

RESEARCH ARTICLE

The high health risks of unaffordable water: An in-depth exploration of pathways from water bill burden to health-related impacts in the United States

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Data Availability Statement: This study analyzes in-depth, semi-structured interviews. Supporting excerpts from the raw data (quotes from interviews with participants) are available within the text of the paper. Complete transcripts include details and information that could reveal the identity of the participants. A deidentified set of transcripts (with names and other identifying information redacted) is deposited in Databrary, a public data repository, along with the codebook used to analyze the data (<https://nyu.databrary.org/volume/1550>).

Abstract

Access to clean and safe water is essential for human health and well-being, but recent and substantial increases in the cost of water for residential customers in the United States endanger the health of those who cannot afford to pay. This study identifies pathways through which unaffordable water bills may influence the behaviors and health of vulnerable people. We interviewed a sample of low-income residential water customers who were experiencing water bill hardship in Boston and Chelsea, Massachusetts, U.S. between October 2018 and December 2019. We conducted a thematic content analysis of interview transcripts. Results showed that some participants improvised ways to pay their water bills, and some confronted obstacles that made it simply impossible to pay at times. Behavioral responses to coping with high water bills were influenced by household earning potential, self-reported health status, caretaking responsibilities, and accessibility of utility assistance programs. Consequences of unaffordable household bills included reduced access to other necessities, debt accumulation, risk of water shutoff, housing insecurity, and public humiliation. Reported health-related impacts of water bill hardship were food insecurity, underutilization of healthcare and medications, and decline in mental health. Comprehensive reforms at all levels of government are needed to make water affordable for all low-income households. Federal investments in water infrastructure, state oversight of affordability and human rights, as well as municipal tiered water pricing and comprehensive assistance policies for low-income households are needed to address the growing water affordability crisis and to mitigate harm to the well-being of vulnerable residents and communities in the United States.

Introduction

Access to clean and safe water is essential for human health and well-being, but recent and substantial increases in the cost of water and sewer services for residential customers in the United

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States endanger the health of those who cannot afford to pay [1, 2]. Between 2000 and 2016, the cost of water and sewer services to U.S. residential customers nearly tripled—rising much faster than other basic expenses and inflation [3]. The average residential combined water and sewer bill increased 80% in some U.S. cities from 2010–2018 [4]. The cost of restoring the nation’s deteriorating physical water infrastructure [5], improving the quality of drinking water [6], and fortifying water systems to handle the effects of climate change [7] will continue to drive up consumer rates in the U.S. for years to come. Water affordability and associated social, economic, and health concerns are intensifying not only in the U.S. but also around the globe [8, 9].

National studies estimate that water bills for 12% of U.S. households exceed a federal affordability guideline, and households in the lowest income quintile pay on average 9.7% of their disposable income for water and sanitation services [10, 11]. Absent federal legislation and aid programs in the U.S. to ensure water affordability, local policies govern how much residents pay for water, who receives assistance to pay water bills, and penalties for nonpayment. Some municipalities offer customer assistance plans (e.g., discounts, payment plans), but only to certain categories of customers, such as the elderly or disabled persons [11–13]. Means-tested water rate restructuring plans aiming for maximum coverage of all low-income customers are gradually being adopted by some large cities [11, 12, 14, 15]. Nevertheless, many cities in the U.S. shut off water services to residential customers who fall behind on their payments, leaving them without running water [16–18]. Other municipalities transfer delinquent water balances to property tax liens, which can cause foreclosures leading to loss of homes [19]. Low-income individuals, who are disproportionately people of color, are more heavily burdened by such policies [20–23]. When family budgets are stretched thin by high water bills and other housing costs, there are adverse outcomes such as deprivation, illness, and cumulative effects on deteriorating physical and mental health over time.

In 2011, the United Nations Special Rapporteur on the Human Rights to Safe Drinking Water and Sanitation noted during a visit to the United States that the cost of water and sanitation services often causes low-income households to “make difficult financial choices in meeting basic service needs” [2]. Water is a basic necessity and water prices impose financial burdens that force people to make spending tradeoffs [1, 24]. The first U.S. national study of the impact of water prices on consumer spending found that 4% of households reported they would not be able to afford some essential goods (e.g., groceries, mortgage/rent, doctor visits, or prescription drugs) and 20.5% said they would have to cut back spending on these essentials if their water bill rose by as little as \$12 per month. Those percentages grew with each successively larger hypothetical increase in monthly water bills. Income was the most important factor explaining differences in hardship: households earning less than \$50,000 a year were 11 times more likely than higher income households to say they would not be able to afford some essential goods if their water bills increased [25]. Similarly, energy insecure households that face threatened power shutoffs forego necessities in order to pay their utility bills [26, 27].

Inadequate sanitation causes a variety of illnesses, not only abroad but also in the U.S. in places where water services are unaffordable. Children are especially vulnerable to sanitation-related illnesses as well as adverse impacts on mental and social development [28, 29]. Fecal-oral infections of skin and eyes due to inadequate hygienic practices such as handwashing and toilet flushing, as well as transmission of waterborne diseases, can result from insufficient water access in homes [30]. In the U.S.-Mexico border region, where many residences do not have piped drinking water or septic tanks, researchers have documented high rates of waterborne illnesses, such as gastrointestinal infections and communicable diseases due to unsanitary water storage containers and conditions in the home [31–33]. In Detroit, water shutoffs have been associated with skin and soft tissue (e.g., staph) and gastrointestinal infections (e.g., shigellosis, giardiasis) [34].

Unaffordable housing, including the cost of water, forces people into unhealthy lifestyles and contributes to health disparities that last a lifetime [35]. Such indirect effects are part of a broader pattern of socioeconomic disadvantage, which has cumulative negative effects on physical and mental health from childhood through old age in high- and middle-income countries [36–38]. Epidemiologists, economists, and social scientists offer intertwined explanations for health disparities that are embedded in socioeconomic disadvantage. These include: 1) low income that limits access to healthcare and medications; 2) restricted access to healthy foods; 3) lower educational and occupational attainment that limits access to reference groups that could provide social support for healthy lifestyles; and 4) more environmental hazards in low-income neighborhoods [39, 40]. In addition, coping with chronic stress, which is more prevalent among people of color, contributes to poor general health and a variety of age-related illnesses [41–44].

In this study, we documented the lived experiences of people with household water bill burdens deemed to be unaffordable according to international and U.S. benchmarks. Our objectives were to describe pathways linking high water bill burden to health-related outcomes, including a variety of behavioral responses given an individual's circumstances, their subsequent consequences, and potential impacts on health. Identifying these pathways has never been more important than during the COVID-19 pandemic, which has highlighted both the importance of clean water to prevent spread of communicable disease and the financial burdens of coping with a prohibitive cost of living while navigating an economic crisis.

Materials and methods

This study took place in Boston and Chelsea, two neighboring coastal cities in Massachusetts, U.S. Boston is the largest city in the state and Chelsea is a smaller post-industrial city. Each city has around 20% of people living below the poverty line, approximately 10% elderly, and approximately 10% persons 18–64 years living with a disability. They are also both majority non-white cities, with white non-Hispanics making up 45% of Boston residents and 20% of Chelsea residents (Table 1).

The unit charge for combined residential water and sewer services was higher in Chelsea during the period of this study (2018–2019), although both cities had experienced substantial increases in combined water-sewer charges over the previous six years, on the order of 25% (Table 1). Compared to 60 other Massachusetts communities served by the Massachusetts Water Resources Authority (MWRA), these rate increases were in the highest quartile [45]. In 2017 and 2018, Chelsea had much higher annual rate increases than Boston, which triggered substantial press coverage and highly public debates about the rising cost of water and sewer services. Both cities bill monthly for combined water and sewer, and both use an ascending block rate with base/minimum charges for water and sewer, which is typical in eastern Massachusetts [45].

Each city has distinct types of water assistance and non-payment consequences for its service area (Table 1). For example, Boston provides a 30% discount on the water portion of the bill for seniors and fully disabled individuals who are homeowners, whereas Chelsea provides a 10% discount on the combined water and sewer bill, but for senior homeowners only [46]. In 2018, Boston provided assistance to 8,881 senior homeowners and 950 people with disabilities, while Chelsea provided assistance to 470 senior homeowners (Table 1). Neither city routinely collects data on the numbers of customers who are eligible or apply for assistance or negotiate a payment plan. Therefore, we are unable to provide reliable estimates on the gap between the numbers of households receiving assistance and those in need, but the utilization rates are quite low. Boston shut off water to 724 homes in 2018 and Chelsea (which has a no-shutoff

Table 1. Municipal-level population characteristics, cost of water, and water utility policies.

US Census ¹	Boston	Chelsea
Population	689,326	39,878
Median Household Income	\$76,298	\$60,370
Persons in Poverty	18.0%	19.1%
Less than High School, ≥18 years	11.3%	30.5%
Persons ≥ 65 years	11.8%	9.7%
Persons with Disability, 18–64 years	8.8%	10.0%
Owner-occupied housing	35.3%	26.9%
White alone, Not Hispanic	44.7%	19.6%
Cost of Residential Combined Water & Sewer²		
*2019 Annual Cost (120 HFC)	\$1,560	\$1,793
2017 rate change	2.5%	5.8%
2018 rate change	4.7%	8.0%
2019 rate change	2.8%	1.0%
6-year (2014–19) rate change	25.3%	23.2%
2018 Municipal Water Customer Assistance Plans³		
Discount Policy	30% (water bill)	10% (water & sewer bill)
Discount Eligibility	Seniors or fully disabled; owner-occupied only	Seniors; owner-occupied only
Number using discount	8,881 seniors; 950 disabled	470 seniors
Payment plan	Yes	No
Number on plan	Not reported	NA
Use of shutoff	Yes	No
Number of shutoffs 2018	724	NA
Use of tax lien	No	Yes
Number of liens 2018	NA	418
Charges/fees	Interest, late fees, shutoff fees	Interest, late fees

Data sources for this table

¹ US Census, American Community Survey 2016–2020 5-Year Estimates

² Annual Water and Sewer Retail Rate Survey [45]

³ Information provided to authors in response to Freedom of Information Law requests, augmented by our own research [46]

* Annual cost of American Water Works Association industry standard measure of 120 hundred cubic feet (HFC) or about 90,000 gallons.

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policy) placed tax liens on 481 properties [46]. Boston residents are assessed additional interest and penalties to restore water service to their homes following a shut off [46].

Sampling and recruitment

We used critical case purposive sampling (an approach widely used in qualitative research to select information-rich cases for the desired phenomenon of interest) to identify residents of Boston and Chelsea who were heavily burdened by domestic water bills [47]. Residents who were at least 21 years of age and who had combined annual water bills and sewer bills that exceeded 3% of annual gross household income within the previous 12 months were eligible to

participate. Thresholds of affordability vary across different agencies; the U.S. Environmental Protection Agency (USEPA) considers a combined annual water and wastewater bill exceeding 4.5% of the area's Median Household Income (MHI) to be unaffordable (8), whereas the United Nations recommends a limit of 3% of an individual household's income as an affordability standard [48, 49]. These thresholds have been widely critiqued, however, because area MHI is a poor indicator of community poverty and an especially poor proxy for assessing a household's ability to pay for essential goods [11, 50, 51]. For the purposes of this study, we defined a threshold of affordability as combined water and sewer bills costing no more than 3% of the household's income. We report our methodology following the COREQ guidelines [52].

The first author, a bilingual female Population Health PhD candidate (at the time of interviews), has training in qualitative and quantitative methods and research expertise in water unaffordability among communities of color. She developed relationships with staff at Boston and Chelsea agencies and community-based organizations that provide social services relating to financial aid, foreclosure assistance, housing support, or other kinds of assistance to meet household needs, including water services. These partners assisted in study recruitment by including advertisements in newsletters and in physical or web-based spaces accessed by clients, and by directly referring clients who were experiencing challenges with their water bill. Recruitment materials were available in English and Spanish and offered interviews in either language. The advertisements offered a \$100 Visa gift card for volunteers who were selected for study participation. Forty individuals contacted the first author by phone or email and she phone-screened volunteers for eligibility. Seven volunteers were ineligible for the study because their water bill/income ratio was less than 3%. Seven people were unreachable after initially contacting the first author to express interest in the study and three screened volunteers did not follow through with plans for an interview after the interviewer made repeated attempts to schedule.

During the screening, the researcher asked the volunteers to report the amount of their highest monthly water bills in the last year and their gross household annual income. She then estimated their annual water bill relative to their annual income to determine eligibility. Some people referred to their bills, but others could recite the amounts from memory. The volunteers did not know the study eligibility criteria so they could not know how the researcher would calculate the 3% water bill/income ratio that would qualify them to participate. Later, during the interviews, the interviewer questioned respondents about their water bills. Many participants went into more detail about their bills, describing month-to-month fluctuations in their water bills and describing sources of income, indicating that they had given truthful information during screening.

Data collection

The research team employed a hybrid inductive and deductive approach for this study, based on semi-structured in-depth interviews, including open-ended questions about uses and cost of household water (i.e., water and sewer services) and questions about hypothesized pathways linking high water bill burden to health-related outcomes. [S1 Fig](#) presents the a priori framework with hypothesized pathways linking unaffordable water to health-related outcomes and [S1 Text](#) contains the interview guide used to conduct interviews. We relied on self-reported health because it is generally consistent with clinical assessments and because it is associated with health-related behaviors, risks, and outcomes [53]. The interviewer also asked participants for sociodemographic information. On average, interviews lasted approximately 25 minutes.

The first author conducted interviews between October 2018 and December 2019 with 22 residents in Boston and Chelsea. The interview settings were chosen by the respondent and no one else was present or within hearing distance during the interviews. Sixteen chose to be interviewed in their homes, four interviews took place in coffee shops, and two were phone interviews. Twenty interviews were audio-recorded and transcribed; the transcripts of the nine interviews conducted in Spanish were translated to English. One participant did not consent to audio recording and another's recorded interview was lost due to technical failure. In both cases, the interviewer took notes during the interview and wrote a detailed summary immediately afterward. All personal identifiers (e.g., name, address) were removed from the transcripts, which were then entered into NVivo 11 (QSR International, Melbourne, Australia) for analysis. We did not return transcripts to the participants.

Most study participants were Chelsea residents (18 of 22 participants), which we attribute to intense community concerns about escalating water rates in the two years prior to our study (Table 1). Sample characteristics are mostly reflective of the Chelsea community, which is predominantly Latinx and low-income (S1 Table presents complete sample characteristics). Nineteen participants identified as members of ethnic minority groups: 14 were Hispanic/Latinx, two identified as Black/African American, and three identified as mixed race or other. More than half the participants ($n = 12$) had a high school education or GED. The median age was 57.5 years (range of 45 to 70 years), and the sample was predominantly female (18 participants). The median gross annual income was \$45,100 (unadjusted for household size) and the median water bill burden (i.e., ratio of water and sewer bill amount due to gross household income) was 9%, substantially higher than our threshold of 3% or the thresholds for water affordability suggested by either the U.S. EPA or UN. All Boston participants reported they had received a water shutoff notice in the past. Although home ownership was not an eligibility criterion for the study, all the participants were homeowners, because water costs for renters in Massachusetts are typically included in rent. Thirteen participants were "mom-and-pop" landlords, most typically of a 2- or 3-unit owner-occupied home, and had a median income of \$50,000 and median water bill burden of 9%. These property owners rely on rent payments from the other units to cover their mortgage payments; they paid the water bill for the whole property.

Data analysis

The first author and a research assistant conducted a thematic content analysis that reflected our hybrid inductive and deductive approach. We began coding manuscripts immediately after the first interview and proceeded iteratively. First, each coder independently coded the interviews, capturing codes that identified pathways we anticipated encountering based on our review of the literature (see S1 Fig) as well as novel themes that emerged in the interviews [54]. Based on this initial round of coding, they developed a preliminary codebook. They independently used this codebook on a random subset ($n = 13$) of interviews and then collaboratively refined the codebook until they reached complete agreement for the definition of each code. The finalized codebook contained 43 codes and was employed for focused coding of each interview by both coders. Inter-coder reliability indicated a strong level of agreement (Kappa coefficient = 0.79). This process of code elaboration led to our refined model of pathways linking unaffordable water to health outcomes (Fig 1).

The research team generated reports that grouped related excerpts from the interviews across five themes: 1) coping strategies for managing unaffordable water bills; 2) reasons for payment difficulties; 3) consequences of water bill non-payment; 4) adjudications between paying water bills and other bills; and 5) participants' perceived health-related impacts. We

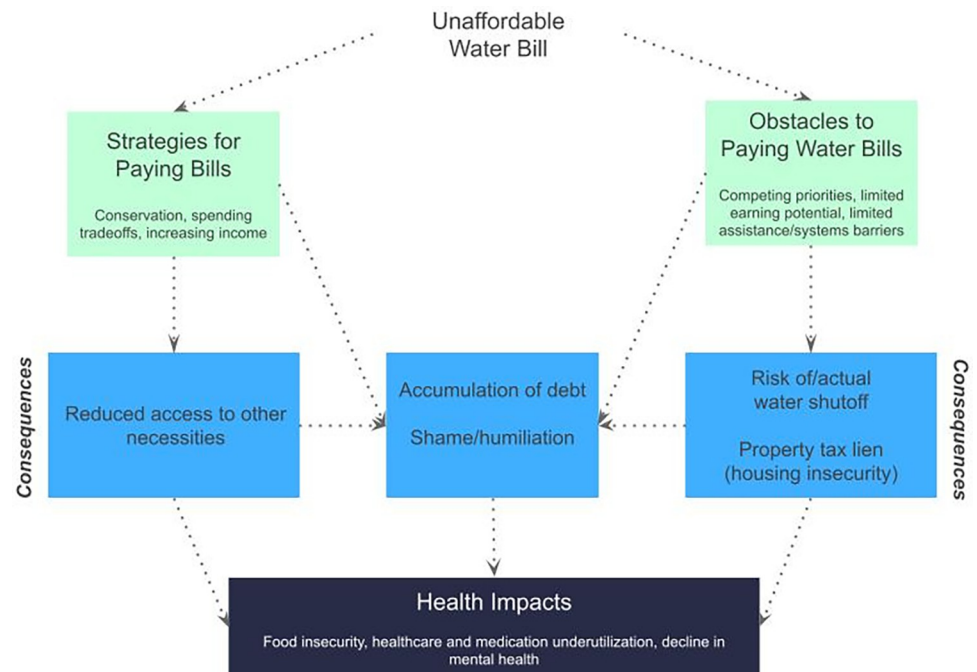


Fig 1. Pathways from water bill hardship to poor health-related outcomes.

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also generated reports regarding experiences of vulnerable groups. Each researcher wrote memos distilling key findings and drawing connections within and between categories. The second and third authors advised on the study design, recruitment strategy, and development of the preliminary codes; they also contributed to writing the manuscript.

As is standard with purposive sampling, the sample size was determined by data saturation (i.e., the point at which recruitment of additional subjects no longer yields new emergent themes) [55]. After coding and reviewing the transcripts for 22 interviews, the research team concluded that no new themes were emerging, and we decided to close recruitment.

Ethics statement

The [redacted for peer review] approved this study on {date and protocol number redacted for peer review}. Data collection began once approval was obtained. Prior to enrolling any participant for this study, oral and written consent for an interview was obtained, in the interviewee's primary language (English or Spanish). Participants had the option to refuse audio recording of the interview.

Results

The confluence of cost-of-living expenses and water cost shaped participants' experiences of water bill hardship. For example, participants in Boston reported lower water bill burden than Chelsea, but the higher cost of living in Boston magnified water bill hardship. The water bill burden in Chelsea has been exacerbated by a recent wave of gentrification, rising rents, and prices for other essential goods.

Our refined conceptual model illustrates the pathways connecting people's behavioral responses to their unaffordable water bills with probable health-related outcomes (Fig 1). We found that to cope with high water bills, participants had either one or both of the following

responses: 1) finding ways to pay the water bill by conserving water, cutting back other expenses, or increasing their income; 2) not paying the water bill or not paying it in full. Participants' responses varied by factors such as household's earning potential, self-reported health status, caretaking responsibilities, and availability of water assistance programs. No matter which response or combination of responses they had in the face of water bill hardship, all pathways led to undesirable consequences with potential negative health impacts. We elaborate on these findings in the following sections and provide representative quotes of each in [Table 2](#).

Strategies for paying water bills

Paying the water bill on time and in full was a high priority for participants, who described myriad coping strategies to achieve this. They reported conserving water as a means of lowering their water bill, most commonly cutting back on length of shower times, frequency of laundry loads, gardening, and in some cases, toilet flushing. Participants also reported installing water efficient fixtures, although they lacked confidence that these devices lowered their water bills. Landlords who rented out a unit in their homes were acutely aware of how their tenants were using water and reminded them to conserve.

All participants reported pressure to remain vigilant over the household budget. They constantly re-evaluated what to cut, identified highest priority bills, and strategized how to increase resources or extend time needed to make payments on bills. A common coping strategy was prioritizing the water bill and cutting budgets for other household expenses. Further, they often likened staying on top of the water bill as a struggle of "robbing Peter to pay Paul." They often referred to their need to reduce payments on other bills (i.e., not paying the balance in full) or borrowing from family or friends to prioritize payment of the water bill.

When possible, participants increased their income or resources to ensure they had enough funds to pay for water and other high priority expenses. For example, five participants reported increasing income through working multiple jobs or overtime hours, taking out a formal loan, or by raising tenants' rent, if they were landlords. A dozen participants described using free or discounted resources, such as more consistent types of assistance (e.g., food stamps) as well as inconsistent types of assistance, such as food drives or one-time financial assistance (for water or other bills) offered by non-profit organizations or family and friends.

Obstacles to paying water bills

Although paying the water bill was a high priority for all participants, employing strategies to achieve this was not possible for some. Those with high-priority expenses could not always preserve funds for the water bill by cutting back on other expenses. Housing insecurity drove some people to prioritize mortgage payments above all other household expenses. They reported that concurrent increases in property tax and water rates have exacerbated their financial hardships. Furthermore, although a handful of participants were able to augment their incomes to cover higher water expenses, many were unable to do so and were unable to pay the water bill in full at one point or another over the previous year. For example, households with older adults or individuals living with a disability were unable to augment their fixed income by means of increasing work hours.

More than two-thirds of the participants told us they could not keep up payments on their water bills because the water utilities offer less accessible and effective assistance compared to gas or electric utilities. They reported receiving income-based energy assistance for heating, but said comparable programs were not available for water bills in either city. There were no participants who were enrolled in a customer assistance plan from water utilities, and most

Table 2. Representative participant quotes relating to responses, consequences, and health impacts of unaffordable water bill burden.

Category	Representative Quote
Strategies for Paying Bills	Water conservation [The water bill goes up] in the summer because I have a little garden outside that I try to grow my own vegetables to save money. Which only cost me money because of the water bill. . . I can't water it to cut a break and save a few dollars. (Participant 1)
	Spending tradeoffs You have to cut everything to be able to pay the water. Last year. . . Yes, eh, I mean, in expenses. I don't spend in clothing, I don't buy anything, I mean. Only if someone gives me something, because I don't work. (Participant 5)
	"Robbing Peter to pay Paul" I mean, a lot of people live the same way. They steal from Peter to pay Paul. What am I gonna pay this month? And then it gets behind on the other one and you keep on running to try to catch them up. . . It's not just me. And it only takes one little thing like a stupid three-hundred-dollar water bill. (Participant 9)
	Increasing income The cost of living is so high that you have to work certain hours. . . My husband works a lot and me too. . . I always work fifty hours so you can do. . . fine with the expenses like that. . . If work allows, you sort of take advantage of it—the overtime—because the overtime is what helps you get the checks more or less so you can cover your expenses. . . [My husband] works more than 50 hours a week. (Participant 15)
Obstacles to Paying Water Bills	Competing priorities [I have gotten behind] because then there is a bill from the college. . . or there's more important, more pressing stuff. Like [they] cannot sign in for classes if you don't pay the fee. It's always something. (Participant 7)
	Limited earning potential You have to focus on [the water bill] and then you forget about something else. . . But I just turned sixty-four. . . When I moved in here, I might have worked three jobs. Now I can't go like that anymore. I get off one job, go to the next one in the morning. I can't do the overnight and go right in. [The money isn't] collecting back like it used to. (Participant 13)
	Systems barriers I've told them I'm disabled. I've even actually brought letters from my doctor's office. And I was never offered a payment plan [or discount]. So I just assumed they didn't do it. Because I brought them a letter and it was like okay, well, this is the minimum that's due right now. (Participant 12)
Consequences of Unaffordable Water	Reduced access to other necessities You spend less money on food, of course. . . Something has to give. If you have a limit of money that you earn per month. . . you say you know what, I'm gonna do lunch and dinner at once. Then I don't have to buy two meals. . . You always cut off things that you can. And that's one of the things that you can. Eat less. (Participant 7)
	Accumulation of debt What's important for me is to gather the money to pay the home. . . Like one focuses more on the house, and that's where you. . . for example, this month I'm not going to pay all of that [water bill], I'm just going to pay fifty dollars. . . I think it's going to take me months to be able to finish paying down that debt. (Participant 4)
	(Risk of) Water shutoff I had to scramble around and borrow money 'cause they were gonna cut me off. And I think it was like a Thursday or Friday and I couldn't afford to go several days without any water. You know. (Participant 12)
	Property tax liens and housing insecurity At the end of the year. . . [if your water debt is] over this certain amount, then they have to send a bill to your mortgage company which then increases your mortgage payments. That has happened to me several times. . . They send you a letter in the mail. (Participant 14)
	Public shame/humiliation At first, I was like 'whoa, they have to tape it on the front door for the whole street to know?' Because everybody knows what that is. . . I was just like, "wow" . . . So yeah. I guess I was just like, shocked and nervous and a little embarrassed. 'Cause I don't like the way they tape that thing on the door. (Participant 11)
Health-Related Impacts	Food insecurity I always pay [the water bill], but I've had to reduce what I pay for [other things]. . . sometimes reduce the food expense. . . You have to buy just the essentials. . . the cheapest. [My wife] has stomach issues. And, the older we get, well, the more expensive things get. . . because the doctor wants us to eat more nutritious foods but it's hard. Because [it] is very expensive. (Participant 20)
	Healthcare and medication underutilization In order for my medicine to last and I don't have to pay a big co-pay, I have to cut every other day. . . I have diabetes, high blood pressure, and cholesterol. . . I have to pay the water bill and cut back on other things. . . it's been keeping me behind a lot of months. . . on other payments. It's either I pay my water bill, or I put food on my table. (Participant 3)
	Decline in mental health Yes, for my health, like I was saying, right, that it affects me very much. There are nights when I don't sleep. I hope my children don't find out, but to tell you the truth, having so much debt affects you. (Participant 4) Now we pay [the water bill] every month, because my husband is working more, but there was a time he was very late [to pay] and then they ended up adding on top of it, and . . . because you're late they also add interest. . . Because everything is very expensive, then here people have to work a lot. So, you don't spend that much time at home and then you [are] really tired. . . I have looked for. . . the way to work enough hours to help my husband cover the expenses and. . . another stress. . . [is] you have to work so much here to cover the expenses that [your] children get dragged behind, poor things. (Participant 15)

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participants had never heard that assistance might be available to them, or they had tried to enroll and been turned down. Senior residents in both cities who were eligible for assistance were unaware of discounts. Although Boston offers payment plans, three of the four participants found them to be inflexible and challenging to navigate and one was completely unaware of the option to use a payment plan, although they had contacted the water utility to request assistance with payment on several occasions.

Moreover, participants also noted that making water payments was difficult due to bureaucratic barriers, such as requirements to visit the utility office in person, long waiting lines to pay overdue bills, and fees to pay bills online. These barriers were most problematic for people with limited mobility or cognitive ability, such as seniors and people with disabilities. In the case of disability-based assistance (available only in Boston), three of the four individuals who self-identified as living with a long-term or short-term disability reported being unaware of any disability-based assistance, even in cases where the participant had specifically requested assistance due to disability.

Consequences of unaffordable water

The most common consequence of paying exorbitant water bills was reduced access to necessities because of household budget cuts. Preserving funds for the water bill typically entailed minimizing the household food budget and spending less on medical services and medications, electricity and gas, clothing, and self-care (e.g., social outings, vacations, exercise). However, several interviewees had essential expenses such as healthcare expenditures or caregiving for children or elders, i.e., areas where they were unable to reduce spending. Those most affected by these high-priority expenses were older adults, individuals living with disabilities, and caretakers. This illustrates the double bind that many people find themselves in, balancing between paying for essential expenses such as utilities and other necessities.

Participants who were able to pay their prohibitive water bills also faced debt accumulation, due to a reliance on informal loans and deferral of payment of other bills (i.e., “robbing Peter to pay Paul”). At the same time, inability to pay the water bill similarly resulted in debt accumulation. In addition to the mounting water bill debt, participants unable to pay their water bill could face interest on unpaid balances, late fees, shutoff notice fees (i.e., fees for delivery of a notice), or mortgage increases, further compounding their debts. Several noted that electric and gas utilities do not charge such fees. They said that unlike gas and electric bills, which fluctuate seasonally, water usage is more consistent throughout the year and there is no relief period for water bills. Participants expressed feeling that they “can’t catch up” because of debt accumulation and that it becomes increasingly challenging to pay their balance down.

Over time, the inability to pay water bills could result in profound consequences for participants. In Boston, unpaid water bills resulted in shutoff notices, and ultimately, water shutoffs. The city of Chelsea does not shut off water; however, Chelsea uses tax liens to transfer water debt to property taxes. Participants told us that they feared having their water bill debt converted to housing debt, which increases housing costs and risk of foreclosure. Interviewees reported enormous pressure and fear of housing instability if they were unable to catch up on their water bill.

Four participants reported public shaming or humiliation. Boston initially sends shutoff notices in the mail and then tapes them to the customer’s front door on colored paper. One participant in Chelsea noted that it is customary practice to list property tax liens in the local community newspaper. Another felt humiliated by constantly living on the verge of having their water shut off and needing to ask friends and family for help to avoid water shutoff.

Health-related impacts of unaffordable water

The health-related impacts of coping behaviors were food insecurity, healthcare underutilization, and medication non-adherence. Participants also reported mental stress and anxiety.

Food insecurity. Food was the most common reduction in basic needs. Two-thirds of participants reported that their grocery budgets have the most elasticity, and many reported being unable to provide the quantity (e.g., skipping meals, smaller portions) and quality (e.g., fruits and vegetables, high-quality protein, organic produce) of foods that they would like for their families. In a handful of cases, people curtailed gardening to conserve water and reduce the water bill, which resulted in less healthy produce available to the household.

Healthcare and medication underutilization. A dozen participants told us that prioritizing the water bill led to underutilization of healthcare and medical procedures, non-adherence to medications for chronic disease or pain management and giving up medical devices or equipment. Some reported discontinuing medication for extended periods or skipping doses to make the prescription last longer. Several participants reported foregoing recommended medical visits or services.

Mental health. Nearly all interviewees described increased stress and anxiety resulting from a confluence of factors: the high cost of water, fear of being without water, resulting accumulation of debt, the inextricable link between water and habitable housing, and sacrificing basic needs to pay the water bill. A handful reported sleepless nights. Such stress and anxiety were exacerbated for participants who internalized trauma resulting from humiliation and shame. On several occasions, participants became visibly angered or even moved to tears when discussing these problems. Many did not access self-care and healthcare resources that might help them cope with such increased stress and anxiety.

Discussion

This study was initiated at a critical time of a national water affordability crisis [17]. Since then, the COVID-19 pandemic triggered an economic crisis at the same time it highlighted the need for clean water and proper hygiene. Temporary moratoria on water shutoffs mandated in hundreds of cities and 20 states in early 2020 [56] reduced the spread of COVID by 4.4% and COVID deaths by 7.4% in counties that implemented them [57]. Most suspensions expired, however, by the end of 2021 and only a few remain in place at this writing. Expired moratoria have left customers with millions of past-due accounts and billions of dollars in accumulated water debt with resumed risks of shutoffs and liens [58]. There is a long history of public health leadership in improving water quality for sanitation and hygiene [59–61]. The pandemic has opened a door for public health advocates to draw attention to the affordability crisis and add their support to demands for universal access to water and the sustenance of basic needs.

Our study contributes to the literature on health-related consequences of unaffordable water on low-income households in U.S. cities and delineates how these effects materialize and are experienced by those with heavy water bill burdens. The findings show that although it is difficult to disentangle water bill hardship from other economic burdens, we nevertheless identified characteristics of the water bill that set it apart. Water is a basic necessity, an essential component of housing security, and (according to the UN) a human right. Our respondents went to extraordinary lengths to pay their water bills, but some faced insurmountable barriers in raising sufficient funds because they could not increase their income or access assistance programs in their cities. For those who paid their water bills (and some who could not), their sacrifices in food, health care and medication, and increased stress necessitated lifestyle compromises that lead to long-term poor health.

Food-insecure families reported reducing the amount and quality of food they purchase and reducing gardening (which might otherwise provide a source of fresh fruits and vegetables). Food insecurity is in turn associated with increased health risks for children (e.g., anemia, anxiety) and adults (e.g., hypertension, diabetes), and overall poorer mental and physical health [62]. Reduced spending on healthcare and medication underutilization directly affect health by exacerbating chronic conditions, and increase comorbidities, health care costs, and mortality [63]. The accumulation of debt due to unpaid bills, use of informal loans, and fees and fines were significant sources of chronic stress for many interviewees. The essential need for water, its requirement as a condition of housing habitability, and fear of losing access to either is a significant stressor. At the same time, being overworked, having reduced access to self-care activities, and experiencing chronic shame exacerbated stress among most of our interviewees. Chronic and unmanaged stress can disturb immune, cardiovascular, and sleep systems and can lead to or exacerbate hypertension, heart disease, depression, and anxiety, poor sleep, and many other mental and physical health problems that shorten lifespans [64, 65].

We found that water unaffordability disproportionately burdens low-income seniors, caregivers, and individuals living with disability or chronic illness. These subgroups are already vulnerable to health problems. Unaffordable water and water shutoff disproportionately burden communities of color [21, 66]. Racial and ethnic minorities already bear an excessive burden of food insecurity [67], healthcare and medication underutilization [68–70], stress [71], diabetes [72], and depression [73], all of which may be compounded by anxiety over rising water bills. Communities with high proportions of vulnerable residents are likely to be cumulatively disadvantaged [74–76], where unaffordable water bills become one of many stressors that interact to produce poor health outcomes.

Policy implications

The cost of water for customers in the U.S. has been rising over time, despite a decades-long decline in residential water consumption [77, 78]. Increasing water bills induced participants in our study to conserve more water indoors and outdoors—a finding that is strongly supported in the literature [79–81]. Studies show that low-income households use less water than high-income households in the U.S. [82, 83] and that lower-income households are likely to cut back on water and other household basic needs in response to even small increases in water prices [25, 82, 84]. Although it is common in the water industry to promote household conservation as a solution to reducing water bills [24], the evidence shows that affordability problems cannot be solved by consumer behavior alone. In the wake of declining consumption, rising infrastructure costs, and decades of decreasing federal support, water utilities have increased customers' per-unit costs to pay for systems maintenance and improvements and service delivery.

Since the interviews for this study were completed in December 2019, Chelsea has not raised the price of water, but Boston increased rates by 3% in 2020 and 9% in 2021. The 2021 annual household combined water and sewer bill for Boston is now nearly equal to Chelsea's bill, and water rates in both cities are about average for communities served by the MWRA [85]. An investigation by the Massachusetts State Advisory Committee to the U.S. Commission on Civil Rights (MA SAC) concluded that the patchwork nature of water pricing and local variation across the state in assistance and penalties contributes to inequality and racial bias. Their 2020 report is critical of the state's failure to guarantee residents' right to water and aid people struggling to pay water bills. The Committee said, the "disorganized highly localized system governing water distribution and costs, combined with the absence of an enforceable state constitutional or statutory right to affordable water, practically guarantees inconsistencies and inequalities" [86].

Comprehensive reforms in water policy at all levels of government—federal, state, and local—are needed to make water affordable for all low-income households in Massachusetts and the U.S. Only recently has the U.S. federal government begun to address decades of disinvestment to help states and localities rebuild and pay for water infrastructure improvements that provide clean, affordable water. The America's Water Infrastructure Act of 2018 authorized federal agencies to partially finance local clean water projects [87], and the Infrastructure Investment and Jobs Act of 2021 (IIJA, also known as the Bipartisan Infrastructure Legislation) contains historic investments in the nation's water infrastructure [88, 89], as well as authorizing \$50 billion over five years to the EPA with favorable state matching terms for lead pipe removal and water treatment.

Federal relief to consumers who cannot afford their water bills finally materialized in relief programs during the COVID-19 pandemic, such as the Consolidated Appropriations Act of 2021 (CAA) [90] and the American Rescue Plan Act of 2021 (ARPA) [91]. Through the CAA, the U.S. Department of Health and Human Services funded grants to states, territories, and tribal communities for the Low-Income Household Water Assistance Program (LIHWAP), a temporary emergency program to assist households with water and sewer bills in fiscal year 2021. ARPA added more funds for assistance with utility bills, rent, and other household expenses to help prevent a massive surge in pandemic-related evictions [92]. These developments at the federal level are encouraging, but we do not know whether LIHWAP funding will be renewed in the future. In this context of uncertainty around the stability of federal support for water projects, MA SAC has urged Massachusetts to revive its own statewide Low-Income Sewer and Water Assistance Program, which has not had appropriated funding since 2003 [86].

Following recommendations from legal, religious, social, and environmental advocacy organizations, some states and localities are leading the way toward consistency and progressive reforms in water pricing and social equity [23, 93–95]. The participants in our study would immediately benefit from three recommendations offered by these advocates: 1) prohibit water shutoffs to homes (Boston); 2) protect property owners from water debt liens that can result in loss of homes (Chelsea); and 3) cancel past water debt and enroll all eligible households in CAPs (Boston and Chelsea). To accomplish the latter, municipal utilities would need to improve their outreach, accuracy of their billing systems, and dispute resolution to prevent unjustified actions against customers. They would also need to release data pertaining to rates, bills, and collections practices; data transparency is a critical element of evidence-based reform [95].

California and New Jersey are examples of states that have passed legislation to make water more affordable. In 2012, California guaranteed residents the right to safe and affordable water, placing responsibility on state agencies to conform with the human rights framework in all future planning for water resources (AB 685) [96]. Since then, the state has allocated millions of dollars to help small community water systems remedy violations of drinking water safety standards with the intent of reducing the cost of water (SB 200), and they have cancelled consumer water debt and provided millions in water bill assistance. In a setback, however, on grounds that funding is not available, the governor vetoed SB 222 in 2022, a bill that would have been the first mandated statewide water rate assistance for all customers [97, 98]. In 2022, New Jersey was the first state to enact legislation requiring all publicly- and privately-owned water, sewer, electric, and gas utilities to make data publicly available and produce quarterly reports at the zip code level on metrics related to water unaffordability such as rates, usage, arrears, shutoffs, assistance recipients, and so on [99]. Some other states (e.g., New York) are considering similar legislation. Massachusetts residents would benefit from adoption of such statewide measures.

In the long run, water rate structures that recognize differences in customers' ability to pay will help all low-income households, rather than limiting assistance to those who qualify for assistance programs based on categorical eligibility, as in Boston and Chelsea. The push to establish a uniform affordability standard to determine who is eligible for lower tiered water rates and CAPs is an active arena in research and advocacy, including national and state proposals [11, 50, 51]. The Unitarian Universalist Service Committee supports a national uniform affordability standard that water bills should not exceed 2.5% of monthly household income [93].

In 2017, Philadelphia became the first city in the U.S. to adopt an income-based water rate affordability plan that uses federal poverty guidelines to determine how much households pay for water [16]. Further, Philadelphia's program provides a route to water debt forgiveness for those consumers who keep current with their tiered payments over twenty-four billing periods [100]. While this program effectively targets households in need of aid, it is financed by charging non-poor households higher rates, and may not be feasible elsewhere because some states have interpreted their laws to prohibit local water districts from using rate-payer funds to offset costs for low-income customers [101]. Water advocates argue that such state laws need to change. Baltimore began accepting applications for its new Water4All program (Ordinance 20–468) in 2022, which discounts water bills for families with incomes below 200% of the federal poverty guidelines, including renters [15]. Detroit, which became the international face of the U.S. water affordability crisis with upwards of 200,000 residential shutoffs since the early 2000's [24], implemented a two-year pilot Detroit Lifeline Plan in 2022 to charge low-income residents no more than 1.8% of monthly income in conjunction with assistance for paying water bills [14]. These changes are in line with policy actions recommended by the International Organization for Economic Cooperation and Development (OECD), which calls for all developed nations to protect the right to water and promote social equity with tiered water pricing and targeted assistance programs [102].

Adopting the international "water as a human right framework," the NAACP Legal Defense Fund argues there are ways to challenge water unaffordability on the ground that it disproportionately impacts minority racial groups [23]. Looking beyond the courts and legislatures, grassroots organizers have independently adopted human rights as a platform to challenge unaffordability and other water abuses through mobilization, coalition building, and direct interventions with government [103–106]. A goal for meaningful restructuring of water services will require community groups in Massachusetts and elsewhere to have a larger role in shaping local policies and holding service providers accountable for their actions.

Our findings from interviews in two cities suggest that the incremental and comprehensive policy changes discussed here would positively impact the health of vulnerable individuals and communities in Massachusetts by enabling more households to pay their bills and avoid crippling spending tradeoffs.

Limitations and future research

This study contributes important findings regarding the complex relationship between water unaffordability and health-related outcomes. Nevertheless, there are limitations worth noting. Critical case purposive sampling constrains a researcher's ability to draw broadly generalizable claims to a large population [47]. This study took place in two cities with very high costs of living, and findings may not be generalizable beyond the Boston metro region. Purposive sampling is most effective at capturing the experiences of people in specific circumstances and our findings may not be generalizable to people earning more than the median income, to people in suburban or rural communities, or to people in other cities.

Our findings highlight the experiences of low-income homeowners, who comprise most water bill customers in Massachusetts. A handful of landlords in our sample report passing water costs on to tenants; it is likely that consequences of water hardship may also be felt by renters, even though these pressures may be invisible because they are not directly responsible for their water bill [86]. Renters comprise more than one-third of the U.S. population and are more likely to experience material hardship and to be racial/ethnic minorities [107]. Further research is needed to understand the health impacts of water unaffordability on renters in the U.S.

Conclusions

Our findings show that water unaffordability has the potential to harm individual health and well-being and exacerbate health inequities in the U.S. Federal funding for rebuilding the nation's water infrastructure could lower utilities' cost of providing water and sewer services, thereby reducing water bills for consumers. Tiered water pricing as well as comprehensive utility assistance programs for low-income households financed by federal, state, and local governments would target more relief from high water bills where it is most needed and promote racial equity. Making water affordable would contribute to improving physical and mental health for vulnerable individuals and communities.

Supporting information

S1 Fig. Hypothesized pathways from water bill Hardship to poor health-related outcomes. (TIF)

S1 Text. Interview guide used to conduct interviews with all participants. (DOCX)

S1 Table. Sample characteristics. (XLSX)

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