



Psychological consequences of the Flint Water Crisis: A scoping review

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Abstract

Objective: To summarize existing literature on the mental health impact of the Flint Water Crisis.

Methods: In March 2020, we searched five databases for literature exploring the psychological consequences of the crisis. Main findings were extracted.

Results: 132 citations were screened and eleven included in the review. Results suggest a negative psychological effect caused by the water crisis, including anxiety and health worries, exacerbated by lowered trust in public health officials, uncertainty about the long-term impacts of the crisis, financial hardships, stigma, and difficulties seeking help. There was evidence that concerns about tap water continued even after the state of emergency was lifted.

Conclusions: With a possible compound effect to residents of Flint with the recent COVID-19 pandemic, the results highlight the need for more resources for psychological health interventions in Flint as well as a need for local governments and health authorities to regain the trust of those affected by the Flint Water Crisis.

Keywords

Mental Health; Flint Water Crisis; Public Health; Literature Review; Psychological Warfare

Introduction

The city of Flint is the urban center of Genesee County, Michigan, USA with a population of over 95,000 according to 2018 estimates and accounting for 25% of Genesee County's population¹. On 25th April 2014, Flint changed its municipal water supply source from Lake Huron to the Flint River as a cost-saving measure². However, the Flint River water was not treated with corrosion control chemicals to ensure the more acidic river water did not cause corrosion of water distribution pipes. By summer 2014, Flint residents had begun reporting changes in the smell, taste and appearance of their water as well as health effects such as skin rashes and hair loss. However, officials insisted the water was safe and dismissed the

idea of a link between water quality and health problems, and residents continued to use tap water. Meanwhile, the supply pipes continued corroding, leaching lead into the water³.

In September 2015, water experts discovered very high levels of lead in the tap water of some Flint homes⁴ and a local pediatrician found increases in children's blood lead levels corresponding with the time of the switch in water sources⁵. The state re-evaluated its water-testing data, discovering elevated levels of contaminants including bacteria and lead in Flint's drinking water, and concluded that the water was, in fact, unsafe^{3,6}. Although the water source was switched back to the Lake Huron source in October 2015, a state of emergency was declared at both the state and federal level in January 2016 which was in effect until August 2016. Despite the state of emergency having been lifted, according to media reports many residents remain fearful of Flint's water, feeling they have not received any explanation for why the crisis was allowed to happen, and still lack trust in public health officials⁷.

Naturally, the crisis has raised concerns about the physical health of Flint residents. Lead exposure can lead to high blood pressure, heart disease, damage to the brain and kidneys, and infertility⁸. Lead exposure is particularly harmful for children, putting them at greater risk of brain and nervous system damage, slowed development and behavioral problems⁹. In addition to physical health concerns, there are also potential mental health consequences of the crisis which cannot be overlooked. Previous research suggests that experiencing a disaster or public health emergency – particularly one that is human-induced - can lead to mental health disorders and substantial negative effects on levels of stress¹⁰. Psychological consequences can occur not only during and in the short-term aftermath of a disaster or crisis but can also affect both adults and children for years after^{11,12}.

Residents of Flint may be particularly at risk of adverse mental health consequences due to the city's long-standing social and economic vulnerabilities. Almost half of Flint's residents live below the federal poverty level¹ and Flint has consistently been rated one of the most violent cities in the US^{13,14}. Flint also has a long history of racial segregation, with environmental racism believed to be a contributor to the water crisis¹⁵. Disadvantaged communities are more likely to be vulnerable to adverse mental health outcomes especially after a disaster and have more barriers to treatment¹⁶. Therefore, the mental health of Flint residents is of particular concern.

Despite the risk to Flint residents in terms of their mental health, the psychological impact of the crisis has received little attention in the literature, and human-focused recovery efforts have been minimal in comparison to the recovery of physical infrastructure¹⁷. But the mental health impact from the Flint Water Crisis may be a long-lasting legacy for generations to come in the community, as has been seen in other post-disaster communities: for example, the fallout of the Chernobyl Nuclear Power Plant in Prip'yat, Ukraine led to gaps in providing mental health care and the impact of this has been labelled as the largest public health problem caused by the accident¹⁸. In fact, the media have frequently compared the Flint situation with the Chernobyl disaster^{19,20} while researchers have labelled the Flint Water Crisis more 'insidious' than Chernobyl²¹, which causes concern as to the potential long-lasting impact of the crisis. Past disasters in other communities have shown the

importance of resilience, which includes the ability to return to self-sufficiency and sustain relatively stable psychological and physical functioning after a traumatic event²². This highlights the importance of considering the level of resilience in Flint's community and how this can be improved. It is important that the psychological consequences of the crisis are not overlooked - particularly now, with the ongoing coronavirus (COVID-19) pandemic. Flint has the highest number of COVID-19 cases in Genesee County: as of 04 May 2020, Flint had recorded 644 cases (representing 39.5% of Genesee County cases), followed by Flint Township with 125 (7.6% of Genesee County's cases), despite Flint only making up 25% of Genesee County's total population²³. The psychological consequences of the unprecedented lockdown of communities in order to reduce transmission is likely to be substantial²⁴, and may be particularly so for communities which have yet to fully recover from a past crisis and are now faced with another one. Taking account of the lessons learned from the fallout from the Chernobyl disaster and with the current situation with the COVID-19 pandemic, applying such learnings of past crises are important for responding and serving the populations affected by COVID-19 and prior disasters.

We aimed to systematically review the published literature on the psychological impact of the Flint water crisis, specifically focusing on characterizing the mental health impact of the crisis and the factors associated with this impact.

Methods

Search strategy

On 27th March 2020, the following search strategy was used to search titles and abstracts in five databases (Medline, PsycInfo, Embase, Global Health and Web of Science) from inception to 2020 Week 12:

1. Flint
2. Water
3. Mental health
4. Behavioural health
5. Behavioral health
6. Psycholog*
7. Consequence*
8. Impact*
9. 3 OR 4 OR 5 OR 6 OR 7 OR 8
10. 1 AND 2 AND 9

The asterisk symbol is used as a truncation command on the Ovid databases – so for example, 'psycholog*' would search for 'psycholog' as a root term with any ending, thus would capture both 'psychology' and 'psychological'; 'consequence*' would capture both 'consequence' and 'consequences'.

Inclusion criteria

To be included in the review, studies had to: i) include primary data; ii) be published in peer-reviewed journals; iii) be written in English; and iv) report on either the psychological consequences of the Flint water crisis or factors associated with psychological outcomes as a result of the crisis.

Screening

One author ran the search strategy on all databases and downloaded resulting citations to EndNote version X9 (Thomson Reuters, New York, USA) where duplicates were automatically removed. Both authors then independently screened all titles for relevance to the review, excluding any which were clearly not relevant. This was followed by screening of abstracts. The full texts of all citations still remaining were obtained and screened for relevance against the inclusion criteria. Finally, the reference lists of included papers were hand-searched for additional relevant studies. Any discrepancies in included papers between authors were resolved through discussion.

Data extraction and synthesis

A spreadsheet was designed in order to systematically extract data from the literature. The following data was extracted: year of study, design and measures used, number of participants, demographic information of participants, and key results. Data extraction was carried out by both authors independently and then their results compared, to ensure accuracy. Thematic analysis²⁵ was used to synthesize the data by coding it and organizing it into themes.

Results

Database searches yielded 216 articles. After 84 duplicates were removed, 132 articles remained for screening. Title screening removed 101 of these; abstract screening removed another 15; and 16 full texts were reviewed. Five were excluded, leaving eleven included in the review (Figure I). Table I summarizes the design and participant information for each study and Table II summarizes the evidence for each of the themes found in the literature.

Impact on mental health

Participants directly affected by the water crisis reported symptoms of poor mental health in general²⁶, post-traumatic stress disorder¹⁷, depression²⁷, anxiety or stress^{27,28,29}, sleep problems^{27,30}, fear²⁸, aggressiveness²⁷, trouble concentrating²⁷, emotional outbursts²⁷, decreased appetite²⁷, and exacerbation of pre-existing health conditions²⁸. A longitudinal study³¹ of thirty expert panelists (from health services, schools and researchers in Genesee County) believed the water crisis was increasing stress, anxiety and to a lesser extent depression among Flint's population, and that residents had been left feeling angry, defeated and on edge. They also believed that effects of stress were not limited to Flint residents and that those outside of Flint could also be stressed due to knowing people affected by the crisis.

A cross-sectional study of 180 Flint residents comparing indicators of psychological wellbeing in Flint after the water crisis with similar indicators in Michigan before the crisis²⁷ found higher negative quality of life indicators in Flint after the crisis than in both 2012 and 2014, as well as significantly higher poor mental health and a significantly higher number of people reporting that physical or mental health had limited their usual activities than in 2013–2015.

However, a longitudinal study (looking at data for almost two hundred residents over three years) published in 2020³² showed some improvements in health outcomes over the years post-crisis: for adults aged 21 and over, aggressiveness, depressed mood, emotional outbursts, and anxiety/stress were lower in 2018 than they were in 2016, and for those aged under 21, there were significant declines in aggressiveness, emotional outbursts and problems in school. However, there were no significant changes in reports of trouble concentrating, decreased appetite or sleep problems for those aged 21 and over; or sleep problems, decreased appetite, depressed mood or anxiety/stress for those under 21.

Risky behaviors

Kruger³³ in a cross-sectional study of over seven hundred people found that those who experienced poorer quality tap water demonstrated higher rates of risk-taking behavior: in particular, poorer water quality experiences were associated with higher likelihood of tobacco smoking, higher self-reported HIV risk, higher likelihood of being involved in a physical fight and less healthy diet. Increased substance use and nicotine use were also noted in two other studies^{27,34} while the longitudinal study by Sneed et al.³² found no significant decrease in substance use over the years after the crisis, 2016–2018. Cuthbertson et al.'s³¹ participants believed that the mental health effects of the crisis could spill over into other areas of behavioral health, and could increase abuse, alcohol misuse, illicit drug use and prescription drug misuse.

Demographic factors associated with mental health outcomes

Participants felt that the entire community would be affected by the stress of the crisis, but particularly those in low-income African-American populations³¹. Kruger et al.¹⁷ found that younger age and fewer years of continuous education were associated with higher PTSD symptoms and likelihood of screening positive for PTSD.

Distrust in public health officials

Cuthbertson et al.'s³¹ participants (thirty expert panelists from health and education services in Genesee County) felt mental health consequences were related not only to the water contamination itself but to distrust of authority figures and lack of confidence in the government. Participants suggested the crisis had created distrust among city and state leadership; residents had lost trust in political officials and community leaders. This led to a feeling of abandonment, due to no one taking responsibility for the water problems, which exacerbated mental health problems. Decreased trust in officials was also noted in other studies^{27,28,29,33,35}. This decrease in trust may be due to feeling overlooked by decision-makers²⁷. In terms of what could be done to restore trust in the government, participants suggested removing local elected officials, more honesty from elected officials, improving

transparency and communication with residents, and fixing the water situation³⁵. Furthermore, 7.9% of participants in this study did not know how trust could be restored, and 10.9% felt nothing could be done to restore it.

Media

Stress was related to news coverage finding high levels of lead in the blood of Flint children³¹. In the same study, the increase in attention from the media was reported as causing an increase in stress as many interpreted it as an indicator that something much worse was unfolding, something over which they had no power.

Living with uncertainty

Participants cited various sources of uncertainty leading to stress: lack of knowledge about where to find lead testing for children in order to assess the potential impact of the crisis on their children³¹; uncertainty of knowing if they had been exposed to lead as well as the unknown severity of effects of lead exposure³¹; feeling that the crisis was not over and would never be fixed^{27,29}; and uncertainty of the long-term effects of the crisis^{28,29}. Sneed et al.³² found a slight decrease between 2016–2018 in the percentage of participants feeling the crisis would never be fixed; however, this was not statistically significant.

Finances

Participants frequently reported financial concerns and hardships^{27,28,29,31,34}. Financial concerns appeared to be higher among Flint residents after the crisis than previously reported in Michigan in 2012 and 2014²⁷. These increased concerns were due to Flint residents paying extremely high water bills for unusable water³¹; decreased property values^{28,29,31}; lacking funds to relocate³¹; decreases in the local economy^{28,31}; decreases in tourism²⁹; and additional monthly expenses such as buying bottled water and water filters, doctor appointments, and buying gasoline to travel to appointments or to pick up water safety supplies³⁴. Sneed et al.'s³² study showed no significant change in financial concern in the years post-crisis, 2016–2018.

Stigma

Participants in one study³¹ (thirty expert panelists from Genesee County) reported a sense of divide between Flint residents and other communities, suggesting others were trying to distance themselves from Flint. For example, biological parents of foster children were reported to be demanding that children not be placed in Flint homes. Similarly, Flint-based community partners and university researchers in another study using both workshops and surveys to assess Flint residents' views²⁸ found that negative consequences from the stigma of poverty and social failures associated with Flint could lead to stress and participants in a third study²⁹ also reported experiencing stigma from non-Flint residents.

Continued concerns about water

In one cross-sectional study of 180 Flint residents²⁷, over 60% of participants reported fear regarding drinking or cooking with filtered tap water, and over half reported 'a lot of' fear around bathing and brushing teeth with unfiltered tap water. As a result of the water crisis,

more than three quarters had reduced their water usage in some way, including decreased duration and frequency of baths and showers and changing bathing methods altogether, for example using baby wipes or hand sanitizer for washing. Participants in another study³⁵ (a cross-sectional study of 405 Flint residents) also reported low trust in water safety, which was a significant predictor of considering leaving the city ($p < 0.001$). Sneed et al.'s longitudinal study³² found that fears related to drinking and cooking with tap water did not significantly decrease between 2016–2018; however, there were much larger decreases in fears of bathing and brushing teeth.

Difficulties seeking help

One study of 180 adults living in Flint²⁷ found that only approximately half of those participants who felt they needed help for behavioral health concerns actually sought help. They reported barriers to seeking help such as finding it difficult to trust in the healthcare system or healthcare providers; finding services too expensive; having no transportation; being disabled or housebound; concerns about what others would think; and lack of health insurance.

Impact on education

Participants believed the crisis had led to decreases in educational attainment, and reported concerns about educational attainment and delinquency in Flint's youth in the years to come²⁸. Participants in this study suggested that a long-term monitoring plan for children exposed to lead was necessary, along with the development of family support programs in schools.

Coping strategies

The majority of Heard-Garris et al.'s³⁴ participants (consisting of 133 drug-using Flint residents) reported using positive coping mechanisms such as active coping, venting, positive reframing, planning, humor, distraction, emotional support seeking, advice-seeking, acceptance, and turning to religion or faith. Negative coping mechanisms such as denial and disengagement were also reported by more than half of the participants, and over 40% reported self-blame.

Discussion

The negative effects caused by the water crisis on Flint's residents have created a variety of mental health issues in the affected population. Studies found in this review suggest various degrees of anxiety, depression, post-traumatic stress, sleep problems and worries about physical health existing in the affected population. Additionally, negative coping strategies such as smoking and alcohol misuse, and risky health behaviors appeared to be response reactions of those affected by the crisis. Whilst more research into risky behaviors in Flint pre-crisis is needed in order to ascertain the extent to which these behaviors are related to the crisis, it is highly possible that they are exacerbated by worsening mental health due to the crisis, which participants themselves believed to be the case³¹. The negative mental health consequences of the crisis may have been exacerbated by lowered trust in public health and government officials, heightened uncertainty about the long-term impacts of the crisis and

the appropriate course of action to resolve emerging issues, and increased amount of financial hardships caused by the crisis. The results of this review also suggest that perceived stigma from others in the community and in the population at large, along with difficulties seeking help, could prevent those affected from improving their respective situation. This review also found evidence that concerns and doubt about the tap water in Flint, Michigan continued even after the state of emergency was lifted.

However, there are some positive implications from this review, as the major stressors identified can be targeted with interventions and consequently their impact lessened. For example, negative coping strategies such as smoking and alcohol misuse and risky health behaviors can be addressed in the Flint community through public health interventions and programs. Programs that enable peer and group support have been effective in establishing and enabling changes in these behaviors^{36,37}. Additionally, in a longitudinal study of the first three years after the crisis, improvements in mental health outcomes as well as a decline in fears of using tap water for bathing and brushing teeth were seen, which suggest public health messages surrounding water usage for these purposes were well-received³². However, other concerns related to the crisis remain unchanged, such as financial worries and an overall concern that the crisis will never be fixed. Use of evidence-informed interventions can reduce these concerns, enhance wellbeing, and improve functioning for affected individuals³⁸. Despite progression in some beliefs, community efforts to reduce psychological distress are still warranted.

The psychological consequences of the Flint water crisis may generalize to other disasters, and support findings from similar incidents involving environmental contamination based on past disasters. For example, studies that examined the long-term mental health consequences of the Chernobyl nuclear power plant disaster showed the affected populations developed an exaggerated sense of presumed exposure and danger due to Chernobyl over time, which fueled an increased level of anxiety and perpetual stigmatization through the generations^{39,40,41,42}. Besides similar results found in this review with impact on mental health and stigmatization, the themes of distrust in government officials and risky behaviors were also seen among populations affected by Chernobyl^{42,43}. There were more depression, anxiety, and overall concerns specifically about children's well-being among the affected populations even decades after the incident – this brings heightened urgency for further investigations and longitudinal studies related to the Flint Water Crisis, to inform interventions to address any long-term mental health identified.

Additionally, the COVID-19 pandemic creates a possible compound effect to those affected by the Flint Water Crisis, as they now face coping with another emergency while still recovering from another. Despite being over three years since the crisis was considered to be over, the communities, as seen in this review, are still reeling from the mental health impact which could be exposed further with the pandemic. Although coronavirus infects people regardless of income, the low-income communities in Michigan have been deeply affected, especially in Genesee County²³. This highlights the issue of how Michigan is segregated by income and race, which have previously been cited as factors responsible for the Water Crisis^{44,45} and may also be crucial factors in the high caseload of confirmed COVID-19 patients in Flint; it has been reported that racial capitalism in Flint is shaping health

inequalities in the pandemic⁴⁶. To our knowledge there is not yet any peer-reviewed published research specifically focused on the mental health impact of COVID-19 on Flint residents; however, the mental health impacts of lockdown are likely to be felt across the globe²⁴ and there have been media reports that the pandemic has had a particularly negative impact on Flint residents⁴⁷.

There are several implications for policy and practice based on the findings of this review. First, rebuilding trust in official communication and science within the Flint community will enhance ongoing efforts to resolve the gaps that were caused by the initial crisis. Local government and public health officials need to ensure they regain the trust of residents along with engaging and involving the Flint community and its members in recovery efforts. For example, ensuring transparency, seeking community input, and enabling two-way communication with the public on resolving issues will allow trust to be built institutionally. Having government and public health officials being held accountable, demonstrating integrity by admitting to mistakes, and seeking input from respected outside experts will bridge their past leadership woes and connect with the communities they are serving⁴⁸.

In Flint, efforts are being made to provide urgent mental health services. Psychological first aid training for people interested in helping others cope with the water emergency has been provided by the Flint Community Resilience Group³¹ and the Flint RECAST program educates residents about trauma⁴⁹. However, there remain concerns about whether enough is being done and whether people would actually seek psychological help⁵⁰. Mental health services need to be readily available and ramped up in the Flint community. Government and public health officials should identify and strengthen resources for mental health services for affected residents, and conduct follow-up mental health assessments to evaluate change over time. Additional mental health interventions should also occur in Flint, especially to address the current COVID-19 pandemic as this may have a profound mental health impact^{24,51,52}. However, economic factors, such as access and costs, need to be considered when implementing mental health interventions. An increase of educational media campaigns and handouts can also enhance the mental health interventions by emphasizing the potential long-term mental health implications of the crisis, providing contact information for support groups and readily available mental health services. All trust-building and mental health services done in the Flint community will build infrastructure and enhance the efforts if future crises arise.

Future research in Flint should go beyond the profound societal effects caused by the crisis and create opportunities to resolve the disadvantages for the Flint community to become an example of a community that can bounce back and be resilient from future public health emergencies. Despite the concept of community resilience having been variously defined by researchers, government officials and public health practitioners without a unifying meaning, several themes found across the definitions align with the results found in this review and help to prioritize future research⁵³. Community participatory research examining crisis communication, leadership and resources can help build trust and evidence-based infrastructure and working relationships between officials and Flint community members. With a compound effect of the current impact caused by the COVID-19 pandemic, maladaptive coping strategies and risky health behaviors may need urgent attention to

manage the distressing emotions and community memory of compounded crises³⁸. Facing multiple public health emergencies can cause inherent challenges for communities but establishing evidence-based mental health interventions can help to enhance their resilience.

Limitations

The majority of studies reviewed were cross-sectional and thus indicate associations, rather than causal relationships; very few studies were longitudinal, so the long-term effects of the Flint Water Crisis are unclear. Much of the included research was conducted while the crisis was ongoing; the full impact of the crisis may therefore be under-estimated, due to the speed with which data was collected. The majority of studies did not compare rates of mental health problems between Flint and other populations, or pre-Water Crisis rates in Flint, making it difficult to truly ascertain the impact of the crisis on mental health; one study²⁷ which did compare rates of psychological distress in Flint with pre-crisis rates of psychological distress in Michigan suggested mental health significantly worsened during the crisis and it would be useful to know if other studies could replicate this finding. Other factors, such as the economic recession or personal circumstances, could also have affected mental health. Additionally, much of the data in the included papers was obtained via self-reports, which may not necessarily be reliable. In terms of the review process itself, the decision to include only peer-reviewed literature and not grey literature may mean that the data reviewed in this article is subject to publication bias.

Conclusion

Literature on the impact of the Flint Water Crisis suggests considerable psychological consequences to Flint residents, exacerbated by mistrust in officials and financial difficulties. While Flint struggles to recover from this crisis, the city has also seen a much higher rate of COVID-19 than other parts of Genesee County, meaning Flint residents now have two disasters to cope with. Our review highlights the urgent need for more mental health resources for the people of Flint, such as services providing help for anxiety, depression and post-traumatic stress disorder; mental health assessments; and support groups.

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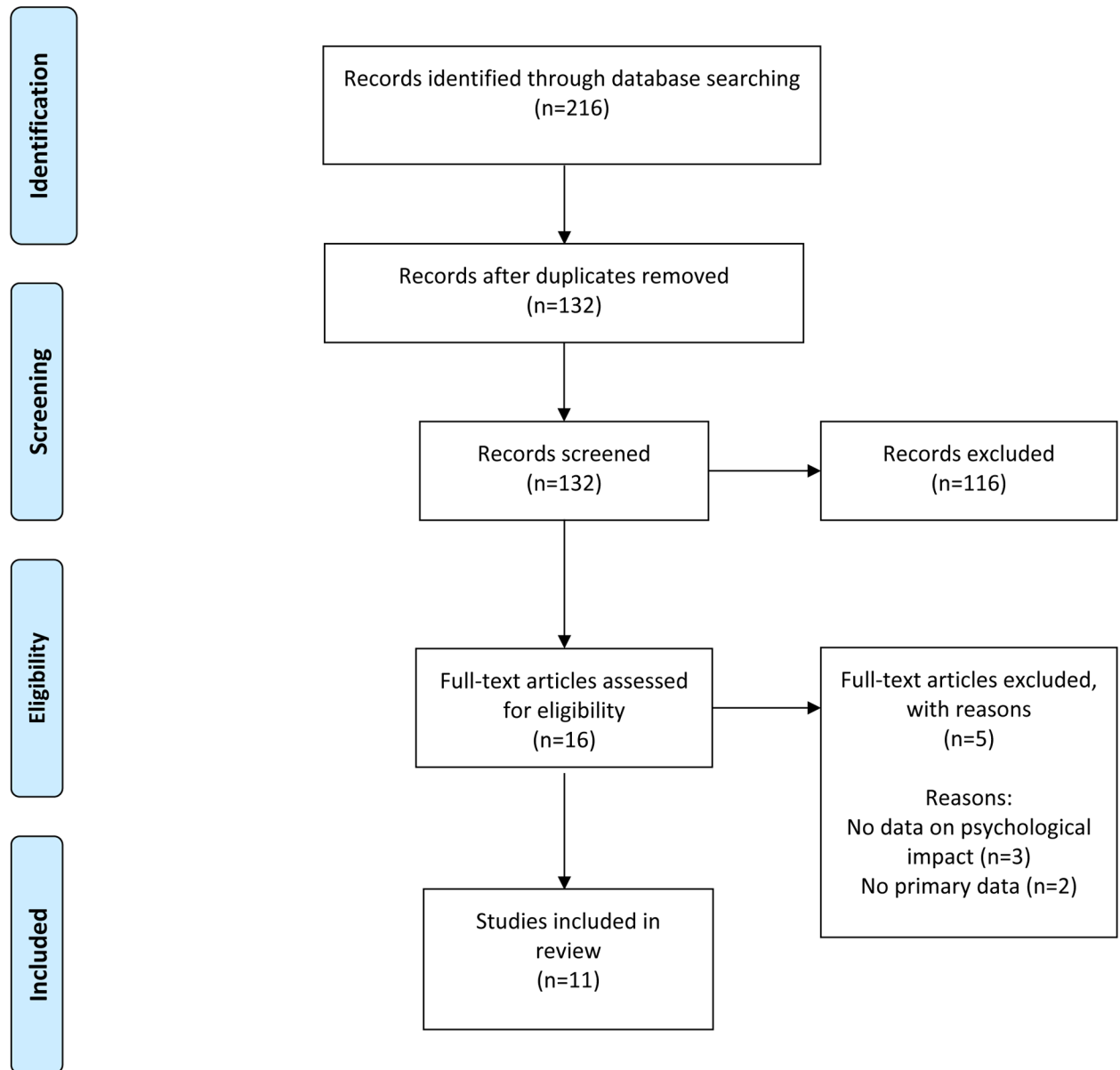


Figure I.
Flow Diagram of Search Strategy

Table 1.

Characteristics of studies included in the review

Study	Design and measures	Participants
Cuthbertson et al. (2016) ³¹	12 monthly surveys with questions about changes in 30 behavioral health related issues and open-response questions about new issues and community events since the previous survey.	30 expert panelists from health services, substance use prevention, health-related NGOs, disability service organizations, schools and researchers in Genesee County.
Fortenberry et al. (2018) ²⁷	Cross-sectional; 2-page questionnaire addressing household demographics, communications, water sources and uses, behavioral health concerns, access and perceived barriers to behavioral health services, chronic disease diagnoses, self-reported physical health consequences, and individual-level behavioral health concerns. Questions from PHQ-2 and GAD-2 to assess depression and anxiety symptoms.	180 Flint residents over the age of 18. Of households interviewed: 88.3% had one or more members aged 21–64, 60.5% had one or more 20 or younger, 25.3% had one or more 65+. Average number of people living in household was 3 (range 1–10). Mean age 49.5 years. 69.2% female.
Gray et al. (2017) ²⁸	2-hour modelling workshops using Mental Modeler software and follow-up cultural consensus survey.	42 in workshops; 137 survey participants.
Heard-Garris et al. (2017) ³⁴	Cross-sectional; survey focusing on exposure, consequences and coping strategies.	133 drug users; mean age 26.1; 52% female.
Kruger et al. (2017a) ¹⁷	Cross-sectional; Short Screening Scale for PTSD	786 Genesee County residents; mean age 51; 72% female.
Kruger et al. (2017b) ²⁶	Cross-sectional; survey including mental and physical health items from the CDC's Behavioral Risk Factor Surveillance System with items on self-reported health and mental health.	277 residents of Flint aged 18+; 69% female; mean age 48 (range 18–94).
Kruger et al. (2017c) ³⁰	Cross-sectional; Survey asking about sleep quality overall during the past month and sleep length during a typical night.	834 Genesee County residents.
Kruger (2018) ³³	Cross-sectional; Survey including several scales relevant to life history theory.	701; mean age 49, range 18–94; 70.9% female.
Morckel & Terzano (2019) ³⁵	Cross-sectional; Survey asking about levels of concern about water crisis, likelihood of leaving the city, perception of water quality, concerns about housing, levels of trust in government, and basic health indicators.	405 Flint residents.
Singer et al. (2017) ²⁹	Community-based 'mental modelling' workshops using Fuzzy Cognitive Mapping and Mental Modeler software to capture beliefs about causes, consequences and solutions to the water crisis; survey asking participants to rank the trustworthiness and usefulness of information sources.	36 Flint residents and officials.
Sneed et al. (2020) ³²	Community Assessment for Public Health Emergency Response (CASPER) assessments over three years; Survey to assess household and individual level self-reported behavioral health concerns, access to behavioral health services, physical health concerns, and water-related resource needs.	180 in 2016, 176 in 2017, 193 in 2018.

Table II.

Themes emerging from included studies

Theme	Reference	Evidence
Impact on mental health	Cuthbertson et al. (2016) ³¹	Respondents believed the water crisis was increasing stress, anxiety and to a lesser extent depression among the city's population, and residents had been left feeling angry, defeated and on edge. Participants believed that effects of stress were not limited to Flint residents and had a contagion effect: even those not directly affected were reported to feel stressed because they knew people affected by it.
	Fortenberry et al. (2018) ²⁷	The majority of households (65.3%) with one or more members aged 21 or over reported at least one household member experienced more behavioral concerns than usual. The prevalence of negative quality of life indicators in Flint was higher than previously reported in Michigan overall in both 2012 and 2014. 29.0% self-reported symptoms of depression and 33.4% self-reported symptoms of anxiety. Among households aged 21+, 49.1% reported more anxiety or stress than usual, 46.8% more sleep problems than usual, 42.3% more of a depressed mood than usual and 33.3% more trouble concentrating than usual. Of households with a member aged under 21, 53.3% reported at least one behavioral concern more than usual; 37.3% reported more problems sleeping, 36.6% reported more aggressiveness, 35.7% reported more trouble concentrating and 33.5% reported more anxiety or stress than usual. 37.0% reported having a physical illness or injury for 14+ days in the last 30 days - significantly higher than the 12.6% reported in the 2014 BRFSS (Behavioral Risk Factor Survey). 37.7% reported poor mental health for 14+ days in last 30 days, significantly higher than 12.9% in 2014 BRFSS. Almost 29% reported that poor physical/mental health limited their usual activities for 14+ days in last 30 days, significantly higher than 8.7% in 2014 BRFSS. When compared to the 2013–2015 BRFSS county-level data, quality of life indicators were significantly higher in this CASPER. Behavioral health concerns for those aged 21 and over (n=177): anxiety/stress, 89 (50.3%); problems sleeping, 85 (48.0%); depressed mood, 76 (42.9%); trouble concentrating, 62 (35.0%); emotional outbursts, 57 (32.2%); aggressiveness, 53 (29.9%); decreased appetite, 53 (29.9%); none, 58 (32.7%). Behavioral health concerns for those under 21 (n=80): problems sleeping 29 (36.3%), aggressiveness 28 (35.0%), trouble concentrating 28 (35.0%), anxiety/stress 27 (33.8%), problems in school 22 (27.5%), depressed mood 23 (28.8%), emotional outbursts 22 (27.5%), decreased appetite 17 (21.3%), none 37 (46.3%).
	Gray et al. (2017) ²⁸	Participants perceived decreases in overall community health, especially for children, and believed the water crisis had led to increases in emotional stress and fear and decreased quality of life as well as exacerbation of pre-existing health conditions.
	Heard-Garris et al. (2017) ³⁴	60% of those exposed to water with elevated lead levels reported the crisis had 'very much' affected their, or their children's, lives. Almost 40% of parents reported changes in their children's health and 65% reported changes in their own health.
	Kruger et al. (2017a) ¹⁷	Perceived tap water quality predicted PTSD symptomatology and positive screening criteria for PTSD, independent of socio-demographics. 20% met the screening criteria for PTSD. Limiting the sample to those known for certain to be Flint residents (n=268) reduced statistical power; although the relationship between reported water quality and level of PTSD symptomatology remained significant, there were no longer any significant predictors of positive screens for PTSD.
	Kruger et al. (2017b) ²⁶	Lower perceived tap water quality was associated with poorer mental and physical health. Poor physical health interfered with daily activities on an average of 4.2 days, while mental health interfered with activities on 2.1 days.
	Kruger et al. (2017c) ³⁰	Lower perceived tap water quality was associated with lower sleep quality and shorter sleep length.
	Singer et al. (2017) ²⁹	Three out of four workshops identified 'stress' as a consequence of the crisis; participants reported that not being able to use water led to an increase in household labor stress and emotional stress.
	Sneed et al. (2020) ³²	This paper showed improvements in health outcomes from 2016 to 2018 for adults aged 21+. Fewer households reported increases in several behavioral health symptoms among adults age 21+ in 2018 than they did in 2016. In 2016, 29.5% reported increases in aggressiveness compared to only 13.2% in 2018. Similar changes were observed in depressed mood, emotional outbursts, and anxiety/stress (42.6% to 14.9%, 32.3% to 11.0%, 49.1% to 26.7% respectively). There were no significant changes in reports of trouble concentrating, decreased appetite or sleep problems. There was no statistically significant difference in the percentage of participants self-reporting poor mental health or interruption of normal activities between 2016–2018; however, there was a slight decrease, with Flint estimates moving closer to Michigan state-wide estimates in 2018. There was a significant increase in the percentage of participants reporting 'no stress due to compromised health from the Flint water crisis', from 37.6% in 2016 to 59.6% in 2018.

Theme	Reference	Evidence
		Participants were also asked about youth aged under 21. From 2016–2018 there were significant declines in the percentage reporting increases in aggressiveness, emotional outbursts, and problems in school (38.4% to 13.2%, 28.7% to 8.3%, and 30.4% to 10.3% respectively). There were no significant changes in the percentage reporting increases in problems sleeping, decreased appetite, depressed mood or anxiety/stress. No significant changes were found in the percentage of households receiving help for behavioral health concerns but there was a significant increase in percentage reporting individuals did not need help - 48.3% in 2016 to 78.3% in 2018.
Risky behaviors	Cuthbertson et al. (2016) ³¹	Participants noted possible spillover effects of mental health effects into other areas of behavioral health: one felt it was increasing abuse, whereas others believed it was increasing alcohol abuse, illicit drug use, and prescription drug misuse.
	Fortenberry et al. (2018) ²⁷	23.0% of households reported at least one member increasing their use of nicotine products.
	Heard-Garris et al. (2017) ³⁴	20.0% of participants reported increased substance use.
	Kruger (2018) ³³	Water quality experiences predicted general tendencies for future planning. Those who experienced poorer quality tap water demonstrated less future-focused time orientations and higher rates of risk-taking behavior. Poorer water quality experiences directly predicted higher likelihoods of being a tobacco smoker. Poor water quality was also associated with higher self-reported HIV risk, higher likelihood of being involved in a physical fight and less healthy diet.
Demographic factors associated with mental health outcomes	Sneed et al. (2020) ³²	There were no significant changes in substance use (tobacco, marijuana, other illicit drugs or prescription drugs) between 2016–2018.
	Cuthbertson et al. (2016) ³¹	Respondents felt that the entire community would be affected by the stress of the crisis, but particularly those in low-income African-American populations.
	Kruger et al. (2017a) ¹⁷	Younger age and fewer years of continuous education were associated with higher PTSD symptoms and likelihood of screening positive for PTSD.
	Cuthbertson et al. (2016) ³¹	Participants felt mental health consequences were related not only to the water contamination itself but to distrust of authority figures and lack of confidence in the government. Participants suggested the crisis had created distrust among city and state leadership; residents had lost trust in political officials and community leaders. This led to a sense of abandonment, due to no one taking responsibility for the water problems, which exacerbated mental health problems.
Distrust in public health officials	Fortenberry et al. (2018) ²⁷	When asked to name their most trusted source of information about the crisis: 31.2% reported only trusting themselves, or no one; 26.4% trusted none of the main sources (school system, federal agencies or social media) and 10.2% reported no trust in the government. Half of households felt overlooked by decision-makers; of the 25.8% of households which reported 'a lot of' stress, 49.6% said it was related to feeling overlooked.
	Gray et al. (2017) ²⁸	Participants reported decreased trust in officials.
	Kruger (2018) ³³	Those who experienced worse tap water quality had lower perceptions of police procedural justice (i.e. whether or not police are fair and trustworthy) and lower intentions to co-operate with police.
	Morckel & Terzano (2019) ³⁵	Flint residents' trust in the local government was much lower than Michiganders' overall levels of trust: 11.3% of Flint residents reported trusting the local government, compared to around 80% in Michigan overall. Levels of trust in local governments in Flint were significantly lower ($p<0.001$) than the nationwide level of trust reported in 1972. Trust in state government was also low: 7.4% for Flint residents, compared to around 70% of Michiganders in general, and significantly lower than 1972 levels ($p<0.001$). This lack of trust in the local government predicted the extent to which participants considered leaving the city ($p=0.021$), while lack of trust in state government was not a significant predictor. 13.3% believed that removing local elected officials could restore trust in the government. 10.9% believed more honesty from elected officials could restore trust, 7.7% felt that improving transparency and communication with residents could restore trust and 9.9% believed trust could be restored by fixing the water situation. However, 7.9% did not know how trust could be restored, and 10.9% felt nothing could be done to restore it.
	Singer et al. (2017) ²⁹	The Governor's pro-business administration and loss of local agency in decision-making were believed to be causes of the crisis. Several participants suggested that Flint residents would not be able to trust the city again.

Theme	Reference	Evidence
Media	Cuthbertson et al. (2016) ³¹	Stress was related to news coverage finding high levels of lead in the blood of Flint children. The increase in attention from the media was reported as causing an increase in stress as many interpreted it as an indicator that something much worse was unfolding, something over which they had no power.
Living with uncertainty	Cuthbertson et al. (2016) ³¹	Stress was created by lack of knowledge about where to find lead testing for children. Stress was also created by the potential permanent physical health effects of lead exposure, and participants identified anxiety as increasing due to the uncertainty of knowing if they had been exposed to lead as well as the unknown severity of effects of lead exposure (which they believed would be unknown for some time).
	Fortenberry et al. (2018) ²⁷	Of the 25.8% of participants who reported 'a lot of stress, 49.6% reported feeling the crisis would never be fixed.
	Gray et al. (2017) ²⁸	Participants perceived uncertainty of the long-term effects of the crisis as potentially leading to stress.
	Singer et al. (2017) ²⁹	Three out of four workshops identified uncertainty as a consequence of the crisis; participants reported feeling the crisis might never be fixed and also reported uncertainty about the long-term effects of the crisis, with some participants fearing that children could still be affected in twenty years.
Finances	Sneed et al. (2020) ³²	There was a slight decrease between 2016–2018 in the percentage of participants feeling the crisis would never be fixed; this was not statistically significant.
	Cuthbertson et al. (2016) ³¹	Participants commented that the crisis had created financial hardship, for various reasons - residents were paying extremely high water bills for unusable water, property values were down, many lacked funds to relocate, and businesses such as restaurants were losing business and laying off workers.
	Fortenberry et al. (2018) ²⁷	This study found higher financial concerns in Flint residents than previously reported in Michigan in general in 2012 and 2014: 55% reported being always, usually or sometimes stressed about paying their rent or mortgage (significantly higher than the 34.8% reported in Michigan in 2012) and 49.5% reported being always, usually, or sometimes stressed about buying nutritious meals (compared to 21.9% in Michigan in 2012). Financial concerns were identified by 33.4% of participants, making them the most frequently cited household need.
	Gray et al. (2017) ²⁸	Participants noted decreases in real estate values and the local economy, which were perceived as leading to stress.
Stigma	Heard-Garris et al. (2017) ³⁴	75% of those exposed to water with elevated lead levels reported additional monthly expenses as a result, mostly due to buying bottled water (53%), water filters (36%) or gasoline to pick up water safety supplies (62%), as well as doctor appointments (20%) and gasoline to drive to these appointments (34%).
	Singer et al. (2017) ²⁹	Three of four workshops identified financial concerns as consequences of the crisis, including decreased tourism and a decrease in property values.
	Sneed et al. (2020) ³²	There were no significant changes in worry about money (for rent/mortgage, or meals) between 2016–2018.
	Cuthbertson et al. (2016) ³¹	The panelists reported a sense of divide between Flint residents and other communities, suggesting others were trying to distance themselves from Flint. For example, biological parents of foster children were reported to be demanding that children not be placed in Flint homes.
Continued concerns about water	Gray et al. (2017) ²⁸	Participants felt that negative consequences from the stigma of poverty and social failures associated with Flint could lead to stress.
	Singer et al. (2017) ²⁹	Participants reported stigma from non-Flint residents.
	Fortenberry et al. (2018) ²⁷	41.2% of participants reported 'a lot of' fear regarding drinking or cooking with filtered tap water, and an additional 22.6% reported 'some' fear surrounding this. 54.7% reported 'a lot of fear around bathing and 54.9% reported 'a lot of fear around brushing their teeth with unfiltered tap water. As a result of the water crisis, 78.1% had reduced their water usage in some way, including decreased duration of baths and showers (66.7%), decreased frequency of baths and showers (58.5%) and changing bathing methods altogether (57.8%) for example using baby wipes or hand sanitizer for washing.
	Morckel & Terzano (2019) ³⁵	Low trust in water safety was a predictor of considering leaving the city ($p<0.001$).

Theme	Reference	Evidence
	Sneed et al. (2020) ³²	Fears relating to drinking/cooking with unfiltered tap water remained in the years post-crisis, decreasing only slightly from 55.8% in 2016 to 50% in 2018. There were larger declines in fear of bathing and brushing teeth, (55.2% and 55.8% in 2016 to 34.2% and 33.9% respectively). There was a slight decrease in fear of drinking/cooking with filtered tap water, but this was not significant (41.2% in 2016 to 30.0% in 2018); similarly, there was a slight decrease in fear of bottled water for drinking/cooking (11.4% in 2016 to 10.4% in 2018).
Difficulties seeking help	Fortenberry et al. (2018) ²⁷	44.7% of households with at least one member aged 21+ had at least one member who felt they needed help for behavioral health concerns, but only 21.3% had actually sought help; similarly, for households with at least one member under 21, 51.9% had at least one member who needed help but only 28.0% had sought help. 22.2% of participants reported difficulties seeking help; 48.3% of these found it difficult to trust in the healthcare system or healthcare providers; 30.2% thought services were too expensive; 24.6% had no transportation; 13.8% were disabled or housebound; 13.2% were worried about what others would think; and 11.9% lacked health insurance.
Impact on education	Gray et al. (2017) ²⁸	Participants believed the crisis had led to decreases in educational attainment, and reported concerns about educational attainment and delinquency in Flint's youth in the years to come. Participants suggested that a long-term monitoring plan for children exposed to lead was necessary, along with the development of family support programs in schools.
Coping strategies	Heard-Garris et al. (2017) ³⁴	Participants reported positive coping mechanisms (active coping, 80%; venting, 99%; positive reframing, 72%; planning, 79%; humor, 44%; distraction, 73%; emotional support seeking, 65%; advice-seeking, 99%; acceptance, 93%; and turning to religion or faith, 74%) and negative coping mechanisms (substance use, 20%; self-blame, 42%; disengagement, 51%; and denial, 59%).