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Urban Water Crisis Causes Significant Public Health Diseases in Jackson, Mississippi USA: An Initial Study of Geographic and Racial Health Inequities

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Abstract: Clean and safe water is at the core of sustainable development, and access to it is critical to public health. Urban water crisis is even more challenging because of population aggregations and its consequences for the clustered social-economic activities in an urban area. It can also be a right issue even in developed countries due to the available investment in water infrastructure and its maintenance that may not be equally available to all communities, in addition to the increasing threats by flooding or drought disasters. Using the decadal urban water crisis in Jackson, Mississippi USA as a case study, this primary research focuses on public health inequities between the white and black, and between the city of Jackson and its eight peripheral cities. The hypothesis is that the urban water crisis in Jackson has resulted in extreme public health injustice geographically against African Americans. Then, this research uses the U.S. Centers for Disease Control and Prevention (CDC) PLACES census tract health data, which provide two health status measurements and 12 health outcomes attributes, to conduct a statistical comparison between Jackson and its eight peripheral cities. The results indicated that the urban water crisis in Jackson already results in immense public health inequities. The small p -values (i.e., $<<0.05$) from T tests showed the significantly worse mental and physical health status and health outcomes in Jackson, Mississippi than other seven cities, which indicated the city of Jackson with about 83% African Americans may already have started a critical degradation in public health, and the current water crisis continuously threatens the black majority communities in Jackson in addition to the city of Canton, another majority-black city. It indicates that the federal and state governments must face and address this crucial crisis of urban water issues caused public health disparities in addition to the social injustice and environmental injustice of clean and safe water availability to the black communities.



Citation: Meng, Q. Urban Water Crisis Causes Significant Public Health Diseases in Jackson, Mississippi USA: An Initial Study of Geographic and Racial Health Inequities. *Sustainability* **2022**, *14*, 16325. <https://doi.org/10.3390/su142416325>

Academic Editor: Lotfi Aleya

Received: 3 November 2022

Accepted: 5 December 2022

Published: 7 December 2022

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Keywords: clean and safe water; health status; health outcomes; geographic health inequity; racial health inequity

1. Introduction

According to a World Health Organization (WHO) worldwide report, about 2.1 billion people lack access to safe water at home, and about 4.5 billion people use water without safely managed sanitation services. Billions of people have been able to use basic drinking water and sanitation service since 2000, but every year there are still about 361,000 children under five years old died due to diarrhea, and contaminated water and poor sanitation may transmit diseases such as cholera, hepatitis A, dysentery, and typhoid [1]. Currently, there are about two billion people facing high water stress, and by the year 2030 about 700 million people may be dislocated because of water scarcity [2]. Most of these inequalities in worldwide water issues are observed in Africa, western Asia, and some rural areas in other places, although “Safe water, sanitation, and hygiene at home should not be a privilege of only those who are rich or live in urban centers” [1]. Additionally, water system infrastructure may lack of updating in certain situations due to ineffective management

and/or planning. For example, there are more than \$1.2 billion worth of well-water infrastructure investment wasted over in the last 20 years [1]. In fact, significant inequity of safe and clean water access exists and persists in both developing and developed countries [3], but it may be overlooked in some regions.

Recently, the city of Jackson, the capital of the state of Mississippi, USA and the largest city in the state, experienced another severe urban water crisis in August and September 2022. Urban water crisis in Jackson, MS, on the one hand, indicates the unbelievable fragility and vulnerability of urban water systems to flooding caused by climate change, because continuous rainfall flooded the Pearl River watershed, where the O.B. Curtis water treatment plant locates, causing a key pump in this water plant out of order on 29 August 2022. Then, it resulted in a severe decrease in water pressure and cut off the availability of drinking water to about 150,000 residents in Jackson. Furthermore, the city has to be remained under a boil water notice for more than a month. In fact, Jackson has experienced climate caused urban water crisis for decades. For example, in February 2021, a winter storm cut off drinking water for tens of thousands of residents, which went on even for a month. Unfortunately, it had experienced similar urban water issues caused by storms in 2018, 2014, and 2010 [4].

On the other hand, The National Association for the Advancement of Colored People (NAACP) president Derrick Johnson (2022) emphasized that the urban water crisis in Jackson is the direct result of social injustice and discrimination against African Americans, who are the major population in Jackson, MS [4]. It means that the water infrastructure issue in Jackson is not new. The federal government and the state should address the serious and existing urban water crisis in Jackson, MS [4]. As we know, the USA is the leader in the world for public drinking water surveillance, and in 1974, the U.S. Environmental Protection Agency (EPA) approved the Safe Drinking Water Act as a form of public health protection [5].

The NAACP has officially submitted a complaint letter to the U.S. Environmental Protection Agency, in which it stated that “This discrimination is evident in the State’s repeatedly having deprived Jackson of federal funds to maintain its public drinking water system in favor of funding smaller, majority-white communities with less acute needs—despite the fact that Jackson is Mississippi’s most populous city, with a demonstrated need for improvements to water infrastructure.” And “The consistent lack of investment is reflected in Jackson’s crumbling drinking water infrastructure, including aging supply and distribution lines that are so fragile that they do not allow the system to maintain sufficient pressure.” The water crisis in Jackson with most black residents is more than just a lack of investment or an infrastructure issue, because of many other cities with majority white well maintain the water and sewer systems. Another majority-black city, Flint in Michigan remains unfixed urban water crisis now given the issue was publicly reported eight years ago. As The Washington Post reported “Mississippi has a long history of White political leaders purposefully, and sometimes illegally, steering needed funding away from Black communities” [2]. Ward, Jr. further stated that similar injustice issues observed in the Lowndes County, Alabama in 2017 revealed by the United Nations, where about 70% black residents suffer diseases caused by impure water and raw sewage [2].

Drinking water contamination problems cause public health diseases and even death. A cause of outbreaks study has found the significant association between water contaminations in the USA from 1971 to 2006 [6], and the estimated annual number of endemic acute gastrointestinal illness cases associated with public drinking water ranges from 4.3 to 11.7 million cases [7] or from 5.5 to 32.8 million cases [8]. Public health diseases caused by drinking water have been found in national wide surveys. In the 2013–2014 survey, the U.S. CDC’s National Outbreak Reporting System (NORS) reported 42 drinking water associated outbreaks, which included at least 1006 cases of illness, 124 hospitalizations, and 13 deaths [9]. The CDC’s NORS reported total 36 drinking water-associated outbreaks in USA during 2007–2008, which caused illness among at least 4128 people with three deaths; etiologic agents were identified 88.9% of the 36 drinking water associated outbreaks,

58.3% outbreaks were associated with bacteria, 13.9% with viruses, 8.3% with parasites, 2.8% with a chemical, 2.8% with both bacteria and viruses, and in addition to 2.8% with both bacteria and parasites [10]. In addition, many studies have proved that drinking water contaminants may directly cause numerous types of diseases including cancers [11–13].

In the USA, the availability of safe drinking water is an outstanding public health achievement, but emerging new waterborne disease challenges seem to be overlooked. These emerging diseases include but are not limited to aging infrastructure, chlorine-tolerant, biofilm-related pathogens, and many others [14,15]. There are obvious knowledge gaps of public health diseases caused by these emerging water contaminant challenges or overlooked traditional waterborne issues associated with aging water infrastructure. Therefore, the comparisons of public health diseases between a city with urban water crisis and its surrounding cities that typically share common social, economic, cultural, and political environments, could fill the knowledge gaps of the significant differences in public health disparities caused by urban water crisis and social injustice, in addition to more insight into drinking water system regulations and failure prevention strategies.

The decadal urban water crisis in Jackson, MS may already result in public health disease crisis in its communities. The objective of this study is to use available public health and geographic data to generate an initial disparity analysis of public health between Jackson and its peripheral cities. This study will highlight the potential significant public health injustice related to the urban water crisis in Jackson. Below, this study organizes the methods and disease data into Section 2, the primary results are summarized in Section 3, Section 4 discusses the potential spatial and social injustice and the related health disparities, and Section 5 is a short conclusion.

2. Materials and Methods

2.1. Data Processing

This study uses the U.S. CDC PLACES census tract health data [16] covering the cities of Jackson and its eight peripheral cities of Brandon, Byram, Canton, Clinton, Flora, Flowood, Madison, and Ridgeland in Mississippi (Figure 1) to analyze the disparities among cities. The two general health status attributes of mental health and physical health and the 12 health outcomes attributes (i.e., arthritis, cancer, high cholesterol, high blood pressure, current asthma, current heart disease, chronic obstructive pulmonary, diabetes, chronic kidney disease, obesity, stroke, and teeth lost) are examined, respectively, for health disparities between Jackson and its eight peripheral cities. More details about this dataset and the attributes are provided by the U.S. CDC PLACES [16].

The decennial 2020 census block data of nine cities are used to scale up to census tract to the CDC PLACES census tract level. The city drinking water resources and city boundary data are considered to enhance the understanding of spatial and racial/ethnic equity in public health with different urban water resources (Figure 1). The 2020 census block data are used to have overall measurements of different race and ethnic components in different cities. Jackson city uses surface water as urban drinking water resources, which is processed by two water plants of O.B. Curtis treatment plant and the J.H. Fewell treatment plant (Figure 1) located within the Pearl River watershed. However, other eight cities surrounding Jackson use well water as drinking water resources, and the city of Byram borrows the water from those wells at the southwest Jackson.

2.2. Statistical Analysis

Descriptive statistics are first applied to the health status and health outcomes in Jackson and its eight peripheral cities to understand the general disease status and distribution. The two-sample T test with unequal variance is applied to the significance test of the prevalence of each type of disease between Jackson and Brandon, Byram, Clinton, Canton, Flora, Flowood, Madison, and Ridgeland, respectively.

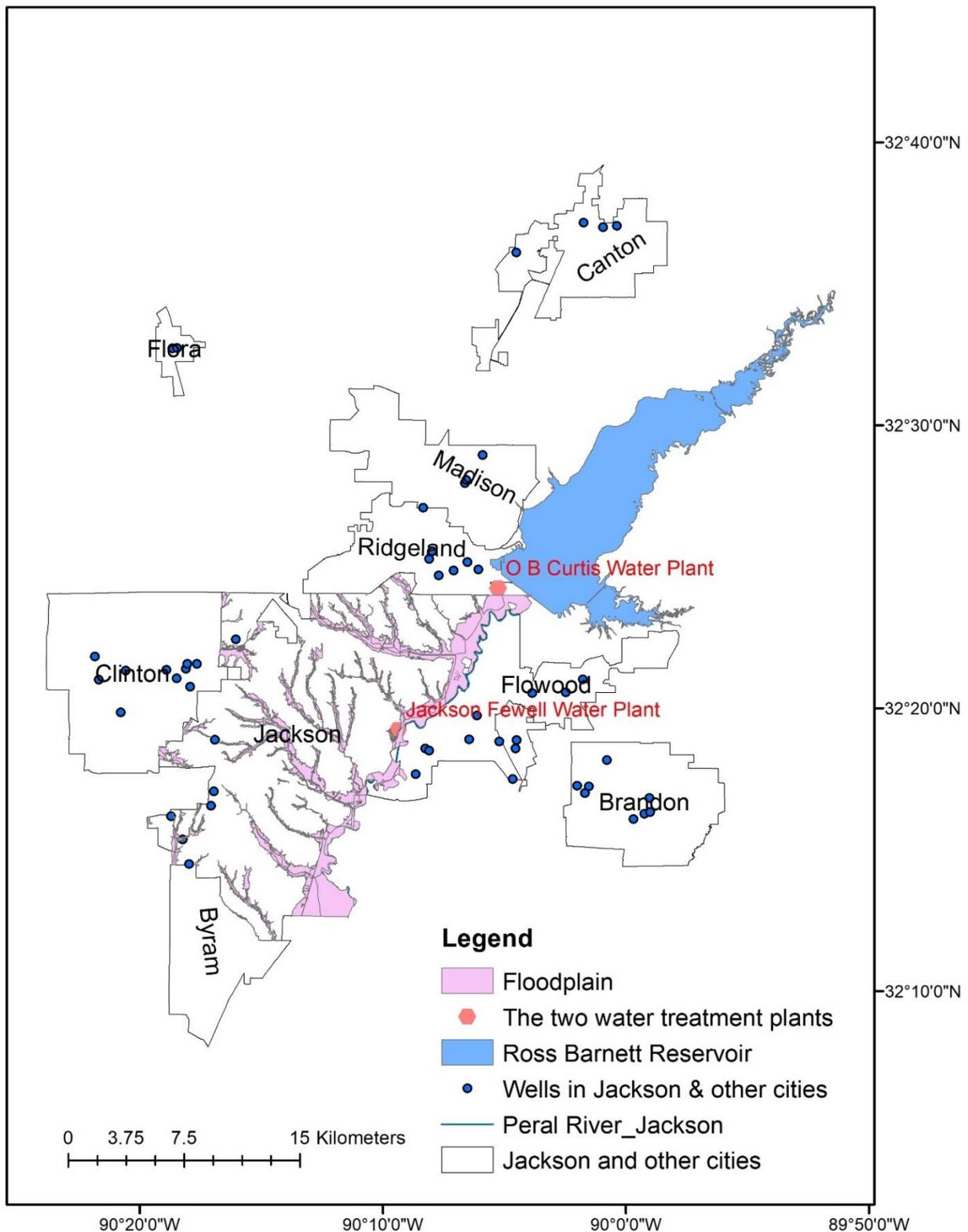


Figure 1. The city of Jackson, its peripheral cities, and urban water resources.

3. Results

3.1. Race and Ethnic Components in Jackson and Its Peripheral Cities

Based on the 2020 census data, the race and ethnic percentages are summarized in Table 1. With a population 153, 463, Jackson is the most populous city in MS. According to the components of the black, the rank from the highest to the lowest among the nine

cities are Jackson (82.5%), Canton (72.7%), Byram (65.4%), Flora (39.8), Ridgeland (39.6%), Clinton (39%), Flowood (28.4%), Brandon (21.8%), and Madison (11.3%). Other races and the Hispanic are in general less than 9% of the total population in each city.

Table 1. The race and ethnic percentages in Jackson and its peripheral cities.

	White	Black	American Indian	Asian	Hawaiian	Hispanic
Jackson	16.2	82.5	0.1	0.3	0.1	0.7
Brandon	76	21.8	0.1	0.2	0.01	1.00
Byram	32.5	65.4	0.2	0.6	0.01	2.0
Clinton	52.6	39.6	0.0	4.3	0.0	4.3
Canton	23.2	72.7	0.3	0.3	0.0	6.0
Flora	56.46	39.77	0.33	0.43	0.00	0.62
Flowood	60.8	28.4	0.3	5.3	0.0	3.3
Madison	79.9	11.3	0.3	6.2	0.0	1.3
Ridgeland	52.7	39.6	0.0	3.2	0.0	6.3

3.2. Health Status Disparities between Jackson and Its Peripheral Cities

The mental health and physical health were first plotted in Figure 2. Apparently, both Jackson and Canton showed much higher averages of prevalence than the other seven cities. To further measure the significant differences between Jackson and other cities. The two sample T test with variant variances were applied, and the results were summarized into Table 2, given the null hypothesis that the general health status in Jackson is better than its peripheral cities. The much smaller *p*-values showed that communities in Jackson experienced significant worse mental and physical health problems than its peripheral cities Brandon, Byram, Clinton, Flora, Flowood, Madison, and Ridgeland, in which the whites are the dominant population. Unfortunately, the Jackson city was as bad as the Canton city, which is also a typical majority-black city, and about 72.7% of the total population are African Americans.

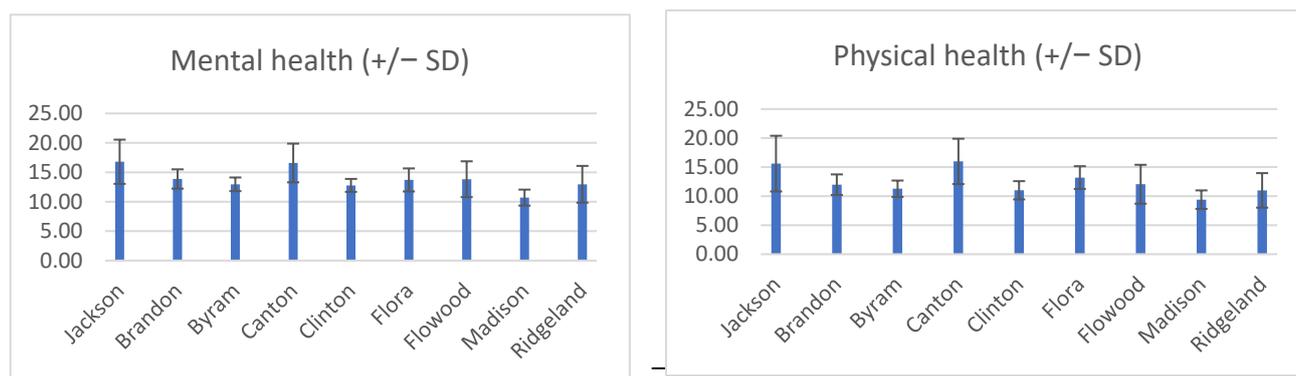


Figure 2. General health status (mental health and physical health sickness, the prevalence) between Jackson and its eight peripheral cities in Mississippi, USA. The statistical analyses are based on the estimates of crude prevalence of mental and physical health not good with more than 14 days of adults surveyed by CDC in 2018 [16].

Table 2. The *t* test *p*-values of health (Mental and Physical) status: Jackson vs. its peripheral cities.

	Brandon	Byram	Canton	Clinton	Flora	Flowood	Madison	Ridgeland
Mental	0.0002	0.0001	0.9	0.0001	0.0002	0.0004	0.0001	0.0002
Physical	0.0002	0.0001	0.8	0.0001	0.001	0.0004	0.0001	0.0002

3.3. The Disparities of Health Outcomes between Jackson and Its Peripheral Cities

The health outcomes of arthritis, high blood pressure, cancer, current asthma, current heart disease, chronic obstructive pulmonary (COPD), diabetes, high cholesterol, chronic kidney disease, obesity, stroke, and teeth lost were first compared using the average prevalence and the standard deviation. The basic results were summarized in Figure 3. In general, there were not obvious differences in the averages of health outcomes of arthritis, cancer, and high cholesterol between Jackson and all its peripheral cities. However, the outcomes of Jackson in the rest nine types including high blood pressure, current asthma, current heart disease, chronic obstructive pulmonary, diabetes, chronic kidney disease, obesity, stroke, and teeth lost were much worse than its peripheral cities of Brandon, Byram, Clinton, Flora, Flowood, Madison, and Ridgeland. Unfortunately, it seems among the nine types of health outcomes, the communities in Jackson city and Canton city experience almost similar worse levels of disease issues than other non-majority black cities, if 70% of total population in a city is used as a threshold to define majority black.

To further explore the differences in these 12 health outcomes, the two sample T test with unequal variance was applied to one by one between Jackson city and its peripheral cities, respectively. The results were summarized into Table 3. (1) One interesting discovery is that the null hypothesis of Jackson city was better than Canon city cannot be rejected, which is consistent with the results in Figure 3. Jackson and Canton share remarkably similar average prevalence in all the twelve types of public health diseases, which are much worse than the rest seven cities. In other words, the majority-black cities showed significant worse health outcomes than the non-majority black cities. (2) For the nine types of diseases of high blood pressure, current asthma, current heart disease, chronic obstructive pulmonary, diabetes, chronic kidney disease, obesity, stroke, and teeth lost, the small p -values showed that the Jackson city was significantly worse than all its peripheral cities except Canton (Table 3). (3) For high cholesterol disease, the Jackson city was better than the city of Brandon and the Flora city but as bad as its other peripheral cities. For cancer, the Jackson city was better than the cities of Brandon, Clinton, Flora, Flowood, and Madison, but at the similar level as Byram and Ridgeland. For arthritis, the Jackson city was worse than Clinton and Ridgeland, but was at the similar level as Brandon, Byram, Canton, Flora, Flowood, and Madison.

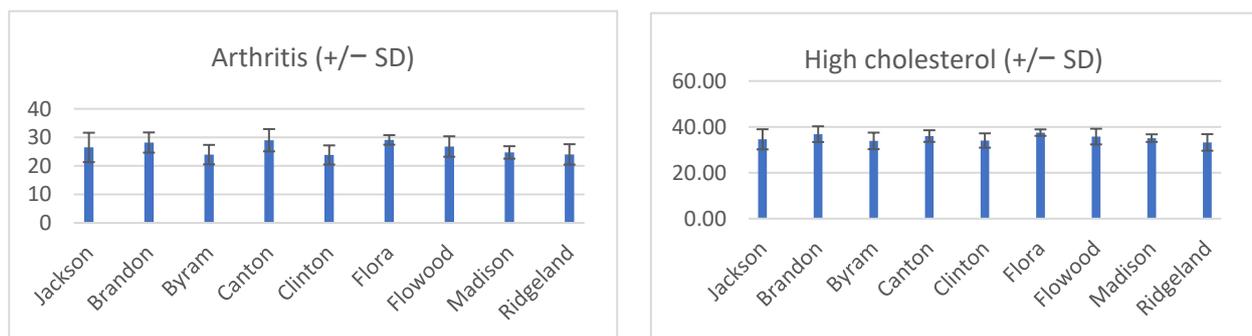


Figure 3. Cont.

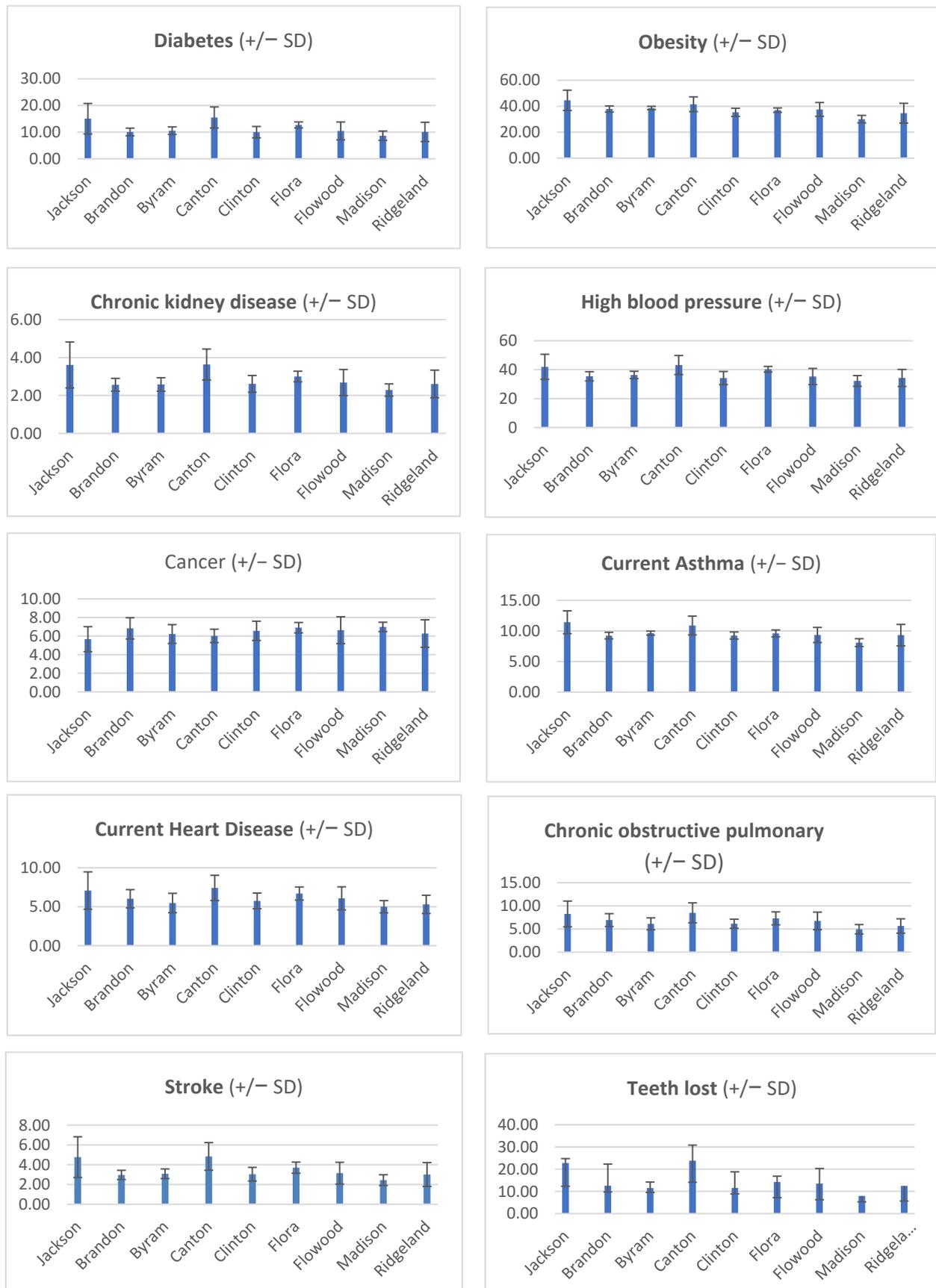


Figure 3. Health outcomes (i.e., the prevalence rate) based on modeling estimates for crude prevalence

of the above diseases among adults with 18 years old and above, 2018; but the estimates for all teeth lost among adults with 65 years old and above [16].

Table 3. The *t* test *p*-values of health outcomes: Jackson vs. its eight peripheral cities.

	Brandon	Byram	Canton	Clinton	Flora	Flowood	Madison	Ridgeland
Arthritis	0.0944	0.1194	0.0935	0.0374	0.0450	0.4667	0.0488	0.0251
Cancer	0.0042	0.1299	0.1637	0.0248	0.0300	0.0366	0.0000	0.0961
High cholesterol	0.0366	0.4505	0.1299	0.3426	0.0451	0.2000	0.2623	0.1243
High blood pressure	0.0000	0.0033	0.3411	0.0006	0.0001	0.0011	0.0000	0.0003
Asthma	0.0000	0.0000	0.2268	0.0000	0.0035	0.0001	0.0000	0.0005
Heart disease	0.0160	0.0238	0.3293	0.0050	0.0080	0.0353	0.0000	0.0002
COPD	0.0112	0.0085	0.4034	0.0001	0.0005	0.0187	0.0000	0.0000
Diabetes	0.0000	0.0001	0.4013	0.0000	0.0001	0.0005	0.0000	0.0002
Kidney	0.0000	0.0002	0.4752	0.0001	0.0003	0.0008	0.0000	0.0002
Obesity	0.0000	0.0000	0.1350	0.0000	0.0001	0.0011	0.0000	0.0002
Stroke	0.0000	0.0000	0.4588	0.0000	0.0003	0.0004	0.0000	0.0001
Teeth lost	0.0000	0.0000	0.4026	0.0000	0.0001	0.0013	0.0000	0.0001

4. Discussion

The much worse health status and health outcomes in Jackson than its peripheral cities showed there must be some significant issues in Jackson's hygiene and environmental health systems. The city of Canton showed similar public health issue as the Jackson city. Unfortunately, the two cities are majority-black communities, and they are much significantly worse than other seven cities especially the majority-white ones in mental health, physical health, and the nine health outcomes of high blood pressure, current asthma, current heart disease, chronic obstructive pulmonary, diabetes, chronic kidney disease, obesity, stroke, and teeth lost. Although Canton is a small city, the federal and state governments must take actions on the diagnostic process about drinking water systems or other environmental health systems to address the critical social and environmental injustice issues.

In the region of Jackson and its peripheral cities, the urban water crisis in Jackson and the contaminants in the drinking water in Canton could be the major cause, while Jackson and its peripheral cities share similar environmental, cultural, social, and economic conditions. According to the water quality report by www.tapesafe.org, the lead contents in tap water (mg/L) are 0.0062 (Canton), 0.0045 (Flowood), 0.0042 (Jackson), 0.0027 (Brandon), 0.0019 (Madison), 0.0013 (Clinton), and 0.001 (Ridgeland), but no records were found for the cities of Byram and Flora. We need to know, the U.S. EPA has set zero as the maximum contaminant level of lead in drinking water, because even an incredibly low lead contaminant in drinking water can significantly harm human health as lead is easy to accumulate in the body over time and risk hence increases over time. In addition, in the last three years, there were 18 times health-based violations of the Safe Drinking Water Act in Jackson that are mainly caused by the fragile drinking water infrastructure, and there was only once in Clinton, and zero for other cities. However, toxic water contaminants of Tetrahydrofuran, 1,3-Butadiene, 1,1,2-Trichloroethane and Bromide were detected in the city of Canton (<https://qualitywatertreatment.com/pages/city-of-canton-water-company-mississippi>, accessed on 1 October 2022).

The trend of differences in arthritis, cancer, and high cholesterol diseases between Jackson and its peripheral cities was not obvious. For example, cancer is ranked one of the top public health diseases in the USA. Black males have significantly higher incidence rate, which is about 1.5 times as likely to die from lung and bronchus cancers than white men [8], and black women with breast cancer have a significant higher rate than white women. The black-white differences in cancer outcomes are not racial differences but the

failure to provide suitable cancer care and related services to the black [8,17,18]. Therefore, this study would argue that the significant worse health status and health outcomes in Jackson city than its peripheral cities could be directly caused by the overlooked decadal urban water crisis, and for example, the U.S. EPA warned Jackson in 1970s and in 2020 [19].

Although there are numerous studies of water crisis, most of them are focusing on water scarcity and domestic or personal hygiene in developing countries. There are few similar crises as Jackson water crisis in a developed country. The water crisis in Flint, Michigan USA is comparable. A number of studies of Flint water crisis showed that the elevated bacteria and lead contaminants in urban water system have resulted in serious consequent public health issues, including birth outcomes [20], fertility [21], and behavioral health problems caused by elevated blood lead level in children [22,23]. More studies recently further showed that the mental health issues and psychological problems including angry, depression, anxiety, stigma, health worries, aggressiveness, trouble concentrating, emotional outbursts, lower trust in public health officials, and sleep problems, in addition to health injustice [24–30]. The Flint water crisis seems like the most pictorial illustration of health inequality in the USA [31], and researchers thought it was even more “insidious” than the Chernobyl disaster [25,32]. Currently, the Jackson water crisis is significant yet overlooked for many years that may end up causing public health consequences even worse than Flint.

More detailed and specific studies are required to address the relationship between urban water crisis and the public health crises in Jackson. It may include data collections of water contaminants in surface water sources in Jackson, tap water quality and its differences across different communities in Jackson, water infrastructure quality, and community health status and health outcomes, in addition to demographic characteristics of age, race/ethnic, and wellness status. Then, the relationship between water and health can be quantitatively and statistically modeled in detail. The governments and communities should establish a practicable plan to diverse water sources and manage and maintain both water quality and water system infrastructure for sustainable urban water supply, which must be an equitable solution to all races and ethnics, especially the underserved communities including any marginalized populations.

5. Conclusions

The urban water crisis in Jackson may already result in immense public health inequities, and the black communities experience significantly higher public health diseases than the majority-white cities in the Jackson region, Mississippi, USA. The significantly worse mental and physical health status and the nine types of health outcomes in Jackson and Canton, which are majority-black cities in the Jackson region, than other seven non-majority black cities have showed Jackson may have started a critical degradation in public health that is still significantly threatening the black communities in Jackson, and likewise, the city of Canton. It indicates that the federal and state governments must face and address this crucial challenge. It is not just a city planning issue but a compounded crisis showing severe social and environmental injustice, such as, the regional water, infrastructure, economic, environmental vulnerability, and other aspects influencing the sustainability of safe drinking water and environmental and public health.

Funding: This research received no external funding.

Data Availability Statement: The input data are extracted from PLACES local health data provided by the U.S. CDC, which are available at <https://www.cdc.gov/places/index.html>, accessed on 1 October 2022.

Conflicts of Interest: The author declares no conflict of interest.

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