., 2008; Dunn et al., 1994; Goto et al., 2015; Goto et al., 2017; Kruger et al., 2017; Li & Zhou, 2020). Conversely, others found that old age correlated significantly with poor mental health (Havenaar et al., 1996; Matthies et al., 2000; McIntyre et al., 2018; Niitsu et al., 2014; O'Leary & Covell, 2002; Tang et al., 2016; Viinamäki et al., 1995). There was also a collection that found no significant correlation between age and mental health outcomes.

The role of gender in predicting mental health was less ambiguous. Females were more likely to experience adverse mental health effects from the experience of living with environmental contamination in most articles exploring whether there was an influence (Beehler et al., 2008; Connon et al., 2019; Havenaar et al., 1996; Li & Zhou, 2020; McIntyre et al., 2018; Niitsu et al., 2014; Prior et al., 2019; Rehner et al., 2000; Vandermoere, 2006; Viinamäki et al., 1995). Similarly, socioeconomic status was predominantly found to have a significant association with mental health, with those from low socioeconomic backgrounds being more likely to report adverse mental health outcomes (Adams et al., 2002; Connon et al., 2019; Dunn et al., 1994; Fleming et al., 1991; Li & Zhou, 2020; McIntyre et al., 2018; Prior et al., 2019; Rehner et al., 2000; Viinamäki et al., 1995). Intriguingly, both for ethnicity and education level, little evidence was found to support the proposal that minorities (Rehner et al., 2000) or those with lower levels of education experienced worse poor mental health outcomes (Chen et al., 2013; Kruger et al., 2017; Li & Zhou, 2020; Niitsu et al., 2014).

The following factors, which were considered less commonly, were observed to significantly correlate with mental health and wellbeing in the few articles that reported on them: having a history of psychological illness (Adams et al., 2002; Goto et al., 2015; Goto et al., 2017), having a disability (Connon et al., 2019; Prior et al., 2019), being a first-time mother or experiencing birth complications (Goto et al., 2015; Goto et al., 2017), having previous serious illness (Dunn et al., 1994), and speaking a language other than English at home in an Australian context (McIntyre et al., 2018). Finally, some factors that were found to correlate with residents' mental health across some but not all articles examining the particular factor were as follows: being unemployed (Adams et al., 2011; Niitsu et al., 2014), being unmarried (Chen et al., 2013; Viinamäki et al., 1995), having a child or children (Fleming et al., 1991; Havenaar et al., 1996; Matthies et al., 2000; McIntyre et al., 2018), being a renter as opposed

to a homeowner (McIntyre et al., 2018), having a high body mass index (Adams et al., 2002), and being a racial minority (Rehner et al., 2000).

Five personal extrinsic factors that were influenced by living with contamination had some evidence of an impact on mental health: displacement (Goto et al., 2015; Goto et al., 2017; Havenaar et al., 1996), financial impacts (Banwell et al., 2021; Calloway et al., 2020; Messer et al., 2019), length of exposure period (Rehner et al, 2000), and damage to participant's home (Niitsu et al., 2014).

3.3.3 Social

Social bonds, such as social and familial support, were found to influence mental health and wellbeing. Adams et al. (2011) and Beehler et al. (2008) found that a lack of familial support was significantly associated with adverse mental health effects, while Adams et al. (2002), Fleming et al. (1982) and Viinamaki et al. (1995) observed the same for social support. Dunn et al. (1994), however, found no significant relationship between social support and distress. Other elements relating to the social, such as media coverage (Cuthbertson et al., 2016), community disagreements (Messer et al., 2019), neighbours moving away (Barnes et al., 2002) and social stigma (Banwell et al., 2021), were observed to predict stress in individual studies.

3.3.4 Environmental

No articles found significant correlations between a mental health outcome and a factor relating to the environment from a contextual standpoint. Chen et al. (2013) did examine whether the location of a contaminated resident in an urban or rural area affected their level of depression, but found no significant correlation. For the impact of the contamination, however, three different factors were considered in regard to their relation to mental health: proximity to a contaminated site, type and severity of contamination, and stage of

remediation. Close proximity to the contaminated site was a significant predictor of poor mental health (Bromet et al., 1990; Connon et al., 2019; O'Leary & Covell, 2002; Prior et al., 2019). Likewise, contaminant type was found to play a significant role, with more difficult to detect and uncertain contaminants found to correlate significantly with worry (Connon et al., 2019; McIntyre et al., 2018; Prior et al., 2019). No correlation between the severity of the contamination and depression or anxiety was found by Beehler et al. (2008). Grasmück and Scholz (2005) found that residents living in a decontaminated region exhibited significantly fewer adverse mental health effects. Conversely, Vandermoere (2006, 2008) observed that the process of decontamination significantly correlated with poor mental health, and Messer et al. (2019) provided anecdotal evidence in support of this, finding residents who lived in a decontaminated area exhibited stress associated with the disruptions caused by the remediation.

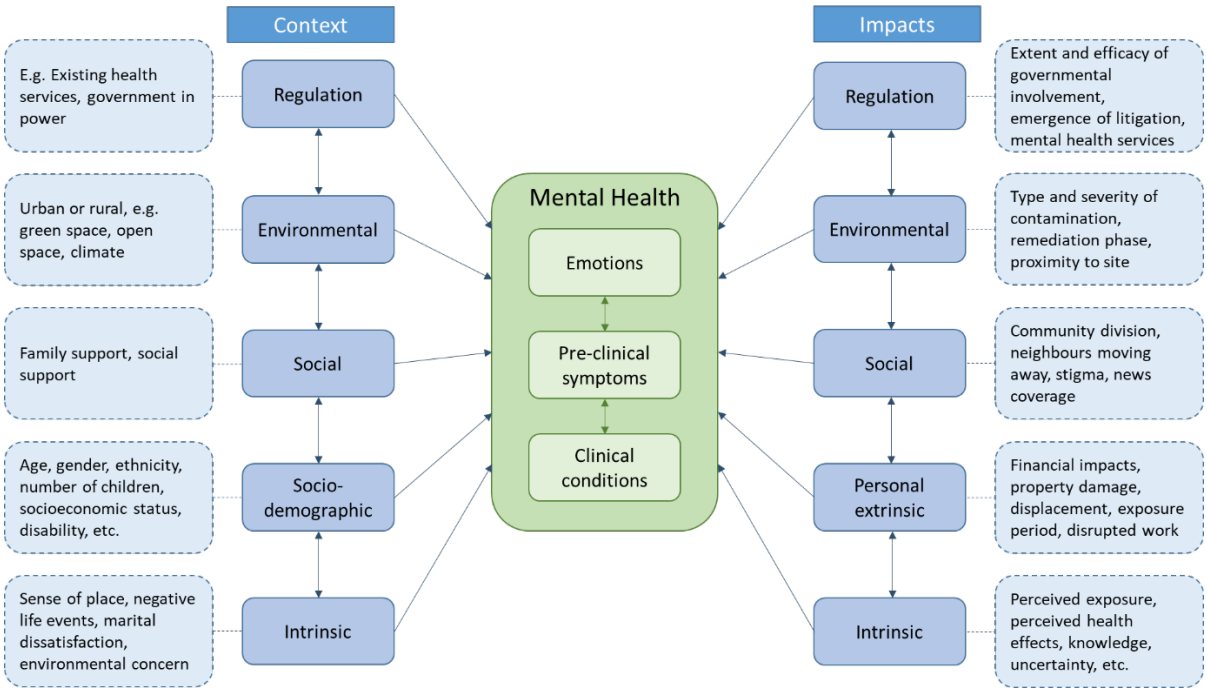
3.3.5 Regulation

No articles reported on contextual factors relating to regulation. However, three impact-related regulation factors were considered: the extent of institutional involvement or abandonment, provision of health services, and involvement in litigation. Qualitatively, Barnes et al. (2002), Messer et al. (2019) and Calloway et al. (2020) all observed that, in cases where government officials were less involved, adverse mental health effects were reported more commonly by residents. Quantitatively, Rehner et al. (2000) observed no significant relationship between the extent of governmental involvement and depression. Greve et al. (2005), on the other hand, found that being involved in litigation proceedings correlated significantly with an increased likelihood of depression among residents. Finally, Calloway et al. (2020) indicated that several participants anecdotally mentioned that mental health services helped them cope with the anxiety and stress they were experiencing due to living near environmental contamination.

3.3.6 Synthesis

This review has synthesised evidence from several studies reporting on the relationship between various psychological and socioecological factors associated with living with environmental contamination and residents' mental health. While the strength of the relationship between each factor and mental health is not reported here, it is worth emphasising that the findings demonstrate that factors relevant to residents' mental health outcomes exist across a range of scales or domains. In a similar manner to Edelstein (2002; 2018), who considers that contamination affects mental health through its disruption to an individual's lifescape (the body, self, home, environment and society), these scales range from within the individual (intrinsic) to the level of government (regulation) (Figure 2). However, extending such scalar frameworks further, within each of these domains, the numerous factors have the potential to shape residents' mental health considerably are detailed. There was somewhat consistent agreement across the articles over the direction of the relationship between said factors and mental health.

Figure 2. Framework showing the pathways linking environmental contamination and mental health and wellbeing.



Note. E.g. signifies possible examples provided by the authors that did not appear in the literature. Etc. signifies that there were more factors examined by papers in this category but not included in this figure.

It is important to emphasise that these factors themselves may shift and warp overtime, as they are affected by one another and altered by spatio-temporal processes. For instance, community division, extent and efficacy of governmental involvement, emergence of litigation, and neighbours moving away, are all factors that manifest varyingly at different times, as events arise and dissipate. Similarly, factors like existing health services and the type and severity of the contamination undoubtedly determine how other factors manifest, such as the extent and efficacy of government involvement and likelihood of litigation being brought. The arrows linking each of the factors together in Figure 2 reference these interrelationships and the capacity of their influence on mental health and wellbeing to shift and change over time.

3.4 Methods for measuring mental health

Eighteen different methods for measuring mental health were adopted across the 31 quantitative, five mixed-methods and five qualitative articles included in this review. These different types of measurement are categorised into the type of data they gather below: objective, subjective, and descriptive.

Objective methods for measuring mental ill-health were uncommon across the papers (n = 2). For instance, Baum et al. (1983) and Collins et al. (1983) used urine samples from participants and concentration tasks to operationalise stress. Subjective methods, such as subjective self-report instruments in unvalidated questionnaires or validated scales (e.g., Symptom Checklist-90), were far more common (n = 36). Finally, the qualitative studies used descriptive data gathered through interviews or open-ended surveys to report the impact on residents' mental health (n = 5). The data obtained from these methods across the articles was examined regarding the language participants used when referring to their mental health and how this was related to their perception and experience of living near environmental contamination.

4. Discussion

The findings of this review add to the growing body of evidence (see, for instance, Schmitt et al., 2021; Sullivan et al., 2021) showing that living with environmental contamination has deleterious effects on residents' mental health and wellbeing. Notably, the findings generally confirm that the experience of living with environmental contamination caused by industrial action increases the likelihood of residents experiencing adverse mental health effects in the form of clinical conditions (GAD, MDD and PTSD), pre-clinical symptoms (depression, anxiety, stress and schizophrenia), and emotions (e.g., fear, anger, concern). Further, these adverse mental health effects are influenced by a range of psychological and socioecological

factors, the majority of which have consistent support of their impacts across the articles included in this review.

This review builds on theories of how environmental contamination relates to the mental health and wellbeing of residents living nearby. It identifies factors found in the literature to correlate with mental health in a systematic and holistic manner, revealing the complex ways mental health is affected by the experience of living with environmental contamination. There are several theoretical implications of this research. First, examining studies reporting on varying levels of adverse mental health effects, from emotions to clinical conditions, allows for an appreciation of the range of psychological responses residents may have to the experience of living with environmental contamination. Significant associations were found for all types of psychological symptoms considered, and across a diverse range of clinical categories, indicating that the experience of living with environmental contamination can result in a wide range of mental health outcomes. While the majority of these psychological responses could be considered harmful for residents, it is worth noting that some responses, such as worry, can instigate behaviours or actions that reduce the severity of adverse psychological conditions (Prior et al., 2019). This broad range of psychological symptoms indicates the importance of measuring for several different types of symptoms when examining the impacts of environmental contamination. Practically, the novel approach of breaking down the factors that predict mental health outcomes into context and impact specific categories could help form management responses to contaminated sites. For instance, those managing contaminated sites should be aware that adverse psychological outcomes are likely to result for residents, and the mental health services implemented to respond to contamination events should be prepared to address different forms of mental ill-health.

Second, synthesising the wide range of factors found to correlate with mental health across the articles included in this review has revealed the complex way mental health and the experience of living with environmental contamination are related. Particularly, the constructed framework enables important or under-researched components to be illuminated and drawn out. For instance, strong agreement as to the significance of certain factors in shaping residents' mental health and wellbeing, such as their socioeconomic status, gender, perception of the risk the contaminant poses to their health, self-rated physical health and trust in government officials, suggests these factors are likely to have considerable relevance in the majority of cases of environmental contamination. Conversely, some factors which were consistently found to have little effect on mental health and wellbeing across the reviewed articles, such as implemented coping behaviours, or that were observed to affect mental health differently across studies, such as young age and old age, should be weighed less heavily when evaluating the mental health impact of contamination on an individual. Beyond this, the framework also reveals that there has been little attention placed on how pre-existing environmental conditions and regulatory regimes (see Figure 2) may shape the mental health and wellbeing of residents living with environmental contamination. These could include factors such as existing health services, amount of green space or the climate. Further research conducted in these domains would be beneficial for expanding on the socioecological framework conducted in this review and for expanding our understanding of how living with environmental contamination relates to mental health and wellbeing.

Third, conceptualising the relationship between mental health and living near environmental contamination in the holistic manner outlined in this review can draw attention to how different components may interrelate to one another. For instance, while Barnes et al. (2002) found that providing compensation to residents did little to alleviate their level of concern for the contamination, it did result in greater community conflict, which residents reported to

contribute greatly to their sadness and resignation. Similarly, Prior et al. (2019) observed that less well-understood contaminants caused greater uncertainty in residents, which exacerbated the level of worry they felt. While such specific between-factor relationships were not drawn out in this study, future research could examine how the factors identified in this research relate to and affect one another and whether they are likely to co-occur. This could help with efforts to predict the potential impacts of contamination events and construct action that best mitigates these effects.

Fourth, this review also reveals that a wide range of methods are used to measure mental health. Most approaches used subjective tools to measure mental health, while far fewer objective and descriptive methods were adopted. The articles that conducted objective measures (Baum et al., 1983; Collins et al., 1983) were conducted in the 1980s, indicating that since then psychological research has moved away from this approach. Similarly, the papers implementing descriptive, qualitative methods (Banwell et al., 2021; Barnes et al., 2002; Calloway et al., 2020; Cuthbertson et al., 2016; Messer et al., 2019) have mainly been conducted in the past few years, suggesting a change in attitude to the benefits of qualitative research. Peters (2010) suggests that qualitative methods in psychology were initially undeveloped because they were seen as lacking objectivity. However, the use of such methods has grown recently as their ability to involve participants and their perspectives, particularly on the usefulness of interventions, has become more appreciated (Schiff, 2018). Further, there is growing awareness of the importance of temporality in contamination events and the potential for affected communities to experience retraumatization across time, as certain events or processes remind those affected of the contamination (Schmitt et al., 2021). Qualitative and participatory methods are particularly capable of drawing out these effects over time and highlighting the processes causing retraumatization more thoroughly than static, quantitative methods (Pain, 2019).

Finally, aligning with Schmitt et al. (2021), we would like to emphasise that much theoretical literature exploring the effects of contamination comes from an environmental justice perspective, although these studies are largely not captured in this review because mental health is not explicitly focused on. Such environmental justice research has consistently demonstrated that contaminated sites are more often concentrated in areas of disadvantage (see, for instance, Davide, Alessandra, & Roberto, 2022; Johnston & Cushing, 2020) and that legal and regulatory processes act to enable and reinforce this unjust placement of hazards (Mohai, Pellow, & Roberts, 2009; Mohai & Saha, 2015). However, due to the homogeneity of contaminated communities (that is, the people living within communities affected by environmental contamination are usually socio-demographically similar), and the fact that most studies utilise a case-control approach, the role disadvantage plays in influencing mental health outcomes, and how legal and regulatory conditions may contribute to this, is potentially not captured in health research. This might explain why ethnicity was not often found to predict mental health in the studies examined in this review; although, socioeconomic status was observed to correlate with mental health outcomes in several studies. It is also important to emphasise that, the location of sites in disadvantaged regions likely contributes to health inequality, particularly mental health inequality, with recent research highlighting the significant contribution of environmental degradation to mental health inequality (Hayes et al., 2018). In order to tackle these inequalities and inform understandings of how unjust legal processes may enable and contribute to current conditions, it is essential that research begins to bridge this current divide between health and environmental justice research.

5. Conclusion

In summary, this review highlights the multitude of ways in which living with environmental contamination shapes residents' mental health and psychological wellbeing. Indeed, a

particular strength of the review is its holistic approach and synthesis of the various socioecological and psychological factors that predict mental health outcomes for residents of contaminated sites. Limitations include the inability to separate factors by the strength of their association with mental health outcomes beyond whether they were observed to be anecdotally or statistically associated, and the lack of consideration of possible relationships between the individual socioecological factors.

This review also highlights some areas that could be addressed by future research. Particularly, attention to the role of regulatory and environmental factors that shape residents' mental health, such as pre-existing regulatory regimes or environmental conditions, would be beneficial for completing the framework initiated in this review. Likewise, most of the countries reported on by the articles in this review are from the Global North, indicating a gap in knowledge around contaminated sites and mental health in the Global South. This will be of increasing importance because most undiscovered contaminated sites are likely located in the Global South (Landrigan et al., 2018). Finally, more qualitative research that draws upon and highlights residents' experiences of living with environmental contamination can reveal additional important factors for shaping mental health and wellbeing and aid in the formation of management strategies that best protect residents.

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Appendix A – Data Extraction

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
Adams et al. (2002). Stress and well-being in mothers of young children 11 years after the Chornobyl nuclear power plant accident	Quantitative (case-control). 11 years after evacuation from contaminated site.	n = 464. Adults, females (mothers). Ukraine. Mothers evacuated from contaminated region surrounding Chernobyl and a control group who had never lived in a contaminated region.	Distress (current): • Symptom Checklist 90-Revised (SCL-90-R) and Global Severity Index (GSI) Depression (lifetime): • Structured Clinical Interview for DSM-III-R	Plutonium, caesium and radioactive iodine from Chernobyl.	Compared to control group, those evacuated from residence as a result of contamination had: • Higher levels of distress ($p < 0.001$) • Higher prevalence of lifetime depression ($p < 0.01$)	Intrinsic (context): • Self-regard • Marital dissatisfaction Sociodemographic (context): • Age • Education • Employment • Socioeconomic status • Smoking • Body Mass Index • Previous psychological illness Social (context): • Social isolation Intrinsic (impact): • Perceived risk to health	Distress: • Perceived risk to health ($p < 0.01$) • Previous psychological illness ($p < 0.01$) • Body Mass Index ($p < 0.01$) • Socioeconomic status ($p < 0.001$) • Marital dissatisfaction ($p < 0.001$); • Social isolation ($p < 0.001$) • Self-regard ($p < 0.001$)	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
Adams et al. (2011). Psychological well-being and risk perceptions of mothers in Kyiv, Ukraine, 19 years after the Chornobyl disaster	Quantitative (case-control). 19 years after evacuation from contaminated site.	n = 797. Adults, females (mothers), Ukraine. Mothers evacuated from contaminated region surrounding Chernobyl and two control groups: 1) mothers in an uncontaminated region of Kyiv (population control) and 2) mothers of unexposed classmates of the evacuee group (neighbourhood control).	Distress (current): • SCL-90 MDD (one-year period prior to interview): • Major depressive module of Composite Interna-tional Diagnostic Interview PTSD (current): • Impact of Events Scale-R (IES-R)	Plutonium, caesium and radioactive iodine from Chernobyl.	Distress levels significantly higher among evacuees compared to controls ($p < 0.001$). MDD rates significantly higher among evacuees compared to neighbourhood control ($p < 0.05$), but not population control ($p > 0.05$). PTSD rates significantly higher among evacuees compared to control groups ($p < 0.001$).	Sociodemographic (context): • Age • Education • Marital status • Employment • Standard of living • Smoking • Body Mass Index • Socioeconomic status Intrinsic (context): • Negative life events • Self-regard Intrinsic (impact): • Coping behaviours • Perceived risk to health Social (context): • Family support	PTSD: • Family support ($p < 0.01$) • Perceived risk to health ($p < 0.001$) MDD: • Employment ($p < 0.01$) • Negative life events ($p < 0.001$) • Self-regard ($p < 0.001$) • Perceived risk to health ($p < 0.01$) Distress: • Employment ($p < 0.01$) • Negative life events ($p < 0.001$) • Self-regard ($p < 0.001$) • Perceived risk to health ($p < 0.001$)	Good

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
Banwell et al. (2021). Health and social concerns about living in three communities affected by per-And polyfluoroalkyl substances (PFAS): A qualitative study in Australia	Qualitative	n = 111 (across 12 focus groups). All ages, all genders, Australia. Residents living near three contaminated sites.	Anxiety and stress: • Open-ended interview questions.	PFAS	Residents of contaminated sites reported feelings of stress and anxiety as a result of the contamination.	Residents reported stress and anxiety affected by: • Potential physical health effects of exposure • Future health of children • Financial uncertainty • Eroding trust • Stigma	NA	Good
Barnes, Baxter, Litva & Staples (2002). The social and psychological impact of the chemical contamination incident in Weston Village, UK: A qualitative analysis	Qualitative	n = 23. Ages 17-70, all genders, England. Residents in an area near a chemical spill.	Stress (current): • Interviews (questions not provided)	Chemical waste (chlorinated solvent - HCBD)	All residents reported enhanced stress levels. A minority described emotional distress.	Stress was reported by residents to be affected by: • Uncertainty associated with the spill • Worry of potential illness • Neighbours moving away • Less institutional involvement.	NA	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
Baum, Gatchel & Schaeffer (1983). Emotional, behavioral, and physiological effects of chronic stress at Three Mile Island	Quantitative (case-control). 17 months after accident.	n = 121. No age range given, all genders, US. Residents of Three Mile Island during the nuclear accident and three control groups.	Distress (current): • SCL-90 Depression (current): • Beck Depression Inventory (BDI)	Nuclear radiation	Compared to control groups, residents of contaminated region had: • Significantly higher levels of distress ($p < 0.05$) • No significant difference in depression levels ($p > 0.05$)	Sociodemographic (context): • Age • Gender • Children • Tenure type • Education • Socioeconomic status Intrinsic (impact): • Task performance	Distress: • Task performance ($p < 0.05$)	Fair
Beehler et al. (2008). A multilevel analysis of long-term psychological distress among Belarusians affected by the Chernobyl disaster	Quantitative (case-control). 20 years after event.	n = 381. Ages 16-64, all genders, Belarus. Residents in two different regions affected by nuclear radiation, one high in radiation and the other lower.	Depression (current): • Brief Symptom Inventory (BSI) Anxiety (current): • BSI Somatisation (current): • BSI	Caesium.	No significant difference in levels of anxiety and depression between residents of high and low radiation regions ($p > 0.05$). Compared to residents in the region with lower radiation levels, those in the higher radiation region had significantly higher somatisation levels ($p < 0.05$).	Sociodemographic (context): • Age • Gender • Employment • Relocation history • Chronic stressors (e.g. financial problems) Intrinsic (context): • Negative life events Intrinsic (impact): • Sense of control	Depression: • Gender (female) ($p < 0.01$) • Age (younger) ($p < 0.01$) • Chronic stressors ($p < 0.001$) • Sense of control ($p < 0.001$) • Family problems ($p < 0.01$) Anxiety: • Gender (female) ($p < 0.001$) • Chronic stressors ($p < 0.001$) • Sense of control ($p < 0.01$)	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
						Social (context): • Family cohesion • Family history of leukaemia Environmental (impact): • Level of contamination at residence	• Family problems ($p < 0.05$) Somatisation: • Gender (female) ($p < 0.001$) • Chronic stressors ($p < 0.001$) • Sense of control ($p < 0.01$) • Family cohesion ($p < 0.01$)	
Bowler, Mergler, Huel & Cone. (1994). Psychological, psychosocial, and psychophysiological sequelae in a community affected by a railroad chemical disaster	Quantitative (case-control). Three months after event.	n = 334. Adults (no age range), all genders, US. Residents living in close proximity to a toxic spill and a control group.	Stress (current): • IES Anxiety (current): • Mood scale (author) • Environ-mental Worry Scale (Bowler, Schwarzer, 1991) Depression (current): • Mood scale Clinical depression and schizophrenia (current):	Metam sodium (pesticide)	Compared to control group, residents living in close proximity to toxic spill had: • Higher levels of anxiety and depression ($p < 0.01$) • Higher levels of depression, anger, fatigue and confusion ($p < 0.05$) • Higher levels of clinical depression and schizophrenia ($p < 0.001$).	NA	NA	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
			• Minnesota Multiphasic Personality Inventory-2 (MMPI-2) Mood, consisting of depression, anger, fatigue and confusion (current): • Profile of Mood States-Revised					
Bromet, Parkinson & Dunn (1990). Long-term mental health consequences of the accident at Three Mile Island	Quantitative (longitudinal)	n = 1032 (9 months) n = 931 (12 months) n = 942 (30 months) n = 882 (42 months) No age range given, all genders, US. Mothers of young children living near TMI and workers at TMI after nuclear	Depression and anxiety (current): • SCL-90 MDD and GAD (lifetime): • Schedule for Affective Disorders and Schizophre-nia (Lifetime version)	Nuclear radiation	Compared to control group, mothers and workers near site had: • Significantly higher levels of depression and anxiety 9 months after event ($p < 0.05$) • No significant different between depression and anxiety levels at 42 months ($p > 0.05$)	Intrinsic (impact): • Perceived risk to health Environmental (impact): • Proximity to site	Depression (9 months): • Perceived risk to health ($p < 0.05$) Depression (12 months): • Perceived risk to health ($p < 0.05$) • Proximity ($p < 0.05$) Depression (30 months): • None Depression (42 months):	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
		accident, and control groups.			• No significant different between MDD and GAD levels at any time ($p > 0.05$)		• Perceived risk to health ($p < 0.05$) • Proximity ($p < 0.05$) Anxiety (9 months): • None Anxiety (12 months): • Perceived risk to health ($p < 0.05$) Anxiety (30 months): • Perceived risk to health ($p < 0.05$) Anxiety (42 months): • Perceived risk to health ($p < 0.05$) • Proximity ($p < 0.05$)	
Calloway et al. (2020). Exploring	Qualitative	n = 9 (6 residents and 3 regulators)	General mental health (current):	PFAS	Residents reported feeling concerned,	Residents reported that their stress	NA	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
Community Psychosocial Stress Related to Per-and Poly-Fluoroalkyl Substances (PFAS) Contamination: Lessons Learned from a Qualitative Study		Ages and genders not provided, United States. Residents and regulators of contaminated site.	• Interview question: "When PFAS contamina-tion became apparent, would you describe your initial actions, thoughts, and feelings during the first month or so?"		anxious, stressed, and angry.	was exacerbated by: • Health concerns • Uncertainty • Institutional delegitimisation • Distrust • Financial burdens. Residents reported that their stress and anxiety was alleviated by: • Provision of mental health services		
Chen, Chen & Landry. (2013). Migration, environmental hazards, and health outcomes in China	Quantitative (cross-sectional)	n = 2866. Ages 18-70, all genders, China. Residents across China who rated perceived environmental hazards around them.	Depression (current): • Center of Epidemiological Studies Depression Scale (CES-D)	Air quality (PM_{10}, SO_2, NO_2), industrial waste, water quality.	Compared to those who perceived toxic waste surrounding their residence as low, those who perceived toxic waste as high had significantly higher rates of depression ($p < 0.01$). No significant association between rate of depression	Sociodemographic (context): • Age • Gender • Education • Employment • Marital status • Ethnicity • Socioeconomic status • Migration history	Depression: • Self-rated physical health ($p < 0.001$) • Married ($p < 0.001$) • Education (years) ($p < 0.001$) • Employed ($p < 0.05$)	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
					and perceived air and water quality around residence ($p > 0.05$).	Environmental (context): • Urban or rural Intrinsic (impact): • Self-rated physical health • Perceived air quality • Perceived water quality • Perceived toxic waste		
Collins, Baum, & Singer (1983). Coping with chronic stress at Three Mile Island: Psychological and biochemical evidence	Quantitative (case-control). 2 years after disaster.	n = 70. No age range, all genders, US. Residents living within 5 miles contaminated site and a control group.	Depression and anxiety (current): • SCL-90	Nuclear radiation	Compared to control group, residents of contaminated site had: • Significantly higher levels of depression ($p < 0.01$) • Significantly higher levels of anxiety ($p < 0.01$)	Intrinsic (impact): • Coping behaviours (problem-oriented thinking and denial)	Depression: • Problem-oriented coping ($p < 0.05$) • Denial ($p < 0.05$) Anxiety: • Problem-oriented coping ($p < 0.05$) • Denial ($p < 0.05$)	Poor
Connon et al. (2019). How does	Mixed methods	n = 486.	Worry (current):	Heavy metals, hydrocarbons,	Compared to those without a disability,	Environmental (impact):	Worry:	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
living with a disability affect resident worry about environmental contamination? A study of a long-term pervasive hazard	(cross-sectional survey with some qualitative open-ended questions)	Ages 18+, all genders, Australia. Residents of several contaminated sites.	• Likert scale rating from question asking about extent of "worry about contamina-tion"	chlorinated solvents, waste, and asbestos	residents of contaminated sites with a disability had significantly higher levels of worry (p < 0.001). Qualitatively, those with a disability were also more negative in their descriptions of what aspects of the contamination they worried about.	• Contaminant type • Proximity to contaminated site Sociodemographic (context): • Disability status • Age • Gender • Education • Socioeconomic status Intrinsic (context): • Sense of place Intrinsic (impact): • Sense of control • Coping behaviours	• Gender (female) (p < 0.001) • Socioeconomic status (p < 0.05) • Sense of control (p < 0.001) • Proximity (p < 0.05) • Contaminant type (hydrocarbon, metal, solvent) (p < 0.001)	
Cuthbertson et al. (2016). Angry, Scared, and Unsure: Mental	Qualitative	n = 263 (30 respondents filling out a survey every	Stress (current): • Open-response survey with	Lead	Residents of Flint reported increased levels of stress.	Stress was reported by residents to be affected by:	NA	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
Health Consequences of Contaminated Water in Flint, Michigan		month for 12 months). Adults, all genders, US. Residents living in Genesee County, Michigan (containing Flint)	stress defined as "feeling nervous, scared, angry, frustrated, and distrustful"		Increases in anxiety and depression levels were also reported by residents, but to a lesser extent. Emotions such as anger, fear and frustration were also reported by residents.	• Worry about potential physical health effects • News coverage • Lack of knowledge around lead testing.		
Dunn et al. (1994). Psychosocial effects of PCB contamination and remediation: the case of Smithville, Ontario	Quantitative (cross-sectional)	n = 535. Ages 18+, all genders, US. Residents from two neighbour-hoods, one with a population exposed to contamination and the other near a waste facility.	Distress: • General Health Question-naire (GHQ)	PCB	Compared to residents near a waste facility, residents near contaminated site did not have significantly higher distress levels (p > 0.05).	Sociodemographic (context): • Age • Gender • Tenure type • Employment • Socioeconomic status • Stressors (e.g. financial problems) • History of serious illness Intrinsic (impact): • Perceived risk to health	Distress: • Age (younger) (p < 0.05) • History of serious illness (p < 0.001) • Socioeconomic status (p < 0.001) • Worried about someone else (p < 0.01)	Good

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
						• Worried about someone else in past 12 months Social (context): • Social support		
Fleming et al. (1982). Mediating influences of social support on stress at Three Mile Island	Quantitative (case-control). 1 year after accident.	n = 109. No age range, all genders, US. Residents living near contami-nated site and a control group.	Anxiety (current): • SCL-90 Depression (current): • BDI	Nuclear radiation	Compared to control group, residents of contaminated site had: • Significantly higher levels of depression ($p < 0.05$) • Significantly higher levels of anxiety ($p < 0.01$)	Social (context): • Social support Intrinsic (impact): • Task performance	Depression: • Social support ($p < 0.001$) Anxiety: • Social support ($p < 0.001$)	Fair
Fleming, O'Keeffe & Baum (1991). Chronic stress and toxic waste:	Quantitative (case-control).	n = 54.	Depression and anxiety (current): • SCL-90	Toxic waste	Compared to control group, residents of contaminated site had:	Sociodemographic (context): • Age	Depression (SCL-90): • Socioeconomic status ($p < 0.05$)	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
The role of uncertainty and helplessness		No age range given, all genders, US. Residents near a toxic waste site and a control group.	Depression (current): • BDI Helplessness: • Survey question on 5-point Likert scale: "how frequently during the preceding 2 weeks they have you been bothered by feelings of helplessness"		• Significantly higher levels of depression in the SCL-90 ($p < 0.01$) • Significantly higher levels of anxiety in the SCL-90 ($p < 0.01$) • Significantly higher levels of depression in the BDI ($p < 0.01$) • Significantly higher levels of helplessness ($p < 0.05$)	• Years of residence • Marital status • Children • Education • Socioeconomic status Intrinsic (impact): • Uncertainty • Feeling ignored	• Uncertainty ($p < 0.05$) • Feeling ignored ($p < 0.001$) Anxiety (SCL-90): • Uncertainty ($p < 0.05$) • Feeling ignored ($p < 0.001$) Depression (BDI): • Family size ($p < 0.05$) • Uncertainty ($p < 0.05$) • Feeling ignored ($p < 0.001$) Helplessness: • Uncertainty ($p < 0.05$)	
Fortenberry et al. (2018). Assessment of Behavioral Health	Quantitative (cross-sectional)	n = 180. Ages 18+, all genders, US.	Depression (current): • Patient Health	Lead	29.4% of residents reported symptoms of depression.	NA	NA	Poor

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
Concerns in the Community Affected by the Flint Water Crisis - Michigan (USA) 2016		Residents in Flint, Michigan.	Questionnaire-2 (PHQ) Anxiety (current): • Generalised Anxiety Disorder-2 module in a PHQ		33.4% of residents reported symptoms of anxiety. 37.7% of residents reported having poor mental health for 14 or more days in past 30 days, significantly higher than results from a survey conducted within the same region prior to the contamination ($p <$ 0.05).			
Gill & Picou. (1998). Technological disaster and	Quantitative (case-control)	n = 696. Ages 18+, all genders, US.	Stress (current): • IES • Subscales were intrusive	Toxic spill: methyl chloride, sodium,	Compared to residents of the toxic spill, residents of the oil spill and hazardous waste	NA	NA	Poor

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
chronic community stress		Residents living near three environmental hazards with associated control groups: • Toxic spill from train derailment and control group (n = 399) • Hazardous waste site and control group (n = 106) • Oil spill and control group (n = 191)	stress and avoidance behaviour	tetraethyl lead, toluene diisocyanate, perchloro-ethylene, styrene, and vinyl chloride. Hazardous waste site: no specification Oil spill: crude oil	sites had significantly higher levels of stress ($p < 0.05$).			
Goto et al. (2015). Immediate effects of the Fukushima nuclear power plant disaster on depressive	Quantitative (cross-sectional).	n = 8196. Ages 15-51, women, Japan. Mothers living in Fukushima, who gave birth after	Depression (current): • Two survey questions: "During the past month, have you often felt	Nuclear radiation	Compared to mothers from other regions, those who lived in the region closest to the nuclear plant had significantly higher	Sociodemographic (context): • Age • Days postpartum • Pregnancy complications	Depression: • Age (younger) ($p < 0.01$) • First time mother ($p < 0.01$) • Obstetrical complications ($p < 0.01$)	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
symptoms among mothers with infants: a prefectural-wide cross-sectional study from the Fukushima Health Management Survey		the nuclear disaster. Compared groups based on which region of Fukushima they lived in (high radiation vs. low radiation).	down, depressed or hopeless?" and "During the past month, have you often found little interest or pleasure in doing things?"		levels of depression ($p < 0.001$).	• Psychiatric history • Gestational age at time of disaster • Obstetrical care after disaster • First-time mother • History of abortion Intrinsic (context): • Maternal confidence	• Pregnancy complications ($p < 0.001$) • History of abortion ($p < 0.01$) • Psychiatric history ($p < 0.01$)	
Goto et al. (2017). The Fukushima nuclear accident affected mothers' depression but not maternal confidence	Quantitative (repeated cross-sectional)	n = 6686 (2012). n = 6423 (2013). Mothers, ages 16-46, Japan. Mothers who registered their	Depression (past month): • 2-item screening measure to assess depressed	Nuclear radiation from power plant accident.	Compared to residents not evacuated, those evacuated had significantly higher levels of depression ($p < 0.001$).	Intrinsic (context): • Maternal confidence Intrinsic (impact): • Concern about radiation	Depression (2012): • Age (younger) ($p < 0.001$) • Relocated ($p < 0.001$) • Psychiatric history ($p < 0.001$)	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
		pregnancies in Fukushima after the nuclear disaster.	mood and anhedonia: (1) "During the past month, have you often felt down, depressed, or hopeless?" (2) "During the past month, have you often found little interest or pleasure in doing things?"			Sociodemographic (context): • Age • Days postpartum • Pregnancy complications • First-time mother • Psychiatric history • Relocated after pregnancy Environmental (impact): • Residential region (high radiation, evacuated region, low radiation)	• First-time mother ($p < 0.001$) • Pregnancy complications ($p < 0.001$) • Concern about radiation ($p < 0.001$) Depression (2013): • Age (younger) ($p < 0.001$) • Relocated ($p < 0.01$) • Psychiatric history ($p < 0.001$) • First-time mother ($p < 0.01$) • Pregnancy complications ($p < 0.001$) • Concern about radiation ($p < 0.05$)	
Grasmück & Scholz. (2005). Risk perception of heavy metal soil contamination by high-exposed and low-exposed	Quantitative (cross-sectional quasi-experimental)	n = 57. Ages 18-80, all genders, Switzerland. Residents near contaminated	Concern (current): • Survey questions on 8-point Likert scale: (1) "to what extent do	Cadmium	Compared to residents in the low-exposure area, those in the high-exposure area had significantly higher levels of concern ($p > 0.05$).	Sociodemographic (context): • Age • Gender • Number of children Intrinsic (impact):	Concern: • Dissonance reducing heuristics ($p < 0.01$) • Environmental concern ($p < 0.01$)	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
inhabitants: the role of knowledge and emotional concerns		site, divided into high-exposure and low-exposure groups.	you feel concerned about the contamina-tion problem?" (2) "to what extent are you emotionally involved?"			• Actual knowledge about contam-ination • Self-estimated knowledge • Desire for further knowledge • Dissonance reducing heuristics • Perceived need for dec-ontamination • Perceived risk to health Intrinsic (context) • Environmental concern	• Self-estimated knowledge ($p < 0.05$) • Desire for further knowledge ($p < 0.05$) • Perceived need for decontamina-tion ($p < 0.01$) • Perceived risk to health ($p < 0.001$)	
Greve et al. (2005). Psychological evaluation of the emotional effects of a community toxic exposure	Quantitative (case-control)	n = 228. Ages 18+ all genders, US. Claimants in a litigation resulting from a toxic spill in	Depression, schizophrenia and anxiety (current): • MMPI-2 Distress (current): • SCL-90-R	A range of toxic chemicals that are known carcinogens.	Compared to control group, residents involved in litigation had: • Higher levels of depression ($p < 0.001$)	NA	NA	Good

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
		Louisiana and an unexposed control group.			• Higher levels of anxiety ($p < 0.001$) • Higher levels of schizophrenia ($p < 0.01$) • Higher levels of distress ($p < 0.001$)			
Havenaar et al. (1996). Mental health problems in the Gomel region (Belarus): An analysis of risk factors in an area affected by the Chernobyl disaster	Quantitative (cross-sectional). 6 years after the event.	n = 1617. Ages 15-65, all genders, Belarus. Residents living in a town affected by radiation from Chernobyl.	Distress (current): • GHQ Clinical disorders (past month): • Munich Diagnostic Checklist to validate GHQ scores against DSM-III-R	Nuclear radiation	Compared to residents living in less contaminated zones, those in high contaminated zones had: • No significant difference in levels of distress or clinical disorders ($p > 0.05$).	Sociodemographic (context): • Age • Gender • Marital status • Employment • Mother of child younger than 18 Personal extrinsic (impact): • Evacuation	Distress: • Gender (female) ($p < 0.05$) • Age (old) ($p < 0.05$) • Evacuation ($p < 0.05$) • Mother of child younger than 18 ($p < 0.05$) Clinical disorders: • Evacuation ($p < 0.05$) • Mother of child younger than 18 ($p < 0.05$)	Fair
Koscheyev et al. (1997). The psychosocial aftermath of the Chernobyl disaster in an area of relatively	Quantitative (cross-sectional). 9 years after disaster.	n = 144. Ages 13-63, all genders, Ukraine. Residents living near Chernobyl.	Concern (current): • Russian Language Radiation Concerns	Nuclear radiation from power plant accident	55.3% of adults and 28.0% of adolescents were concerned about the radiation when they felt aches or pains in their body.	NA	NA	Poor

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
low contamination			Question-naire		64.9% of adults and 36.0% of adolescents were concerned about family members developing illness from the radiation.			
Kruger et al. (2017). Toxic trauma: Household water quality experiences predict posttraumatic stress disorder symptoms during the Flint, Michigan, water crisis	Quantitative (cross-sectional).	n = 786. Ages 18+, all genders, US. Residents living in Flint, Michigan, and broader region of Genesee County.	PTSD (lifetime): • Short Screening Scale for PTSD.	Lead.	Compared to other residents of Genesee County, Flint residents had significantly higher rates of PTSD ($p < 0.01$).	Sociodemographic (context): • Age • Gender • Education • Ethnicity Intrinsic (impact): • Perceived tap water quality	PTSD: • Age (younger) ($p < 0.01$) • Education (less) ($p < 0.01$) • Perceived tap water quality ($p < 0.001$)	Fair
Li & Zhou (2020). Effects of objective and subjective environmental pollution on well-being in urban China: A structural	Quantitative (cross-sectional)	n = 11,908. Ages 18+, all genders, China. Participants were those in a national survey who rated	Happiness and sadness: • Rated frequencies of happy and sad emotions they experienced	Solid waste, water and air pollution	Compared to participants who perceived environmental pollution around them as low, those who perceived it as high had significantly higher frequencies	Sociodemographic (context): • Age • Gender • Socioeconomic status • Education • Marital status	Happiness and sadness: • Self-rated physical health ($p < 0.01$) • Age (young) ($p < 0.01$) • Gender (female) ($p < 0.01$)	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
equation model approach		perceived environmental hazards around them.	in recent months on a 4-point scale		of sad emotions ($p < 0.05$). Compared to participants who lived in an environmental pollution free area, those who lived in a more polluted area had no significant difference in prevalence of happy and sad emotions ($p > 0.05$).	Intrinsic (impact): • Self-rated physical health	• Marital status ($p < 0.01$) • Education (more) ($p < 0.01$) • Socioeconomic status ($p < 0.01$)	
Matthies, Hoeger & Guski (2000). Living on polluted soil: Determinants of stress symptoms	Quantitative (case-control). 9 years after discovery of contamination, just as decontamination finished.	n = 415. Ages 20-70, all genders, Germany. Residents living in a contaminated area and a control group.	Stress (current): • Survey questions concerning sleep disorders and irritability	Benzopyrene, dicyclopentadiene, benzol, toluol, and xylol.	Compared to a control group, residents of contaminated site had significantly higher levels of stress ($p < 0.001$).	Sociodemographic (context): • Age • Gender • Children • Socioeconomic status • Education • Smoking Intrinsic (impact):	Stress: • Age (older) ($p < 0.01$) • Number of children ($p < 0.01$) • Perceived risk to health ($p < 0.001$) • Trust in management ($p < 0.001$)	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
						• Perceived risk to health • Trust in management Personal extrinsic (impact): • Actual exposure		
McIntyre et al. (2018). Sociodemographic predictors of residents worry about contaminated sites	Quantitative (cross-sectional)	n = 2009. Ages 18+, all genders, Australia. Residents living around 13 contaminated sites.	Worry: • Survey question on 11-point Likert scale: "How worried are you about contamina-tion at the site?"	Contaminants at sites included heavy metals, hydrocarbons, chlorinated solvents, waste, and asbestos.	Compared to residents of sites contaminated by asbestos, hydrocarbons and waste, residents of heavy metal sites had significantly higher levels of worry ($p < 0.001$).	Sociodemographic (context): • Age • Gender • Children • Socioeconomic status • Education • Tenure type • Language other than English	Worry: • Gender (female) ($p < 0.001$) • Age (35-75) ($p < 0.001$) • Socioeconomic status ($p < 0.001$) • Tenure type (rent) ($p < 0.05$) • Heard of contaminant ($p < 0.001$)	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
						Intrinsic (impact): • Heard of contaminant Intrinsic (context): • Sense of place Environmental (impact): • Proximity to contaminated site	• Language other than English ($p < 0.001$) • Children ($p < 0.01$) • Knowledge ($p < 0.001$) • Sense of place ($p < 0.01$)	
Messer, Adams & Shriver. (2019). Living with chronic contamination: a comparative analysis of divergent psychosocial impacts	Qualitative.	n = 105. Adults, all genders, US. Residents in contaminated regions (Canon City, n = 54; Blackwell, n = 51), and regulators and members of	Stress: • Resident descriptions through open-ended interview questions.	Zinc and cadmium, nuclear radiation	Residents reported that a range experiences relating to living with environmental contamination contributed to stress, as well emotions such as fear and helplessness.	Stress was reported by residents to be exacerbated by: • Uncertainty from poor management • Uncertainty around health effects • Community divide • Financial impacts • Lack of trust	NA	Fair

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		environmental organisations.				• False claims and poor institutional transparency. Residents reported stress was alleviated by: • Greater certainty in management and clean-up.		
Niitsu et al. (2014). The psychological impact of a dual-disaster caused by earthquakes and radioactive contamination in Ichinoseki after the Great East Japan Earthquake	Quantitative (cross-sectional).	n = 902. Ages 20-79, all genders, Japan. Residents in an area affected by an earthquake and nuclear accident simultaneously.	Distress (current): • Kessler Psychologi-cal Distress Scale (K6)	Nuclear (co-occurring with an earthquake)	Residents who perceived they had been exposed to radiation had significantly higher levels of distress ($p < 0.001$).	Sociodemographic (context): • Age • Gender • Employment • Education • House occupants Personal extrinsic (impact): • Property damage	Distress: • Age (older) ($p < 0.01$) • Gender (female) ($p < 0.01$) • Education (less) ($p < 0.001$) • Unemployed ($p < 0.001$) • Property damage ($p < 0.01$)	Fair
O'Leary & Covell. (2002). The Tar	Quantitative (case-control).	n = 510.	Depression (current):	Poly-nuclear aromatic	Compared to the control, students in	Sociodemographic (context):	Depression:	Good

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Ponds kids: Toxic environments and adolescent well-being		Ages 12-14, all genders, Canada. Students in a contaminated neighbourhood and a control group.	• The Children's Depression Inventory Worry (current): • Worries and Concern Index (15-item instrument)	hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs).	the contaminated region had: • Significantly higher levels of worry ($p < 0.01$) • No significance different in levels of depression ($p > 0.05$).	• Age • Gender • Employment • Education • House occupants Environmental (impact): • Proximity to contaminated site Intrinsic (context): • Environmental concern • Common adolescent worries Intrinsic (impact): • Perceived risk to health	• Age (older) ($p < 0.01$) • Environmental concern ($p < 0.01$) • Perceived risk to health ($p < 0.01$) • Common adolescent worries ($p < 0.01$) Worry: • Proximity to contaminated site ($p < 0.01$)	
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Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
Prior et al. (2019). A geography of residents' worry about the disruptive effects of contaminated sites	Mixed methods (cross-sectional with some qualitative open-ended questions)	n = 485. Ages 18-89, all genders, Australia. Residents living near 13 contaminated sites.	Worry (current): • Survey question asking participations on an 11-point Likert scale to rate "how worried are you about the contamination at the [site]"	Heavy metals, hydrocarbons, chlorinated solvents, waste and asbestos.	Compared to residents of sites contaminated by asbestos, those living with hydrocarbons, heavy metals and chlorinated solvents had significantly higher levels of worry ($p < 0.001$).	Sociodemographic (context): • Age • Gender • Children • Socioeconomic status • Education • Disability status Environmental (impact): • Proximity to contaminated site Intrinsic (context): • Sense of place Residents reported worry was affected by: • Possible health effects on them and others • Effects on environmental health • Damage to the home	Worry: • Gender (female) ($p < 0.001$) • Socioeconomic status (high) ($p < 0.05$) • Disability status ($p < 0.001$) • Proximity to contaminated site ($p < 0.05$)	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
Rehner et al. (2000). Depression among victims of south Mississippi's methyl parathion disaster	Quantitative (cross-sectional)	n = 115. Adults, all genders, US. Residents living within contaminated area divided into four levels of severity.	Depression (current): • CES-D	Methyl parathion (pesticide)	Compared to residents in the less severely contaminated areas, those in the more contaminated regions had no significant difference in level of depression ($p > 0.05$).	Sociodemographic (context): • Age • Gender • Ethnicity • Socioeconomic status • Education • Tenure type • Marital status Personal extrinsic (impact): • Period of exposure (time) Intrinsic (impact): • Self-rated physical health Regulation (impact): • Governmental involvement	Depression: • Gender (female) ($p < 0.01$) • Ethnicity ($p < 0.05$) • Socioeconomic status (low) ($p < 0.01$) • Longer period of exposure ($p < 0.001$)	Fair

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Sneed et al. (2020). Behavioral health concerns during the Flint water crisis, 2016–2018	Quantitative (longitudinal)	n = 180 (2016). n = 176 (2017). n = 193 (2018). Ages 18+, all genders, US. Residents in Flint, Michigan.	Depression: • PHQ-2 Anxiety: • Generalised Anxiety Disorder Scale (GAD-2) Distress: • Three-point scale asking how much stress participant was experiencing Fear: • Three-point scale asking how much fear participant was experiencing	Lead	Compared to the earlier period (2016), residents of contaminated region in the later period (2018) had: • Lower levels of depression ($p < 0.05$); • No significant difference in levels of anxiety ($p > 0.05$); • Lower levels of distress ($p < 0.05$); • No significant difference in levels of fear ($p > 0.05$).	NA	NA	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
Tang et al. (2016). Combined and Relative Effect Levels of Perceived Risk, Knowledge, Optimism, Pessimism, and Social Trust on Anxiety among Inhabitants Concerning Living on Heavy Metal Contaminated Soil	Mixed methods (predominantly cross-sectional survey, some semi-structured interviews)	n = 499 (survey). n = 15 (interviews). Ages 18+, all genders, China. Residents from villages in a contaminated region.	Anxiety (current): • State Anxiety Scale.	Heavy metals (copper, cadmium, lead and zinc)	Residents who perceived the contamination was a higher risk to their health had significantly higher levels of anxiety ($p < 0.01$).	Sociodemographic (context): • Age • Gender • Education • Employment Intrinsic (context): • Optimistic/ pessimistic Intrinsic (impact): • Trust in government • Knowledge of contaminant	Anxiety: • Age (older) ($p < 0.001$) • Employment ($p < 0.001$) • Trust in government ($p < 0.01$) • Pessimistic ($p < 0.01$)	Fair
Vandermoere (2006). The process of soil excavation in a community - Site-specific determinants of stress perception	Mixed methods (predominantly cross-sectional survey, some semi-structured interviews)	n = 98 (survey) n = 19 (interviews) Ages 22-79, all genders, Belgium. Residents near a contaminated site.	Stress (current): • Perceived Stress Scale (PSS).	Heavy metals and polyaromatic hydrocarbons.	Compared to residents in a zone about to undergo decontamination/ remediation, those in a zone that had already been decontaminated had significantly higher stress levels ($p < 0.001$).	Sociodemographic (context): • Age • Gender • Education • Socioeconomic status Intrinsic (impact): • Perceived risk to health • Perceived lack of knowledge • Perceived environmental impacts	Stress: • Gender (female) ($p < 0.01$) • Perceived lack of knowledge ($p < 0.01$)	Fair

Authors, date and study title	Type of study	Study population	Method/mental health measure	Type of contaminant	Mental health outcomes	Independent variables (factors)	Factors associated with mental health outcomes	Quality assessment
Vandermoere (2008). Psychosocial health of residents exposed to soil pollution in a Flemish neighbourhood	Quantitative (case-control)	n = 270. Adults, all genders, Belgium. Residents living in a contaminated area.	Distress (current): • GHQ Anxiety (current): • SCL	Heavy metals and polyaromatic hydrocarbons.	Compared to the control group, residents in contaminated region had: • Significantly higher levels of distress ($p < 0.001$) • No significant difference in anxiety levels ($p > 0.05$)	Sociodemographic (context): • Age • Gender • Education • Socioeconomic status Environmental (impact): • Decontamina-tion phase (completed or underway) Intrinsic (impact): • Perceived risk to health • Perceived environmental impacts • Perceived participation • Perceived need for remediation	Distress: • Decontamination completed ($p < 0.001$)	Fair

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Viinamaki et al. (1995). The Chernobyl accident and mental wellbeing – a population study	Quantitative (case-control). 7 years after event.	n = 603. Ages 17+, all genders, Russia. Residents near Chernobyl and a control group.	Distress (current): • GHQ	Nuclear radiation	Compared to the control group, residents near Chernobyl had significantly higher distress ($p < 0.05$).	Sociodemographic (context): • Age • Gender • Marital status • Socioeconomic status Social (context): • Social support Intrinsic (impact): • Uncertainty • Self-rated health	Distress: • Gender (female) ($p < 0.001$); • Age (old) ($p < 0.01$); • Unmarried ($p < 0.01$); • Socioeconomic status ($p < 0.01$); • Social support (poor) ($p < 0.05$); • Self-rated health ($p < 0.05$); • Uncertainty ($p < 0.01$).	Fair
Whiteman, Dunne & Burnett. (1995). Psychological and social correlates of attrition in a longitudinal study of hazardous waste exposure	Quantitative (longitudinal)	n = 251 (initial) n = 121 (follow-up after 7-8 months) Adults, all genders, Australia. Residents living near a contaminated site (comparing those who	Stress (current): • Stressful Life Events Inventory Distress (current): • GHQ • IES Worry (current): • 17 items relating to worry about	Hydrocarbons, organic lead and sulphuric acid	In the initial survey, compared to resi-dents who replied to the follow-up survey, those who did not reply at follow-up because they were uncontactable or had move away had: • Significantly higher levels of stress ($p < 0.05$)	NA	NA	Fair

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		responded to a follow-up survey 7-8 months after initial with those who did not, who were considered to have moved away or be uncontactable).	waste incident		• Significantly higher levels of worry ($p < 0.05$) • No significant difference in distress levels ($p > 0.05$) Compared to the initial survey, residents who were contactable at the follow-up had: • No significant difference in stress levels ($p > 0.05$) • Significantly lower levels of distress ($p < 0.01$) • No significant difference in worry levels			

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Zierold, Sears & Brock. (2016). Exposure-Reducing Behaviors Among Residents Living Near a Coal Ash Storage Site	Mixed methods (cross-sectional with small qualitative interviews component)	n = 26 (focus group). n = 231 (survey). Ages 18-72, all genders, US. Residents living near a large coal ash storage site.	Worry (current): • Survey question on 5-item Likert scale: "How worried are you about being exposed to coal ash?"	Coal ash storage site.	Compared to residents who believed they had not been exposed to the pollution, those who did perceive they had been exposed had significantly higher levels of worry ($p < 0.001$). A majority of residents reported that they were worried about exposure to the coal ash.	Sociodemographic (context): • Age • Gender • Tenure type • Smoking status Personal extrinsic (impact): • Period of exposure (time) Intrinsic (impact): • Perceived risk to health • Self-rated physical health • Exposure reducing behaviour	Worry: • Perceived risk to health ($p < 0.001$) • Exposure reducing behaviour ($p < 0.01$) • Self-rated physical health ($p < 0.05$)	Fair

Abbreviations:

BDI: Beck Depression Inventory

BSI: Brief Symptom Inventory

CES-D: Center for Epidemiological Studies-Depression Scale

DSM-III-R: Diagnostic and Statistical Manual of Mental Disorders, Third Edition, Revised

GAD: Generalised Anxiety Disorder

GHQ: General Health Questionnaire

GSI: Global Severity Index

IES: Impact of Events Scale

K6: Kessler Psychological Distress Scale

MDD: Major Depressive Disorder

MMPI-2: Minnesota Multiphasic Personality Inventory-2

PAH: Poly-nuclear aromatic hydrocarbons

PFAS: Per- and poly-fluoroalkyl substances

PHQ: Patient Health Questionnaire

PCB: Polychlorinated biphenyls

PSS: Perceived Stress Scale

PTSD: Post Traumatic Stress Disorder

SCL: Symptom Checklist