

Behavioral Health and Water-Related Concerns During the Flint Water Crisis, 2016-2018

Abstract

In April 2014, a switch in the municipal water source for Flint, Michigan resulted in contamination of the water supply with lead, a toxic health hazard. Since the onset of this Flint Water Crisis, there has been considerable interest in behavioral health outcomes for Flint residents. In 2016, local, state, and federal partners began to collect household-level, emergency-related behavioral and physical health information in Flint. Follow-up data were conducted in 2017 and 2018 to evaluate changes in behavioral health outcomes and the effectiveness of behavioral health programming. From 2016 to 2018, Flint residents demonstrated improvements across several behavioral health outcomes; however, residents continued to experience crisis-related stress, including fear that the crisis would never be fixed. Future behavioral health efforts in the city should focus on continuing to provide behavioral health services to residents and restoring trust within the community.

Keywords:

Community behavioral health, stress, youth, families

Introduction

In April 2014, cost-saving measures led to a switch in the municipal water source for Flint, Michigan from Lake Huron and the Detroit River to the local, cheaper Flint River. Inadequate treatment processes for Flint River water resulted in corrosion of the city's lead pipes, ultimately contaminating the water supply with lead and other materials. Consequently, more than 100,000 individuals who lived in and/or worked in the city of Flint after the water switch were exposed to drinking water tainted with lead, a toxic metal that can affect multiple organ systems and lead to lifelong health harm, particularly in children (Centers for Disease Control and Prevention, 2005). In September 2015, local researchers published findings that described elevated blood lead levels in Flint children under the age of 5 after the water switch (Hanna-Attisha, 2016). In response, county officials declared a public health emergency in October 2015 and warned residents to avoid consumption of unfiltered Flint municipal water. Shortly thereafter, the water source was switched back to Lake Huron. A federal state of emergency was declared in January 2016 in Genesee County, where Flint is located.

From the onset of the FWC, there has been considerable interest in both physical/behavioral health outcomes and water-related concerns among Flint residents. Prolonged lead exposure has been linked to numerous adverse physical health outcomes, including increased risk of high blood pressure, heart disease, and kidney disease (National Institute for Occupational Safety and Health, 2018). Further, numerous studies have demonstrated the potential adverse mental health effects of disasters, particularly if they involve widespread community disruption or protracted recovery (Bonanno, Galea, Bucciarelli, & Vlahov, 2007). Under the most severe circumstances, individuals can experience increases in depressive symptoms, anxiety, substance use, and sleep disturbance (Foa, 2006).

In addition to the general potential adverse effects of widespread disasters, monitoring of behavioral health outcomes in Flint is particularly important due to Flint's longstanding social and economic vulnerabilities. Flint, Michigan is a predominantly non-white (56.6% African-American), highly disadvantaged city overwhelmed by racial segregation, violence, unemployment, poverty, and chronic disease. Among the 83 counties in Michigan, Genesee County (where Flint is located) ranks 82nd for health outcomes (Robert Wood Johnson Foundation 2018), and forty-two percent of Flint residents live below the federal poverty level (U.S. Census Bureau, 2018). Further, since the late 2000s Flint has consistently ranked in the top 10 of the most violent cities in the United States (Adams,

2017). Disadvantaged communities are often vulnerable to adverse behavioral health outcomes under ordinary circumstances. People with mental illness are overrepresented in poor communities and barriers to treatment are often pronounced in such areas. Consequently, public health disasters in disadvantaged communities tend to exacerbate pre-existing behavioral health disparities.

With these potential negative effects in mind, federal, state, and local authorities initiated numerous behavioral health and water-related initiatives in Flint starting in early 2016 to combat the potential adverse effects of the Flint Water Crisis (FWC) on the community. The Genesee County Health Department began providing walk-in blood lead testing for children and adults in Genesee County (where Flint is located). Mobile food pantries were established at various locations throughout the city to provide residents with free fresh fruits and vegetables that could potentially combat the negative health effects of lead. Free water tests and filters were provided at distribution points throughout the city. Crisis behavioral health services were initiated throughout the city in partnership with Genesee Health System (the local public behavioral health provider), the Michigan Department of Health and Human Services, and federal partners. These services include a mobile mental health unit that provides mental and behavioral health services, education on available resources, and referrals to other programs for adults and children impacted by the trauma and stress of the FWC. The state of Michigan began a free bottled water program in January 2016 in Flint, supplying bottled water and filters at publically advertised distribution points in the city and delivering water to residents without installed and functioning water filters. This program ended in April 2018, as state officials declared that water quality had returned to acceptable levels, despite concerns from local officials. Since then, bottled water, water filters, food/nutritional services have continued to be distributed through help centers managed by the local food bank staged at area churches.

In May 2016, the Centers for Disease Control and Prevention (CDC), along with state and local officials, community residents, and local academic partners, conducted a Community Assessment for Public Health Emergency Response (CASPER), an epidemiologic technique designed to generate individual and household-level data on physical and behavioral health outcomes in communities impacted by public health disasters (CDC, 2012). Behavioral health findings from the initial May 2016 CASPER in Flint have been previously published (Fortenberry, Reynolds, Burrer, Johnson-Lawrence, Wang, Schnall et al., 2018). This assessment revealed behavioral health outcomes among Flint residents that were poorer than those reported in both the 2012 and 2014 Michigan Behavioral Risk Factor Surveillance System. Further, data from the 2016 CASPER suggested widespread

distrust of state and local government and high rates of distress across the population. Follow-up CASPER assessments were conducted in Flint in December 2017 and July 2018 to assess changes in behavioral, physical health, and water-related needs among Flint residents since the initial assessment. The current study describes changes in outcomes among Flint residents from May 2016 to July 2018.

Methods

Design

CASPER assessments were conducted in May 2016, December 2017, and July 2018 within the geographic limits of the city of Flint. In May 2016, the CASPER was led by the CDC, in conjunction with local and state partners. In 2017 and 2018, the CASPER was led by staff from Flint Resilience in Communities after Stress and Trauma (ReCAST), a grant to the city of Flint from the Substance Abuse and Mental Health Services Administration (SAMHSA) to promote community resilience and recovery following the Flint Water Crisis. Each time, the CASPER was conducted to assess the following: 1) household- and individual-level self-reported behavioral health concerns; 2) household access to behavioral health services, including substance abuse and mental health services, and perceived barriers to access; 3) self-reported physical health concerns; and 4) water-related resource needs and barriers to resources.

For each CASPER, a representative sample of Flint households was obtained using a two-stage cluster sampling method (Centers for Disease Control and Prevention, 2012). First, housing data from the 2010 Census were utilized to identify households within the geographic limits of the city of Flint that would comprise the sampling frame. Then, 30 blocks (clusters) were randomly sampled from within the sampling frame. These 30 clusters were selected with a probability proportional to the number of housing units within the clusters from the predefined sampling frame using the Geographic Information Systems (GIS) CASPER tool. Then, interview teams selected 7 households for from each of the 30 clusters for interviews using systematic random sampling methods, for a total of 210 possible interviews. Interview pairs were assigned 2-3 clusters each and given GIS maps of their respective clusters. Pairs were told to visit every n th household in the cluster (where “ n ” is the total number of households in the cluster divide by seven) in order to select the 7 households needed for interviews. Teams made at least 3 attempts at each of the selected households. After three attempts, teams selected a replacement household. Teams also recorded if housing structures appeared to be vacant or destroyed, and selected replacement households in those cases as well.

Interview teams consisting of community residents and staff from local community organizations, universities, and state agencies participated in a 2-3 hour training prior to conducting interviews over three days in the field. Interviews were conducted during daylight hours approximately 5 hours per day. Interviewers visited households in pairs. One member of each household answered a battery of questions on behalf of the entire household. In addition to household-level questions, the respondent also answered a series of questions about his/her own individual health. One member of each household aged ≥ 18 years was selected to complete an interview on behalf of the entire household. This person also answered individual-level demographic and health-related questions on his/her own behalf. In addition to administering the CASPER questionnaire, teams also provided respondents with public health informational materials. Finally, interview teams completed confidential referral forms at households where there were critical physical and/or behavioral health needs.

Questionnaire and Consent Form

Respondents completed a two-page questionnaire that included household-level questions about household composition, past and current water usage, behavioral health concerns for youth (aged <21 years) and adults (aged ≥ 21 years), access and barriers to obtaining behavioral health services, substance use, and chronic health conditions. They also provided individual-level demographic and behavioral health information.

The CASPER questionnaire and consent forms were submitted to the Institutional Review Boards (IRBs) of the Michigan Department of Health and Human Services (2016) and Michigan State University (2017, 2018). Both IRBs determined that the CASPER was not research; thus, it was exempt from human subjects review. All respondents were provided with a copy of the consent form to keep.

Household Behavioral Health

Respondents were asked to describe changes in behavioral outcomes among adults (age 21+) in their households. First, they were asked about increases in symptoms that might reflect adverse behavioral outcomes, including trouble concentrating, aggressiveness, problems sleeping, decreased appetite, depressed mood, emotional outbursts, and increased anxiety/stress. In the May 2016 CASPER, respondents were asked to describe changes since October 2015 (when the Flint Water Crisis was announced). The December 2017 CASPER asked about time since May 2016 (when the last CASPER was conducted), and the July 2018 CASPER asked about the time since December 2017.

Respondents were also asked if any members of their households age 21+ or aged <21 years had received help from a counselor/pastor/clergy member, therapist, or case/social worker for behavioral health concerns since October 2015 (May 2016 survey) or since the last CASPER assessment (December 2017 and July 2018 surveys). They were also given the option to indicate if there were members of their household who needed help but did not receive it and if there were members of their household in each age group who simply did not need help.

Substance Use

Respondents were asked to indicate if members of their households had increased their use of alcohol, tobacco products (e.g. cigarettes, e-cigarettes, chewing tobacco), marijuana, other illicit drugs, and prescription/over-the counter drugs at all three timepoints (data not shown).

Individual Behavioral Health

Respondents were also asked to provide information about their own individual behavioral health concerns. Specifically they were asked to provide information about depressive symptoms (2-item Patient Health Questionnaire; PHQ-2; Kroenke, Spitzer, & Williams, 2003) and anxiety (2-item Generalized Anxiety Disorder Scale; GAD-2; Kroenke, Spitzer, Williams, Monahan, & Löwe, 2007) over the past 2 weeks. Individuals were considered to be depressed or have anxiety if they scored 3 or higher (out of a possible score of 6) on either the PHQ-2 or GAD-2, respectively. Respondents were also asked how often (always, sometimes, rarely, never) over the last 12 months they had been worried about paying the rent/mortgage or worried about having enough money to buy nutritious meals. Finally, respondents were also asked about their health over the past 30 days using questions from the Behavioral Risk Factor Surveillance survey, a nationally representative, population-based telephone survey of behavioral health risk conducted among U.S. adults aged ≥ 18 years (Centers for Disease Control and Prevention, 2013). Specifically, individual respondents were asked to indicate the number of days over the past 30 days in which they had any physical illness or injury, poor mental health, or interruption of normal activities due to poor physical or mental health. Responses were categorized as either ≤ 13 days or ≥ 14 days. Responses were also compared to responses from the state of Michigan (BRFSS) survey.

Household Water Crisis-Related Stress and Fear

Respondents were asked to indicate how much stress (none, some, a lot) members of their household had experienced related to the Flint Water Crisis due to compromised health, financial worries, added stressors to daily routine, feeling overlooked by decision makers, and feeling that the crisis would never be fixed. They were also

asked about household fears (none, some, a lot) related to using various water sources, including filtered tap water for cooking/drinking, bottled water for cooking/drinking, unfiltered tap water for cooking/drinking, unfiltered tap water for bathing, and unfiltered tap water for brushing teeth.

Water Usage and Household Needs

Respondents were asked to indicate their household's current sources of water. Multiple sources could be selected and included unfiltered tap water, bottled water from the store, filtered tap water, water from distribution sites, and well water. Respondents were also asked about household difficulties in obtaining filtered tap water, bottled water and well water. Finally, to gauge household needs, respondents were asked the following open-ended question: "What is your household's greatest need?" Responses were classified into 12 broad categories (money/financial, safe water, housing, transportation, plumbing/repairs, food, filters, health-related, transportation, work/employment, nothing, other).

Data Analysis

Weighted frequencies and percentages (and their respective 95% confidence intervals) were calculated to derive population estimates from sampled responses. Both individual and household weighting variables were utilized: a household weighting variable was calculated to account for the likelihood of selecting a household, and an individual weighting variable was calculated to account for the likelihood of selecting a respondent within a household. The household weight was used to calculate results for all household-level questions, and the individual weight was used to calculate results for all individual-level questions. Data analyses were performed using Epi Info (Version 7; CDC, Atlanta, Georgia USA).

Results were compared across the three data collection points (May 2016, December 2017, and July 2018). During the May 2016 interview, respondents were queried about occurrences since October 2015 (when widespread knowledge of the Flint Water Crisis started). The December 2017 survey asked about the time since May 2016 (the previous CASPER assessment), and the July 2018 survey asked about the time since December 2017 (the date of the previous CASPER assessment). Changes across the three time points were considered to statistically significant at $p < 0.05$ if the confidence intervals did not overlap. Behavioral health findings from the May 2016 survey were taken from CASPER findings previously published (Fortenberry et al., 2018).

Results

The completion goal for all three data collection points was 210 interviews. Out of 210, 180 interviews were completed in May 2016, 176 interviews were completed in December 2017, and 193 interviews were completed in July 2018, yielding completion rates of 85.7%, 83.8%, and 91.9%, respectively.

The demographic characteristics of the households sampled are provided in Table 1. There were no statistically significant changes in household composition from 2016 to 2018. Single-family dwellings comprised more than 90% of all households across the three data collection points. Roughly half (51.7-66.2%) of all housing structures were occupied by owners, and there were a median of 2.0-2.2 residents who lived in each household. Very few households (1.0-3.1%) included individuals who did not speak English, and 3.0-4.4% of households included a person who was pregnant. Of households in Flint, 16.2-20.7% included children ages 5 and under, and 16.7-24.2 included adults aged ≥ 65 years.

Of those individuals who completed the interview (Table 1), there were fewer male respondents in 2016 compared to 2018 (31.0% versus 45.8%, respectively). More than half (57.1-59.9%) of individual respondents were African-American, and 2.4-5.2% of respondents were of Hispanic ethnicity. Most respondents were longtime Flint residents (mean length of residency 33.6-36.2 years).

Household Behavioral Health

Respondents were asked to describe changes in behavioral outcomes among adults (age 21+) in their households. First, they were asked about increases in symptoms that might reflect adverse behavioral outcomes, including trouble concentrating, aggressiveness, problems sleeping, decreased appetite, depressed mood, emotional outbursts, and increased anxiety/stress. In the May 2016 CASPER, respondents were asked to describe changes since October 2015 (when the Flint Water Crisis was announced). The December 2017 CASPER asked about time since May 2016 (when the last CASPER was conducted), and the July 2018 CASPER asked about the time since December 2017.

Across all three time points, fewer households reported increases in several behavioral health symptoms among adults ages 21+ from 2016 to 2018 (Table 2). In 2016, 29.5% (95% CI: 21.2%-37.8%) of households reported increases in aggressiveness, compared to only 13.2% (95% CI: 6.4%-19.9%) in 2018. Similar changes were observed from 2016 to 2018 with respect to depressed mood, emotional outbursts, and anxiety/stress. In 2016, 42.6% (95% CI: 33.4-41.7%) of households reported increases in depressed mood among adult household members, compare to only 14.9% (95% CI: 7.7-22.1%) in 2018. With respect to emotional outbursts 32.3% (95% CI: 23.6-

41.1%) of households reported increases in 2016 compared to only 11.0% (95% CI: 4.8-17.2%) in 2018, and 49.1% (95% CI: 41.8-56.5%) of households reported increases anxiety/stress, compared to only 26.7% (95% CI: 16.5-37.0%) in 2018. There were no statistically significant changes in reports of trouble concentrating, decreased appetite, or problems sleeping (Table 2).

Respondents were also asked if any members of their households age 21+ had received help from a counselor pastor/clergy member, therapist, or case/social worker for behavioral health concerns. They were also given the option to indicate if there were members of their household who needed help but did not receive it and members of their household who simply did not need help. There were no statistically significant changes in the percentage of households that received help (Table 3); however there was a significant increase in the percentage of household members reporting that individuals in their households did not need help. In 2016, 48.3% (95% CI: 35.1-61.4%) of households reported that no adults in their household needed behavioral health services compared to 78.3% (95% CI: 64.7-82.9%) in 2018.

Respondents were asked to report on similar outcomes among youth aged <21 years in their households (Table 2). In addition to reporting on increases in previously described symptoms (i.e. trouble concentrating, aggressiveness, problems sleeping, decreased appetite, depressed mood, emotional outbursts, and increased anxiety/stress), respondents were also asked about increases in problems in school (Table 2). They were also asked if youth in their households aged <21 years had received help for behavioral health concerns as previously described. From 2016 to 2018, there were statistically significant declines in the percentage of households reporting increases in aggressiveness, emotional outbursts, and problems in school. In 2016, 38.4% of households (95% CI: 26.2-50.5%) reported increases in aggressiveness among youth aged <21 years, compared to only 13.2% (95% CI: 2.0-23.4%) in 2018. With respect to emotional outbursts, 28.7% of households (95% CI: 17.4-39.9%) reported increases in this age group in 2016 compared to only 8.3% (95% CI: (from 28.7% to 8.3%) in 2018; 30.4% of households (95% CI: 19.1-41.8%) reported increases in problems in school in 2016, compared to only 10.3% (95% CI: 3.0-17.7%) in 2018. There were no statistically significant changes in the percentage of households reporting increases in problems sleeping, decreased appetite, depressed mood, or anxiety/stress. Further, with respect to receiving help from counselors and other professionals, the percentage of households reporting that youth did not need help for behavioral health concerns increased from 48.3% in 2016 (95% CI: 35.1-61.4%) to 73.8% (95% CI: 64.7-86.0%) in 2018 (Table 3).

Substance Use

Respondents were asked to indicate if members of their households had increased their use of alcohol, tobacco products (e.g. cigarettes, e-cigarettes, chewing tobacco), marijuana, other illicit drugs, and prescription/over-the-counter drugs at all three timepoints (data not shown). There were no statistically significant changes in the percentage of households reporting increased use of any of these substances, with 19.6-23.7% of households reporting increased tobacco use, 11.1-14.5% of households reported increased marijuana use, 0.5-1.1% of households reporting increased other illicit drug use, and 4.3-7.9% of households reporting increased use of prescription/over-the-counter drugs.

Individual Behavioral Health

There was a statistically significant decrease in the percentage of individuals who were depressed based on scores from the 2-item Patient Health Questionnaire (PHQ-2; Table 4). The percentage of individuals considered to be depressed decreased from 29.6% (95% CI: 21.2-38.0) in 2016 to 13.1% (95% CI: 6.1-20.1%) in 2018. There was no statistically significant change in the percentage of individuals meeting criteria for anxiety based on the 2-item Generalized Anxiety Disorder Scale. In 2016, 33.7% (95% CI: 25.5-41.8%) of respondents reported anxiety; in 2018, 19.8% (95% CI: 11.8-27.8%) of respondents reported anxiety (Table 4). There also were no significant changes in worries about money for rent/mortgage or for nutritious meals from 2016 to 2018 (Table 4). In 2016, 22.6% (95% CI: 14.7-30.6%) of respondents always/usually worried about having enough money for rent/mortgage, compared to 19.0% (9.5-28.4%) of respondents in 2018 (difference not statistically significant). With respect to money for nutritious meals, 25.4% (95% CI: 15.7-35.2%) of respondents always/usually worried about having enough money for nutritious meals in 2016, compared to 19.2% (95% CI: 9.9-28.2%) of respondents in 2018 (difference not statistically significant).

With respect to the BRFSS behavioral health questions (Table 5), the percentage of individual reporting \geq 14 days of physical illness/injury, poor mental health, or interruption of normal activities decreased from 2016 to 2018; however, these changes were not statistically significant. We observed, however, that 2018 city of Flint estimates moved closer to Michigan statewide estimates. In May 2016, 37.0% (95% CI: 26.6-47.5%) of individual respondents reported that they had at least 14 days of *physical illness and injury* during the past 30 days, compared to 21.1% (95% CI: 11.3-30.9%) of respondents in May 2018. By comparison, state of Michigan data estimated that 13.0% (95% CI: 12.1-13.9%) of respondents statewide had a similar number of days of physical illness and injury.

In Flint, 38.0% of individual respondents (95% CI: 31.6-44.4%) reported *poor mental health* for at least 14 of the last 30 days in May 2016, compared to 22.1% (95% CI: 10.9-33.3%) of respondents in July 2018. Statewide, 11.9% (95% CI: 11.0-12.8%) of Michigan residents reported at least 14 days of *poor mental health*. Finally, 29.1% of Flint respondents (95% CI: 20.8-37.3%) in May 2016 reported that their normal activities had been interrupted for at least 14 of the last 30 days due to poor physical or mental health, compared to 17.2% (95% CI: 7.7-26.7%) of Flint respondents in 2018. In statewide data, 25.1% (95% CI: 24.0-26.3%) of respondents reported that their normal activities had been interrupted due to poor physical or mental health.

Household Water Crisis-Related Stress and Fear

There was a significant increase from 2016 to 2018 in the percentage of households reporting no stress due to compromised health from the Flint Water Crisis (Table 6). In 2016, 37.6% (95% CI: 30.7-44.5%) of households reported no stress due to compromised health, compared to 56.9% (44.8-68.9%) of households in 2018. There were no significant changes in the other domains from 2016 to 2018. In 2016, 32.9% (95% CI: 25.4-40.4%) of respondents had “a lot” of financial worries and in 2018, 24.8% (14.6%-35.1%) of households reported “a lot” of worries (changes not significant). In 2016, 50.0% (42.7%-57.4%) of respondents reported “a lot” of worry regarding feeling that the crisis would never be fixed, and in 2018, 44.1% (95% CI: 30.5%-57.7%) reported “a lot” or worry regarding the same issue (changes not significant; Table 6).

Households maintained some water-related fears from 2016 to 2018 (Table 6). In 2016, 55.8% (95% CI: 50.6%-65.1%) of households reported “a lot” of fear related to drinking/cooking with unfiltered tap water, and this fear persisted in 2018, with 50.0% (95% CI: 38.5-61.5%) of respondents reporting “a lot” of fear. There were, however, declines related to fear of bathing and brushing teeth with unfiltered tap water. In 2016, 55.2% (95% CI: 47.9%-62.4%) and 55.8% (95% CI: 48.6-61.6%) of households reported “a lot” of fear related to bathing and brushing teeth with unfiltered tap water, respectively. By 2018, those percentages decreased to 34.2% (95% CI: 22.8%-45.7%) and 33.9% (95% CI: 22.6-45.2%), respectively. Residents also had some fears related to using filtered tap water for drinking/cooking. In 2016, 41.2% (33.7%-48.8%) of households reported “a lot” of fear related to using filtered tap water for drinking/cooking and 30.0% (95% CI: 19.0-41.0%) still reported fear in 2018 (change not significant). There was, however, much less fear related to use of bottled water for drinking/cooking. Only 11.4% (95% CI: 6.7%-16.0%) of respondents reported “a lot” of fear related to use of bottled water for drinking/cooking in 2016 and 10.4% (95% CI: 2.3-18.4%) of respondents did so in 2018 (Table 6).

Water Usage and Household Needs

Respondents were asked to indicate their household's current sources of water. Multiple sources could be selected and included unfiltered tap water, bottled water from the store, filtered tap water, water from distribution sites, and well water. Respondents were also asked about household difficulties in obtaining filtered tap water, bottled water and well water. Finally, to gauge household needs, respondents were asked the following open-ended question: "What is your household's greatest need?" Responses were classified into 12 broad categories (money/financial, safe water, housing, transportation, plumbing/repairs, food, filters, health-related, transportation, work/employment, nothing, other).

In 2016, distribution sites were the most common water source, with 75.0% (95% CI: 64.4-85.5%) of households receiving water from these sites (Table 7). Other common water sources included bottled water from the store (51.6% of households; 95% CI: 40.3%-62.8%) and filtered tap water (41.1% of households; 95% CI: 30.1-52.1%). Water usage changed significantly from 2016 to 2018. By 2018, the most common water source was filtered tap water (84.6% of households; 95% CI: 78.3-90.9%), followed by bottled water from the store (83.8% of households; 95% CI: 77.2-90.4%). Usage of water from distribution sites decreased to 33.9% (95% CI: 24.8-43.0%).

The percentage of households reporting difficulties in obtaining water increased substantially from 2016 to 2018. In 2016, 16.9% of households (95% CI: reporting difficulties in obtaining water. By 2018, the percentage increased to 46.1%. Among those reporting difficulties in obtaining water in 2018, the most common difficulties were distribution sites not giving out enough filters (23.4%), distribution sites not giving out enough bottled water (34.4%) and not having enough water to purchase filters (19.8%).

Across all three time points, the greatest household needs were money/financial needs, safe water, and plumbing/home repairs. In 2016, 33.6% (95% CI: 26.4-40.7%) of respondents reported that money/financial needs were their greatest households. By 2018, that number declined to 16.6% (95% CI: 8.7%-24.5%). In 2016, 27.5% (95% CI: 19.8-35.2%) of respondents reported that safe water was their greatest household need; there was no significant change during the 2018 assessment, with 34.5% (95% CI: 23.9-45.2%) of respondents indicating that safe water was there greatest household need. In 2016, 14.7% (95% CI: 8.0%-21.5%) of households cited plumbing/home repairs as their greatest household need; there was no significant change in this percentage in 2018, as 8.2% (95% CI: 3.1-13.3%) of households reported plumbing/home repairs as their greatest need. Finally, 9.6% of

households (95% CI: 4.8-14.6%) reported that they had no household needs in 2016. This percentage remained the same in 2018 (13.8%; 95% CI: 4.7%-22.9%)

Discussion

Data from the three CASPER assessments in 2016, 2017, and 2018 suggest several improvements in behavioral health and water-related outcomes among Flint residents. Among adults age 21+, there were improvements in many behavioral health-related symptoms, including fewer households reporting increases in aggressiveness, depressed mood, and anxiety/stress. There were also significant increases in the percentage of households with adults that did not need behavioral health services. On an individual level, the percentage of adult respondents with depressive symptoms declined substantially from 2016 to 2018. Further, the percentage of individual respondents who reported substantial poor physical health, poor mental health, and interruption of their normal activities due to poor physical/mental health declined near levels observed in Michigan statewide by 2018. For youth aged <21years, there were also improvements. In 2018, fewer households reported increases in aggressiveness, emotional outbursts, and problems in school in this age group compared to 2016. Further, there was an increase in the percentage of youth who did not need behavioral health services.

The increase in behavioral health and social services for Flint residents since 2016 are likely to have played a role in the improvements observed in Flint households. Since the onset of the Flint Water Crisis, numerous behavioral health and social welfare programs have been initiated, including a free water/filter distribution program, increased lead testing (<https://www.cityofflint.com/wp-content/uploads/Lead-Safe-Home-Program-Combined-Application-2017.pdf>), the addition of mobile behavioral health units that travel throughout the community, and increases in funding to the public behavioral health authority (<http://www.genhs.org/water>). Community members and professionals have received training in mental health first aid and psychological first aid (<http://www.genhs.org/mhfa>), and funding to the city of Flint (www.flintrecast.com) from the Substance Abuse and Mental Health Services Administration (SAMHSA) has supported ongoing behavioral health programming for youth, families, and working professionals. The CASPER assessments conducted in 2016, 2017, and 2018 were designed to serve as an evaluation of the impact of these efforts within the community.

There have also been some improvements in water-related concerns since 2016. In 2016, more than half of all households reported significant fears related to bathing and brushing their teeth with unfiltered tap water, despite state and local assurance that using unfiltered water for these purposes was safe. By 2018, the percentages of

households reported such fears had declined significantly. This decline suggests that public health messaging surrounding water usage has been well-received by residents. Further, in 2018, fewer residents reported feeling stress from the Flint Water Crisis related to compromised health. This is likely due to the increase in public health programming and the influx of health resources into the community since 2016.

Despite improvements in some areas, many behavioral health and water-related concerns remained unchanged from 2016 to 2018. Of note is the continued stress that households reported related to the Flint Water crisis itself. In 2016, fifty percent of respondents reported “a lot” of stress in terms of feeling as though the water crisis never would never be fixed. This number was relatively unchanged in 2018. Further, residents continued to feel overlooked by decision makers, and continued to feel as though the water crisis added financial worries and stress to their daily routine. Additionally, residents reported increased difficulty in obtaining bottled water in the 2018 assessment. This change likely reflects the withdrawal of state-funded bottled water resources that occurred in April 2018. Since the closing of the state-funded distribution centers, residents have continued to prefer bottled water; however, they have relied on distributions through local churches and other agencies in lieu of larger scale efforts.

This study had a number of strengths. We utilized a population-based sampling methodology to collect household-level data on behavioral health and water-related outcomes in the city of Flint. Thus, unlike convenience samples, our data provide representative information on the needs of Flint households. Further, our interview teams consisted of both community residents and professionals with experience in administering surveys. Residents were knowledgeable of the neighborhoods that were visited, and (in many cases) conducted interviews in their own neighborhoods. This likely contributed to our high response rates.

This study is not without limitations. We randomly selected one member of each household to provide data on behalf of the entire household. That household member might not have accurate knowledge of the needs of other household members, specifically as it relates to behavioral health needs. Further, social desirability bias may render individuals reluctant to report behavioral health needs within their households. We would expect, however, that would be true across all three time points; thus, changes in behavioral health outcomes over time would likely withstand such bias. Finally, the positive changes that we observed in several outcomes might not reflect actual improvements in outcomes. Rather, they might reflect changes in residents’ coping strategies. For example, we observed a decrease in the percentage of residents who reported fears related to bathing and brushing teeth with

unfiltered tap water from 2016 to 2018. This decline may be due to the fact that residents simply stopped using the unfiltered tap water rather than them having greater confidence in the water quality. Our survey was not designed to make such distinctions.

Overall, behavioral health and water-related concerns improved in the city of Flint from 2016 to 2018; however, community efforts to reduce psychological distress are still warranted. Future efforts should focus on sustaining new and existing behavioral health resources and ensuring that they continue to be disseminated throughout the community.

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