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How does living with a disability affect resident worry about environmental contamination? A study of a long-term pervasive hazard

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How does living with a disability affect resident worry about environmental contamination? A study of a long-term pervasive hazard

While a growing body of research within the environmental hazards scholarship examines how disability affects human responses to major, sudden-onset environmental disasters, little attention has been given to understanding how disability affects responses to long-term, pervasive environmental hazards. Research analysing human responses to land and groundwater legacy contamination in residential areas has drawn attention to the prevalence and impact of worry within the chronic hazard context. Although this research identified the significance of demographic and psychosocial determinants of worry, the question of how living with a disability affects resident worry about contamination remains unanswered. This article provides a cornerstone study for exploring the relation between worry about environmental contamination and disability. A study of 486 adults living in 13 urban residential areas in Australia affected by a range of contaminants was undertaken in 2014. Ordinal logistic regression analysis found respondents with a disability were significantly more likely to worry about contamination than those without. People living with a disability had significantly higher amounts of worry about the contamination than those living without. The findings about residents' changes to daily habits in response to the contamination and perceptions of personal control over exposure to the contamination present important considerations for understanding the implications of worry for people living with and without a disability in the environmental contamination context. Worry about perceived risks associated with environmental contamination may be reduced through tailoring public health information to the concerns of specific population groups, including people living with disabilities.

Keywords: Disability; Worry; Environmental Contamination; Pervasive Hazard; Australia

Introduction

People living with a disability have been found to be more likely to experience negative health and quality-of-life impacts as a result of exposure to sudden-onset, major forms of

hazards, such as earthquakes and hurricanes, compared to those who live without disability (Abbott & Porter, 2013; Kelman & Stough, 2015; Twigg, Kett, Bottomley, Tan, & Nasreddin, 2011; Wisner, Blaikie, & Cannon, 2004). Recent scholarship examining human responses to long-term land and groundwater contamination in residential areas from former industrial activity has drawn attention to the presence, significance and impact of worry and its sociodemographic determinants within the long-term pervasive hazard context (McIntyre, Prior, Connon, Adams, & Madden, 2018; Prior, Hubbard, & Rai, 2017). However, there is little understanding of how people living with a disability respond to slow-onset, long-term, pervasive (i.e. chronic) environmental hazards, including worry about contamination. This paper addresses this shortcoming by examining the relations between people living with a disability and their level of worry about nearby environmental contamination.

Environmental contamination from industrial activity presents a significant risk to urban public health (Fazzo, Minichilli & Santoro et al., 2017). An estimated 61 million people worldwide are affected by heavy metals and toxic chemicals from contaminated sites (Landrigan et al., 2017), with exposure being responsible for the ill health of hundreds of thousands of people (Landrigan, Fuller, & Horton, 2015). Given that more than two-thirds of the world's population are predicted to be living in urban environments by 2050 (World Health Organisation, 2016), understanding and addressing the impacts of environmental contamination on health are crucial for improving public health outcomes (Mudu, Terracini, & Martuzzi, 2014).

The impact of environmental contamination on human health and quality-of-life has been increasingly acknowledged, with an emphasis on understanding how sociodemographic factors influence responses to environmental contamination (Ahmad, Morshed Ahmad, Sadia, & Ahmad, 2017; Ajibade & McBean, 2015; Cutter, Barnes, & Berry et al., 2008; Few & Tran, 2010; Israel, Schulz & Estrada-Martinez et al., 2006; Mansfield, 2012; McIntyre et al., 2018).

Children, the elderly, people of low socioeconomic status and ethnically marginalised groups are recognised as being most vulnerable to the objective health risks associated with environmental contamination (Gershon, Portacolone, & Nwankwo et al., 2017; Litt & Burke, 2002; Ochodo, Ndetei, Moturi, & Otieno, 2014). The long-term effects of contamination on physical and mental health have also been increasingly acknowledged within environmental contamination health policy (Australia Environmental Health, 2012), and in remediation engagement guidelines (Heath, Pollard, Hurdey, & Smith, 2010). There have been efforts to improve health and risk communication practices (Litt & Burke, 2002); however, it is unknown if information provided is meeting the needs of people living with disabilities (Turner 2016, in Sparf, 2016, p245; Wolbring, 2009).

According to *The International Classification of Functioning, Disability and Health* (World Health Organisation, 2011), disability refers to “impairments, activity limitations and participation restrictions present for 6 months or more and affect a person’s daily life”. Disability is therefore not just a health problem, but a dynamic interaction between the person affected and the wider contextual environment (Martin, 2013). Living with a disability represents a critical consideration in the context of environmental hazard risk given that over 15% of the global population have some form of disability (WHO, 2011). These numbers are expected to rise over the next 50 years (Lunenfeld & Stratton, 2013).

Long-term pervasive environmental hazards are not associated with immediate threats to life like sudden-onset disasters such as earthquakes, but with long-term health and quality of life impacts (Ochodo, Ndetei, Mouturi, & Otieno, 2014). The research on disability and hazards is primarily concentrated on the *actual* (objective) risks to health, rather than the importance of *perceived* (subjective) risk in shaping responses to hazard threats (Couch & Coles, 2011; Landrigan et al., 2017). Perceived risk is understood as awareness of the existence of a hazard and contains “both realist and relationist dimensions” (Mythen 2004, p

99); meaning that although perceptions of risk may be influenced by the presence of an actual risk, an individuals' perceptions of a threat may not correspond to the actual risk. This is because sociocultural factors shape individual beliefs and can sway their response (Mythen, 2004, p99). The few studies that have examined disability and perceived risk have identified the role of individual belief formation, agency, and decision-making in shaping responses to environmental hazards (Engelman, Ivey, Tseng, & Neuhauser, 2017; Gershon et al., 2017; Marceron and Rohrbeck, 2019). For example, Gershon et al.,'s (2017) study of 'hazard anxiety' concludes that hazard anxiety is more likely to be present amongst people living with disabilities compared to the general population.

Self-efficacy also affects the way people respond to environmental hazards. Self-efficacy (i.e. control belief) reflects the extent to which a person believes in their ability to carry through courses of action and determines whether individuals will be able to display coping abilities (Bandura 1997, in Fridberg & Gustavsson, 2017). The combination of self-efficacy and a person's actual control (i.e. available resources) influence how a person behaves in a specific situation (Ajzen, 1991). Consequently, self-efficacy is an important consideration in how people with disabilities respond to both perceived and actual risks in an environmental hazard context. For example, two studies (Engelman et al., 2017 & Marceron & Rohrbeck, 2018) focused on major, sudden-onset, environmental hazards found high levels of self-efficacy were associated with emergency preparedness amongst people with disabilities. Research is needed to determine the role of self-efficacy in how people living with disabilities respond to pervasive hazards.

Recent studies on responses to pervasive hazards have focused on the influence of worry in how people respond to industrial contamination. Worry is a cognitive state and is defined as "a chain of thoughts and images, negatively affect-laden and relatively uncontrollable" that "represents an attempt to engage in mental problem-solving on an issue

whose outcome is uncertain but contains the possibility of one or more negative outcomes” (Borkovec et al., 1983, p10). Worry is understood as involving an emotional dimension and is a characteristic feature of anxiety, but differs from anxiety which is generally an affective state (Ruscio & Borkovec, 2004). Worry has been described as an important consideration within contemporary ‘risk’ societies, because human beings are future-orientated and uncertainty about the future can potentially dominate people’s thoughts, emotions, and behaviours (Sjoberg 1998, p86). Worry can be understood as a key mechanism that people use to address both perceived and actual risk (Prior et al., 2017), and is shaped by individual psychosocial factors (Borkovec et al., 1983).

Worry has significant implications for health and wellbeing, with higher levels associated with direct and indirect negative health and quality of life impacts, which may or may not manifest physiologically (Andrea et al., 2004). Excessive or prolonged worry over time is associated with the development of anxiety disorders (Andrea et al., 2004). Worry is more likely to become pathological in uncertain situations with potentially negative outcomes, as in the case of environmental contamination (Hirsch & Mathews, 2012). Pathological worry is characterised by chronic, excessive and uncontrollable worry that involves repetitive to obsessive thinking about potential negative outcomes that may result from the object of worry to the extent that it induces significant mental distress (Hirsch & Mathews, 2012). The thresholds separating pathological worry from less harmful levels of worry are: preoccupation with thinking about the worry, experiencing a sense of a loss of control of one’s life as a result of the worry, hypervigilance to the perceived threat, a tendency to view normal stimulus as threatening, and significant behavioural change to the extent that attempts to avoid the object of worry interfere with normal daily functioning (Borkovec, Sadick & Hopkins, 1991). Pathological worry is also negatively associated with active, problem-focused coping (Davey, 1994).

Most of the research examining the long-term health impacts of environmental hazards amongst the general population focuses on the development of objective physical and mental health conditions, such as clinical depression (Cuthbertson, Newkirk, Ilardo, Loveridge, & Skidmore, 2016; Ochodo et al., 2014), but this can be argued to undermine the interplay between physical and mental health and quality-of-life outcomes (Aldred & Jungnickel, 2013; Alessa, Kliskey, Busey, Hinzman, & White, 2008; Bickerstaff & Walker, 2003). This is because the adverse effects that excessive worry can have on a person's health over time are not restricted to their physical and mental health, but their ability to 'flourish' more generally (Fleuret & Atkinson, 2007; Stefanovic, 2008). This occurs because a person's wellbeing and everyday lifeworld mutually presuppose and afford each other (Stefanovic, 2008), with the need for a safe environment for everyday life being particularly important for overall wellbeing (Smith, 2012). Contamination can negatively affect people's 'normal' assumptions about life, particularly about health, personal control, home, and environment (Edelstein 2004); thus, the perceived safety of a resident's lifeworld can be disrupted, diminishing its ability to accommodate 'human flourishing' (Fleuret & Atkinson, 2007, p109).

While research suggests that worry can have negative health outcomes (Hirsch & Matthews, 2012), other research has shown that worry within the normal range can play a critical role in adaptive decision-making, with an appraisal of impending negative thought or danger allowing inner preparation for a subsequent threat or danger stimulus (Floyd, Prentice-Dunn, & Rogers, 2000; Shreve, Begg, Fordham & Müller, 2016; Waters, 2008). Although a state of worry may be fleeting, its influence on a person's decision-making and response actions can endure after the worrying has ceased (Andrade & Ariely, 2009). In instances where the actual health risks of exposure to environmental contamination are uncertain, worry about perceived health risks may promote positive adaptive behaviour to

minimise exposure (Floyd et al., 2000; Renn, 2004). Furthermore, engagement in risk protective behaviours is also associated with enhanced perceptions of control over exposure (Lazarus & Folkman, 1984; Renn, 2004).

Self-efficacy is important within the context of chronic contamination as it influences abilities to actually carry out positive adaptive behaviours that minimise exposure (Butterfield, Hill, Postma, Butterfield, & Odom-Maryon, 2011; Engelman et al., 2017). Low self-efficacy is associated with low adaptive capacity and greater fatalistic perceptions (Butterfield et al., 2011), while high self-efficacy is associated with greater perceived ability to undertake positive behaviour change to respond to the source of worry (Butterfield et al., 2011). Therefore, while high levels of worry may positively influence the desire to undertake health protective behaviour, low self-efficacy may have a negative effect on whether an individual can make behavioural changes in order to respond to threats (Butterfield et al., 2011; Oneal, Odom-Maryon, Postma, Hill, & Butterfield, 2013). The combination of heightened recognition of exposure and perceived inability to act may also lead to perceptions of loss of control, increased pessimism, or unhelpful defence mechanisms such as denial (Lazarus & Folkman, 1984). A lack of resources or support may also negatively influence self-efficacy and ability to act upon worry by adopting health protective behaviours (Floyd et al., 2000).

Research has identified a diversity of factors that influence residents' level of worry about environmental contamination beyond the contaminant itself. These include socio-demographic factors (Couch & Coles, 2011; Freudenburg & Davidson, 2009), level of knowledge and understanding about the contamination at the site (McIntyre et al., 2018), physical environmental contextual factors (Bonaiuto, Alves, De Dominicis, & Petrucci, 2016), institutional contextual factors: influence of mainstream media, and attitudes and responses of health authorities, governments and industrial organisations (Prior et al., 2017).

Key findings from this research are that females, including mothers with children residing at home, are more likely to worry about environmental contamination compared to males (Couch & Coles, 2011; Powell, Dunwoody, Griffin & Neuwirth, 2007). Higher levels of education and income are associated with less concern about environmental hazard risks (Slimak & Dietz, 2006), while lower incomes are linked to higher levels of worry about contamination (Powell et al., 2007). One study examining worry about remediation of contaminated sites found that residents aged 75 and over or under 35 were more likely to be worried about remediation than those aged between 35 and 74 (Prior et al., 2017). Physical proximity of residents in relation to a contaminated site and having a strong sense of place—how specific physical locations have socially constructed meanings for residents—has been associated with lower degrees of worry (Burningham & Thrush, 2004; Venables et al., 2012), while contaminant type (e.g. heavy metal, hydrocarbon, waste or solvent) has also been shown to predict worry (Elliott et al., 1999). Greater level of knowledge about the contaminant is associated with lower levels of worry (McIntyre et al., 2018, Powell et al., 2007), while the media may either downplay or amplify the perceived threat of a particular risk (Janmaimool & Watanabe, 2014, Shepherd, 2012). Research has also shown how low baseline levels of trust in government and industry is associated with higher levels of worry about contaminated site remediation (Prior et al., 2017).

Despite the body of research into the predictors of worry related to environmental hazards, it is unknown how living with a disability influences worry in this context. Understanding the association between disability and worry is important given that the management of contaminated sites and remediation need to recognise the value of engaging diverse stakeholder experiences in order to produce more holistic, sustainable approaches to the management of contaminated sites (McIntyre et al., 2018). Furthermore, failure to engage

with the experiences of people living with disabilities risks contributing to the marginalisation of people with disabilities in policy and practice (Wolbring, 2009).

This study aims to address the existing knowledge gap and contribute to the understanding of the relation between living with a disability and worry in three ways. First, it examines the relations between disability, demographic and psychosocial characteristics, physical environmental factors, and worry about environmental contamination in adults residing in 13 contaminated urban sites across Australia. Second, it aims to describe the most predominant issues of worry in people living with disabilities in the long-term environmental contamination context and how these might compare to those without disabilities. Third, our study compares behavioural responses to contamination between people living with and without disabilities and discusses the implications of this for considering potential responses to worry within this context.

Methods

Participants, recruitment and procedure

This was a sub-study analysis of a cross-sectional study that collected data from a random telephone survey and follow-up online questionnaire from 486 adults aged 18 years and over (approximately 19% of the total eligible residents). Participants lived near 13 contaminated urban sites in New South Wales, South Australia, Australian Capital Territory, Tasmania, Queensland, and Victoria. These sites were chosen because Australia's cities are significantly affected by land and groundwater contamination from decades of industrial activity and inadequate environmental management (Litt & Burke, 2002). Purposive sampling was used to select the sites, with suitable locations being identified through consultation with the Australian Remediation Industry, each state's Environmental Protection Agency, and the

Australian Land and Groundwater Association. A range of environmental contaminants, including heavy metals, chemicals, chlorinated solvents, hydrocarbons, asbestos and putrescible waste, were known to have affected each location. The larger study examined the experiences of 2009 residents living near contaminated sites across Australia in order to improve resident engagement with the remediation of contaminated lands in New South Wales Australia.

Participants were randomly selected from a database of residents living in neighbourhoods near the contaminated sites. This offered an inclusive approach that enabled an extensive number of stakeholders to participate. The survey was conducted using computer-assisted telephone interviewing (CATI) software to enable direct recording of data and to control for logically incorrect answers. This also enabled interim reporting to ensure data was accurately recorded and provided built-in logic to enhance data accuracy and branching logic to direct interviewers through the questionnaire. Surveys were completed between 24 March and 30 September 2014 by 12 researchers who would call residents between Mondays and Thursdays from 15:30 to 20:00. If calls went unanswered up to five further attempts were made. Survey completion time varied from 10 to 38 minutes; averaging 20.4 minutes. The online survey was conducted between 2014 and 105. The study was approved by The University of Technology Sydney Human Research Ethics Committee. All participants provided informed consent prior to engaging in the survey.

Participant characteristics are described in **Table 1**.

Questionnaire and measures

Contaminant type

Respondents were read an outline of the contaminant found at the site near their neighbourhood. These included heavy metals, hydrocarbons, chlorinated solvents, waste, and

asbestos. The site was also identified. Specific health risks associated with each type of contaminant were not identified to avoid influencing responses. Contaminant types were categorised into five 0/1 dummy variables with value 1 if the contaminant discussed was classified as a hydrocarbon, metal, chlorinated solvent, waste, or asbestos. No potential consequences, including the health risks, related to the presence of the contaminant were described in order to avoid influencing the responses to the questionnaire.

Worry about contamination

Participants were asked the question “How worried are you about the contamination at the [site]?” to determine their level of worry. This was rated on an 11-point Likert type scale from 0 (*Not at all worried*) to 10 (*Extremely worried*).

Disability status

Disability status was determined by the following question: “Do you regularly need help with daily tasks because of long-term illness or disability?”, with response options: *Yes*, *No*, or *Prefer not to answer*. Those who answered *Yes* were considered to have a disability.

Participants were not asked to disclose any pre-existing mental or physical health conditions, as the study was designed to show how levels of worry about contamination were distributed across the population rather than how worry may be amplified as a result of pre-existing health conditions in specific population groups, including people with disabilities. The wording of the question focuses on quality-of-life impacts of living with a disability rather than specific type of disability. This may also help minimise unwillingness to disclose disability due to stigmas associated with disability and mental ill health (Philo, Parr, & Burns, 2003). This also avoids undermining the interplay between physical and mental disability for overall wellbeing (Gleeson & Kearns, 2001). Participants disability status was categorised

into a 0/1 dummy variable with value 1 if disability (including long-term illness) status was Yes.

Demographic variables

The survey collected demographic information including age, gender, level of education, and household income. For the regression analysis education level was categorised into a 0/1 dummy with value 1 if the respondent had a university degree or higher. Gender was categorised into 0/1 dummy with value 1 if the respondent is male. Age was categorised into three 0/1 dummy variables with value 1 if the respondent is under 35, aged 35-54, or 55+. Income was categorised into four 0/1 dummy variables for household income between \$0-\$40k p.a., \$40-\$80k p.a., \$80-\$120k p.a., and over \$120k p.a (AUD).

Environmental variables

Sense of place was measured using two items: “I feel like I belong to the community where I live”, and “For me, this is the ideal place to live”, which were found to be highly (0.87) correlated. These items required a response on an 11-point Likert type scale with higher values reflecting stronger agreement. To measure proximity to site, location data in the form of latitude and longitude coordinates for the home of each respondent was collected. Polygons were created for the boundaries of each contamination site using geographic information system (GIS) software. The minimum Cartesian distance (minimum distance between the respondent’s home and the contaminated site boundary) was used as a measure of physical proximity to contaminated sites.

Belief about personal control over contamination

Participants' belief in their personal ability to control the potential impacts of exposure to contaminants was examined by the question: "How much personal control do you feel you have over your own contact with the contamination at the site", on an 11-point Likert type scale (0 = *No control* to 10 = *Total control*), with higher values reflecting a greater amount of perceived control. For the regression analysis this variable was categorised into a 0/1 dummy with value 1 if the respondent believed they had a low level of control over the contamination.

Issues influencing worry

To determine the most important issues that may influence worry relating to neighbourhood contamination, participants were asked the following open-ended question: "What is the first thought or image that comes to mind when you think of the contamination at the site?" This question was chosen as it enables participants to define the key issues associated with contamination that concern them in their own words, thus avoiding researcher bias in identifying possible issues of worry, and allows the most urgently pressing or concerning issues to be readily identified.

Behaviour change in response to the contamination

To examine behavioural responses to the presence of contamination the question: "Have you changed any daily habits since becoming aware of the contamination at the site", where participants could answer *Yes*, *No*, or *Don't know*. Participants who answered *Yes* to this question were then asked to answer in their own words, "Briefly describe what daily habits have you changed since becoming aware of the contamination at the site?"

Data analysis

IBM SPSS for Windows version 25 and R software (R Development Core Team, 2011) were used to analyse data. Descriptive statistics were used to report frequencies and percentages. Ordinal logistic regression was used to determine the predictive influence of disability status on the dependent variable level of worry about contamination. The confounding variables (age, gender, income, education level, proximity to site, sense of place, contaminant type, belief about level of control over the contaminant) were chosen as feasible predictors found in broader environmental hazards research (Ochodo et al., 2014; Powell et al., 2007; Venables et al., 2012). Chi square analysis tested differences in proportions between categorical variables. Difference between two groups on a continuous variable was determined by an independent t-test, or Welsh's t-test if homogeneity of variances was violated.

Open-ended questions were analysed through a process of coding according to thematic content, in a ground-up, evidence-based approach to the development of theory (Strauss and Corbin, 1998). Coding for answers to the question "What is the first thought or image that comes to mind when you think of the contamination at the site?", was undertaken manually at two levels. First, responses were coded according to the main issues raised by participants, which were used to develop five main categories: "Environmental health", "Human health and wellbeing", "Political issues", "Other negative issues", and "Other". These were then given secondary codes to organise data under each main category into a series of sub-categories to provide greater insight into specific topics of immediate concern. Responses to the question "What daily habits have you changed since becoming aware of the contamination at the site?", were manually coded according to types of behaviour changes raised by participants' in their answers to the question and subsequently used to develop seven categories as reported in the results. Comparison was then made of reported behavioural changes according to participant disability status.

Results

Disability status and worry about contamination

The majority of participants (n = 402, 82.8%) reported that they did not live with a disability, compared to 16% (n = 79) who reported living with a disability. Five participants chose not to answer. More females (n = 46, 59%) than males (n = 32, 41%) reported living with a disability. People living with a disability reported a higher mean level of worry about contamination (M = 8.67, SD = 1.35, Min 5, Max 10) than those who did not report living with a disability (M = 5.26, SD = 2.72, Min 0, Max 10). The difference between groups was statistically significant (CI 2.79, 4.03; p = .000).

Belief in ability to personally control exposure to contamination

Participants in this study reported a low level of perceived personal control over their contact with the contamination (M = 3.16, SD = 3.36, Min 0, Max 10). An independent t-test revealed there was no significant difference (p = .96) between people living with a disability (M = 3.17, SD = 3.67) and those without a disability (M = 3.14, SD = 3.30) in their level of perceived control over exposure to the contaminant.

Predictors of worry about contamination

The ordinal logistic regression found people who reported having a disability were significantly more likely to worry about contamination compared to those that did not (OR 12.49; 95% CI 7.58, 20.58; p = .000). The results indicate that disability is a strong predictor of worry about environmental contamination amongst residents living in neighbourhoods affected by land and groundwater contaminants. The variables gender, income, control belief,

and proximity to site were all significant predictors of worry about contamination. Females were more likely to worry about contamination than males (OR 0.43; 95% CI 0.29, 0.65; $p = .000$), as were those with a moderate income (\$80K to \$120K p.a. AUD) compared to people on a higher income (over \$120K p.a.) (OR 1.87; 95% CI 1.06, 3.30; $p = .02$).

Residents who had a low amount of control belief compared to those with a high amount of perceived control over exposure to the contaminant were significantly more likely to worry about contamination (OR 2.24; 95% CI 1.35, 3.70; $p = .000$). Similarly, those who lived closer to a contamination site were significantly more likely to worry compared to those living further away (OR 1.36; 95% CI 1.03, 1.80; $p = .03$). Three contamination types were found to be significant predictors of worry; the presence of hydrocarbon, metal, and chlorinated solvent was more likely to cause worry about contamination than asbestos (see **Table 2**).

Key foci of participants worry

A slightly higher proportion of respondents who reported living with a disability (95%, 75 out of 79) compared to those who did not (84%, 335 out of 401) indicated words, images and short phrases that were negative, which indicated that the contamination represented an unwanted and ongoing source of concern, such as expressions of the contaminant being troublesome or worrying. These negative expressions by participants who reported living with a disability were used to describe particular environmental, health, or political issues as source of prominent concern.

Of participants living with a disability, a greater percentage mentioned worries or concerns about the impact of contamination on the health of the environment (63%, 50 out of 79) compared to participants without a disability (52%, 209 out of 401). The specific issues

of worry were similar as they all included concerns about the impacts on water, soil, air, and flora and fauna.

A greater proportion of participants with a disability were also more likely to mention worries or concerns relating to the human health impacts of environmental contamination (92%, 73 out of 79) than participants without a disability (65%, 259 out of 401). A broad range of concerns about health were evident in the statements, including the risk of specific diseases and impairments, such as “brain impairment” that can result from contact with the contamination, concern about a general “threat to human life”, worries that the health risks are unknown and undetectable thus could lead to an “undetectable slow death”, and concern that specific activities at the site of contamination have health risks that could result from “digging up soil that could be contaminated with dust flying through the air”.

In contrast, a lower proportion of participants living with disabilities (10%, 8 out of 79) compared to those without a disability (20%, 80 out of 401) described concerns about political factors. Specific areas of concern included the role and activity of corporate bodies and industry, the roles and actions taken by the Government, and general concerns about questions of responsibility over the contamination. See **Table 3** for detailed frequencies of participant responses.

Behaviour changes in response to awareness of the contamination

Of the participants living with a disability, 11% reported changing their daily habits because of contamination in their neighbourhood, which compared to 9% of those without a disability. Chi square analysis found no significant difference in probability distributions between those who were and were not living with a disability and change in daily habits (see **Table 4**). The most common behaviour changes that both groups reported were similar and included:

- Deliberately avoiding the area in order to reduce exposure to the contaminant.
Expressions of avoidance were indicated in statements amongst both those with disabilities and those without disabilities, such as “I avoid the general area of the sites”, “I avoid walking or driving near the site because of building dust”, and “I avoid going near the area of concern”.
- Changes to food and water consumption practices involved filtering or not drinking tap water and not eating fruit or vegetables grown in the area.
- Three participants with disabilities (33.3%) and 7 (20.6%) those without disabilities also indicated that they made changes to their recreational pursuits because of contamination, including walking behaviours, gardening and fishing activities.

See **Table 5** for full results.

Discussion

This is the first known study to explore how living with a disability affects worry in the land and groundwater long-term environmental contamination context. People reporting a disability were significantly more likely to worry about contamination compared to those without a disability.

It is important to consider the influence of the confounding variables in the regression model, as these may help explain the variance in worry. This is necessary considering the large confidence interval for the odds ratio for disability as a predictor of worry about contamination. A number of demographic factors were found to be significant predictors of resident worry. Women were significantly more likely to worry than men. This corresponds with the findings from previous studies exploring the link between gender and worry about environmental contamination (Powell et al., 2007). Those in the higher income brackets

(\$80K-\$120K p.a. AUD) were found to be more likely to worry about contamination, which aligns with remediation technology research that found residents with higher income were more likely to worry than others (Prior et al., 2017). Findings from previous research suggests this might be explained by those with a higher income being better educated and having more knowledge of the risks associated with contaminants (Powell et al., 2007). Yet, our study found that university education was not a significant predictor of worry, so the reasons for greater worry amongst those with higher incomes requires further examination. Finally, age was not found to predict worry, contrasting with previous studies showing older and younger aged adults being more likely to worry about the remediation of contaminated lands (Prior et al., 2017).

Three contamination types were found to be significant predictors of worry, with greater levels of worry being associated with hydrocarbons, metals, or chlorinated solvents, when compared to asbestos. This finding is consistent with research reporting that contaminant type is predictive of degree of worry associated with contamination remediation technologies (Prior et al., 2017), and may reflect the “invisible” nature of hydrocarbons, metals, and chlorinated solvents compared to asbestos and waste (Prior, Gorman-Murray, McIntyre, et al., 2019).

Our study found that people who lived in closer proximity to contaminated sites were more likely to worry about contamination compared to those living further away. This is consistent with previous research exploring proximity and worry (Burningham & Thrush, 2004). Sense of place was not a significant predictor of worry, which contradicts previous research reporting that people with a stronger sense of place within a residential environment are more likely to worry about contamination remediation technologies (Prior et al., 2017). This study also provides insight into the possible predominant foci of worry amongst people living near contaminated sites. Human health issues were the most commonly identified

cause of concern amongst both people living with and living without disabilities, with a slightly higher proportion of people living with a disability focusing on health issues. A possible reason for this finding is that people living with disabilities (and existing chronic health) may be more conscious of the possible health risks associated with the contamination and the impact of the contamination on pre-existing health conditions.

Changes to daily habits and routines provide insights into how people may positively adapt their behaviour in order to respond to worry about the health impacts associated with contamination by minimising the risk of exposure to the contamination (Butterfield et al., 2011). This study showed that a similar proportion of participants living with and without disability made changes to their daily routines. From this, it can be inferred that people with disabilities are potentially no less likely to be able actively undertake adaptive behaviour in order to minimise harm from a perceived or actual hazard given that worry, within the normal range, is known to play a critical role influencing adaptive decision-making and action (Shreve et al., 2016). This is an important consideration to make when examining the implications of higher levels of worry amongst people with disabilities. It may be the case that they are just as likely to use their worry in decision-making to adapt their lives around the contamination and to limit exposure to risks than their non-disabled counterparts. This is an area for future research.

The higher levels of worry found amongst people with disabilities in our study may imply that over long periods of time they may be potentially at greater risk of developing pathological forms of worry. Higher levels of worry are implicated in the development of pathological worry and anxiety disorders (Borkovec, Sadick & Hopkins, 1991). However, this may not always occur as this study showed that avoidance behaviours aimed to minimise exposure to the source of worry did not interfere with normal daily functioning and instead

reflected positive adaptive practices undertaken to ensure the continuation of normal daily activities.

The perception of having personal control over the ability to limit exposure to a source of risk is associated with greater ability to successfully execute adaptive health behaviours (Butterworth et al., 2011). However, this perception of control is also affected by actual control (i.e. resource availability) (Floyd et al., 2000). Previous research focusing on disability in relation to environmental hazard responses suggests that people living with disability are less likely to adapt in response to environmental hazards given existing inequalities in the distribution of resources and the unequal position of people with disabilities in society more generally (Priestley & Hemingway, 2006). This is because these inequalities can lower perceptions of ability to control exposure to hazards and decrease actual ability to respond (Priestley & Hemingway, 2006). Our findings show that significant numbers of participants with disabilities believe they have low control over limiting their exposure to contamination. This has important implications for understanding the possible consequences of increased worry amongst people living with disability. This low perceived ability to limit contact with the contamination could potentially impede the possible adoption of adaptive action in response to higher levels of worry and increase the risks of despondency and pessimism associated with living in areas affected by contamination (Lazarus & Folkman, 1984). This has important implications for public health communications and for disaster risk reduction, as it may be that having greater access to knowledge about how to limit exposure may help to promote adaptive action and a higher perceived ability to control exposure. However, it is important to note that on average, participants in our study reported having low levels of perceived control. This suggests that disability itself does not influence perceptions of personal control over contact with contamination.

Recommendations

The findings present important implications for the development and implementation of strategies for public health hazard risk information in the context of contaminated environments. It is important that meaningful and accurate information about objective health risks associated with contamination is specifically developed and tailored to the needs of specific population groups, including those with disabilities, for each individual contaminated site.

Failure to engage with and address the experiences of people with disabilities could be argued to risk disseminating information that inadequately meets their needs (Gleeson & Kearns, 2001). Also, failure to engage people with disabilities in the development of contaminated land management strategies could also risk perpetuating existing inequalities of representation in policy and practice (Gleeson & Kearns, 2001).

People with disabilities may however be more distrustful of information disseminated by official organisations as a consequence of having their needs and opinions previously ignored or undermined (Scully, 2013; Twigg et al., 2011). Many of the current environmental hazard response management models continue to place people with disabilities together with other population groups within a single category of ‘vulnerable people’ (see Twigg et al., 2011). Efforts should instead be made to address concerns raised by people with disabilities in a way that avoids merging their concerns with the concerns raised by members of other vulnerable population groups. Experts should also avoid using data about actual risks in deliberate attempts to encourage people to stop worrying about perceived risks, as this can result in community members feeling that what they perceive to be legitimate claims to their concerns are being ignored (Sandman, 2008). However, important information about actual health risks should not be concealed from the public either, as this is likely to result in further breakdowns of trust (Kuchinskaya, 2012). Effort must therefore be made to identify the most

trusted of sources for health risk information to facilitate effective dissemination (Smillie & Blissett, 2010).

This study presents important implications for policy-makers involved in the remediation of contaminated lands. Currently, many of the Australian regulatory documents used by organisations fail to reflect specific awareness of how disability may feature in shaping resident responses to environmental contamination (Agate & Clarke, 2016; National Environment Protection Council, 1999). New understandings about the relations between disability and worry and indications of the possible issues of worry amongst people with disabilities should prove helpful for improving existing policy documents, including the National Environment Protection Council, and the New South Wales Government Office, which decision-makers draw upon when developing their official plans for responding to environmental contamination. This is particularly important given that studies in the sustainable remediation context found that recommendations for improving remediation practices are less likely to be fully endorsed by internal and external stakeholders until they have been embedded in regulatory, institutional documents (Hou, Al-Tabbaa, Chen, and Mamic, 2014). Therefore, ensuring that the needs of people with disabilities are successfully incorporated into developments in remediation practices requires the prioritisation of policy and regulatory document reform.

Limitations

This study provides a cornerstone for further research into the relationship between disability and response to environmental contaminants. However, there are important limitations that require note. The breadth of the study across 13 Australian case study sites shows the findings are not isolated to a specific case study site. Yet, this design also means our findings may not be generalisable beyond the Australian context.

The survey questions are limited to providing an overview of the respondents' immediate thoughts feelings towards the issue in question. Conducting face-to-face semi-structured follow-up interviews with participants may elucidate valuable and more in-depth information about the reasons for increased levels of worry amongst people living with disabilities. Furthermore, while the study aimed to be as inclusive as possible, participation was dependent upon ability to independently operate a telephone. Consequently, people with certain disabilities (e.g., those with profound hearing impairments or speech difficulties without ready access to assistive technology) may have been unable to participate. Electronic communication of the survey in text form and pre-arrangement of telephone calls to enable participants to organise assistance to enable them to participate could have enhanced inclusivity.

Suggestions for Further Research

The mental health impact of long-term worry about contamination is currently unknown. This is particularly important to establish in relation to people living with a disability, as mental health problems such as anxiety are often comorbid with chronic illness and disability (Katon, 2011). Future research could determine longitudinal effects of worry on the prevalence of anxiety disorders and impacts on quality of life amongst those living in contaminated areas. Other studies should examine whether particular contaminants, such as heavy metals, worry people with disabilities more than other members of the population. Additional studies could involve examining links between disability and worry about the use of environmental remediation technologies. This would build upon existing studies that examine how sociodemographic factors, such as age, influence residents' level of worry about remediation technology (Prior et al., 2017). Another avenue for future research could

focus on whether and how the media or presence of advocacy groups affects worry amongst people with disabilities in the long-term, pervasive, environmental contamination context.

Conclusion

Environmental contamination presents a significant challenge to the health and quality of life of urban residents in Australia, as well as for residents in other cities across the globe. With the expansion of the Australian urban population and the redevelopment of industrial sites into residential areas, vast numbers face exposure to contaminants, including heavy metals and hydrocarbons (Environmental Health Australia, 2012). This is the first known study to have explored the relation between disability and worry in the chronic environmental contamination context. The findings suggest that residents living with a disability are more likely to display higher levels worry about contamination than other residents and suggest that the human health impacts are likely to be the predominant focus of worry. Consideration of how disability affects responses to environmental contamination is important for improving policies and practices of hazard risk communication in order to provide more meaningful information about the risks associated with particular forms of environmental contaminants.

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Declaration of interest

None.

Table 1: Demographic characteristics of participants.

Demographic characteristic (n)*	Total sample (N=486) n (%)
Gender (485)	
Female	269 (55)
Male	216 (45)
Age range (485)	
18-34	36 (7)
35-54	148 (31)
55-74	256 (53)
75+	45 (9)
Disability (486)	
Yes	79 (16)
No	401 (83)
Would prefer not to answer	5 (1)
Speak language other than English (486)	
Yes	62 (13)
No	424 (87)
University education (486)	
Yes	317 (65)
No	169 (35)
Income (AUD p.a.) (417)	
Zero to 40K	69 (14)
40K to 80K	115 (24)
80- 120K	92 (19)
120K +	141 (29)

*Number of responses to question

Table 2: Ordered logistic regression predicting likelihood of worry about contamination.

	Coefficient estimate	SE	t value	OR	95% CI	p value
Age						
55+	0.05	0.20	0.25	1.05	[0.71, 1.56]	0.81
Under 35	0.15	0.34	0.43	1.16	[0.59, 2.26]	0.67
Gender (Male)	-0.82	0.18	-4.58	0.44	[0.31, 0.63]	<0.001**
Income (AUD p.a.)						
Zero to 40k	0.33	0.30	1.08	1.39	[0.76, 2.52]	0.28
40k to 80k	0.18	0.25	0.74	1.20	[0.74, 1.95]	0.46
80k to 120k	0.57	0.25	2.30	1.77	[1.09, 2.88]	0.02*
Over 120k	0.72	0.31	2.34	2.04	[1.12, 3.72]	0.02*
University Education (Yes)	-0.01	0.19	-0.06	0.99	[0.68, 1.44]	0.96
Disability Status (Yes)	2.53	0.26	9.92	12.49	[7.58, 20.58]	<0.001**
Distance from Contamination Site	0.31	0.14	2.15	1.36	[1.03, 1.80]	0.03*
Sense of Place (Yes)	0.08	0.05	1.79	1.09	[0.99, 1.19]	0.07
Contamination Type						
Hydrocarbon	0.83	0.23	3.58	2.29	[1.46, 3.60]	<0.001**
Metal	1.04	0.27	3.86	2.84	[1.67, 4.83]	<0.001**
Solvent	1.35	0.31	4.41	3.84	[2.11, 6.98]	<0.001**
Waste	0.19	0.31	0.59	1.20	[0.65, 2.22]	0.55

Note. SE = standard error, OR = odds ratio, CI = confidence interval, AUD = Australian dollars.

*p<0.05, **p <0.001

Table 3: Frequency analysis of coded data for disability status and first thoughts and images that come to mind when thinking about the contaminant site.

What is the first thought or image that comes to mind when you think of the contamination at the site? (N=485)			
Participant Responses	Disability Status		
	Disability (n=79)	No Disability (n=401) n (%)	Prefer not to say (n=5)
Negative statements and expressions indicating concerns about particular issues	75 (95)	335 (84)	5 (100)

<i>Environmental health*</i>	50 (63)	209 (52)	3 (60)
Water	12 (15)	52 (13)	0 (0)
Soil, earth, land	22 (28)	101 (25)	3 (60)
Air	7 (9)	30 (8)	0 (0)
Flora/Fauna	8 (10)	20 (5)	0 (0)
General environmental hazard/disaster	1 (1)	6 (2)	0 (0)
<i>Human health and wellbeing*</i>	73 (92)	259 (65)	5 (100)
Physical health	40 (51)	142 (35)	1 (20)
Psychological and mental health	18 (23)	57 (14)	2 (40)
Health impacts amongst vulnerable groups (specifically elderly people, pregnant women and young children)	7 (9)	24 (6)	1 (20)
Impact on lifestyle and general wellbeing	7 (9)	23 (6)	0 (0)
Lack of information about the actual health impacts	1 (1)	13 (3)	1 (20)
<i>Political issues*</i>	8 (10)	82 (20)	2 (40)
Role of corporations & industry	3 (4)	35 (9)	1 (20)
Role of government	3 (4)	37 (9)	1 (20)
Responsibility for contamination	2 (3)	10 (5)	0 (0)
<i>Other non-specific negative concerns*</i> (e.g. general statements about ‘damage’, ‘toxic’, ‘harmful’, ‘bad’)	8 (10)	31 (8)	0 (0)
Statements with no direct expression of negativity and which do not indicate concern or worry	2 (3)	19 (5)	0 (0)
Don’t know/no thought	2 (3)	47 (12)	0 (0)

* Issue of predominant concern representative of likely issues of worry.

Table 4: Chi-square test between disability status and changes to daily habits.

Disability Status (n)*	Changed daily habits since becoming aware of the contamination (n = 480)			<i>p</i>
	Yes (n = 43)	No (n = 414)	Unsure (n = 23)	
Disability (79)	9 (11)	63 (80)	7 (9)	.113
No Disability (401)	34 (9)	351 (88)	16 (4)	

*Five participants preferred not to answer.

Table 5: Frequency analysis of disability status and coded data for types changes to daily habits.

Briefly describe what changes have you made to your daily habits since becoming aware of the contamination at your site? (n = 44)		
Category of activity	Disability status	
	Disability (n = 9)	No disability (n = 34)
	n (%)*	
Avoiding the contaminated area	5 (56)	17 (50)
Changes to food and water consumption activities	3 (33)	4 (12)
Changes to leisure and recreational activities	3 (33)	7 (21)
Changes to hygiene practices (personal and home cleaning)	2 (6)	3 (9)
Changes to waste disposal practices	0 (0)	3 (9)
Changes to volunteering and community activities	0 (0)	1 (3)
Increase in information seeking behaviour	0 (0)	1 (3)

*Frequency and percent of total n of each category of disability status.