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Public Perceptions and Evaluations of Drinking Water Quality in Idaho: A 35-Year Survey Analysis

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Abstract: Water is regarded as the most critical natural resource in Idaho, with drinking water identified as its most essential aspect. To assess public perceptions and evaluations of drinking water quality, a survey instrument was developed and distributed to Idaho residents over the past 35 years. Key areas of focus included the safety of home drinking water, the use of in-home water filters, consumption of bottled water, frequency of water testing, and concerns about potential pollutants. Surveys were administered in 1988, 1993, 1998, 2002, 2005, 2010, 2015, 2018, and 2022, with findings indicating a gradual decline in perceived drinking water safety, from 90.2% in 1988 to 80.2% in 2022. The use of in-home water filtration systems increased significantly, rising from 16.2% in 1988 to 29.7% in 2022, potentially driven by extensive advertising campaigns rather than increased contamination concerns. Bottled water usage peaked at 33% in 2010 but has since declined to less than 11% in 2022, a trend attributed to heightened public awareness of tap water safety and environmental concerns related to plastic waste. No significant long-term patterns in water testing were observed, although rural residents, who rely on private wells, were more likely to test their water due to the absence of regular testing requirements. Hard water (with a high content of Ca and/or Mg) emerged as the primary contaminant identified by respondents, with no other significant pollutants widely reported. These findings offer valuable insights into shifting public perceptions of water quality and the factors influencing household water consumption practices in Idaho over the last three decades.

Keywords: Bottled water; Drinking water quality; In-home water filters; Public opinion surveys; Water testing

1. Introduction

The United Nations (UN) suggests that a safe and plentiful supply of water should be a basic human right (Gleick, 1998). However, over 800 million people suffer annually from water-borne diseases. These diseases cause a high mortality rate in young children. When hydration needs and agricultural demands for food production are considered, each human on the earth needs approximately 900,000 liters of water on an annual basis. In water-scare countries, people's demand for water is supplemented or met by importing food from temperate-region countries. The minimum daily water requirement for a person ranges from 7 to 50 liters per day to the minimum in cooler climates to higher estimates between 1,350 and 4,600 liters per day in dry climates (Chenoweth, 2008; Falkenmark, 1986; Gleick, 1996). The minimum 50-liter water per day is used to meet four basic water requirements, i.e., drinking water for survival, human hygiene, water for sanitation, and household food preparation (Chenoweth, 2008). According to the World Water Assessment Programme (2003) and the World Health Organization UNICEF (2000), strictly from a drinking water standpoint, a human adult should consume between 1.9 and 2.2 liters per day on average.

Drinking water has been valued and protected based on the scientific knowledge at the time by societies for over 5,500 years (Spellman, 2017). Certain human activities that make drinking water unsafe were first identified by the ancient Mesopotamians. This society created laws, which provided the minimum separation distances between human drinking water sources and activities and were thought to make water unsafe. The Romans later added many tools to the safety of drinking water, including aqueduct delivery systems and sand filters to improve water quality. Advances in organic chemistry and microbiology in the 1800's greatly improved the quality of

drinking water. This period is known as the “progressive period” in drinking water history, when cities in the developed world treated water supplies for microbial pathogens and then safely delivered the treated water to households in Europe and parts of North America. In the 1960s, communities began to treat drinking water for harmful organic and inorganic chemicals. Eventually, radionucleides were removed from drinking water to improve its clarity.

Since 2017, more than 75 studies on drinking water have been documented in the scientific literature. This growing focus on drinking water is observed across the globe, with approximately 40%, 35%, and 25% of these studies representing highly developed, middle-developed, and less-developed countries, respectively. In the USA, over 480,000 households lack complete plumbing for safe drinking water and over 1,165 community water systems have significant drinking water violations (Mueller & Gasteyer, 2021). Drinking water in Canada and the USA is not universally clean, affordable, trustworthy or equitably governed (Meehan et al., 2020). Recent studies in the USA indicate that a higher proportion of Hispanics and Native Americans have higher levels of arsenic and uranium in their water supplies than the population as a whole (Martinez-Morata et al., 2022). Scientists have suggested that drinking water quality needs significant improvement in underserved communities by increasing support for small and rural water systems in the USA (Patel et al., 2020).

Many heavily populated countries, including China, India and Pakistan, have been grappling with significant drinking water quality issues and have achieved various degrees of success. The one commonality is that as affluence increases in these countries, the demand for improvements in the drinking water quality continues to increase (Ahmad, 2024; Ji et al., 2020). Substantial differences were identified after comparing drinking water parameters in Africa and the USA. In the USA, advanced water treatment technologies and stringent regulations enhance the drinking water quality; however, aging pipes, pesticides and emerging pollutants such as per- and polyfluoroalkyl substances make water quality less secure. Conversely, in Africa, widespread inadequate infrastructure, pollution and poor regulation enforcement put a significant percentage of Africans at risk (Otorkpa et al., 2024). The water quality index, which is often used to access drinking water quality in many parts of the world, was found to be valid on a localized basis. However, recent studies have shown that the index has little value when using large data sets from differing geographic areas (Manna & Biswas, 2023). In the modern world, drinking water quality can significantly vary within a building using best green plumbing technology (Salehi et al., 2020). Consequently, innovations of better water sensor technology are needed for highly sustainable modern and future systems. It is important to remove pesticides from drinking water prior to its distribution to the public; however, current treatment methods are costly and can cause secondary pollution. Advanced oxidation processes should be invested as clean technologies to protect humans and the environment from these pesticides (Syafrudin et al., 2021).

In 1974, the Congress of the USA passed the Safe Drinking Water Act of 1974 to protect drinking water in cities and large towns. The Environmental Protection Agency was charged with the enforcement of this act. All cities were required to regularly test their drinking water and address any health issues associated with its safety. Similar regulations were developed and enforced in Canada, Australia, Japan, South Korea and most western European countries. Consequently, citizens residing in urban areas of these countries could be assured that their drinking water was safe for consumption based on current scientific information during this time period.

Many researchers have studied consumer acceptance of drinking water by citizens (Allaire et al., 2018; Javidi & Pierce, 2018; Syme & Williams, 1993). Coupled with scientific studies, the research reassured the public that their water at the tap was safe in cities of developed countries. However, in rural areas, the public was encouraged to test and protect their water supplies. But protection was up to the individual consumer rather than the government.

Public surveys of drinking water conducted in Canada, Japan, France, the UK, the USA and South Africa have shown that most consumers are satisfied with the quality of their drinking water. However, most of these studies were conducted at a specific time point rather than measuring consumer views over a longer term. In addition, there are still concerns about taste and emerging contaminants, including new organic chemicals and pharmaceuticals in drinking water. Therefore, public surveys should continue and document consumer trends over long periods of time. This long-term study was developed to understand important trends in drinking water quality based on issues considered important by consumers. These types of studies lack the scientific literature due to insufficient funding mechanisms to understand long-term trends about issues currently important with drinking water quality. Consequently, this study was developed in Idaho to investigate public satisfaction and concerns with drinking water over a 35-year period. A repeated measures survey (RPM) was developed to quiz consumers about their concerns about several aspects of drinking water. This RPM was conducted in 1988, 1993, 1998, 2002, 2005, 2007, 2010, 2015, 2018 and 2022. This report summarizes consumer perceptions of drinking water in Idaho over this 35-year period, which is important because of its demonstration of long-term consumer feelings about drinking water quality.

2. Methodology

A RPM instrument was developed to assess public attitudes and concerns about drinking water issues in Idaho,

USA. Within this survey instrument, a set of questions were provided for Idahoans about the source of drinking water within their residence and their perceptions of several issues, i.e., drinking water safety, the use of in-home water filters, bottled water, testing of drinking water, and pollution concerns about drinking water. The six specific questions for this survey study are as follows:

Q1. Do you consider your drinking water (water at the tap) safe to drink? *Choose one answer: a. yes, it is safe; b. no, it is not safe; c. I don't know.*

Q2. What is your primary source of drinking water in your primary Idaho residence? *Choose one answer: a. city water; b. private well; c. bottled water; d. private surface water source; e. I don't know.*

Q3. Do you use a secondary in-home filter to further purify your water? *Choose one answer: a. yes; b. no; c. I don't know.*

Q4. Do you use bottled water to meet at least a portion of your drinking water needs? *Choose one answer: a. yes; b. no; c. I don't know.*

Q5. Do you have your drinking water at your tap tested at least once every five years? *Choose one answer: a. yes; b. no; c. I don't know.*

Q6. List any contaminants that you suspect to be in your drinking water: _____.

In addition to the six basic survey questions, several sub-questions were asked about each specific issue. For instance, in addition to the third question, the public was asked about the types of their in-home filters that were used, their plumbing and placement within the residence. In 1988, 1993, 1998, 2002, 2005, 2010, 2015, 2018 and 2022, these survey questions were embedded within larger 60-question surveys, which were sent to between 1,400 and 2,100 adult residents of Idaho.

The main targeted audience was a representative sample of adult residents in Idaho. In addition to the survey topics, demographic information, including county of residence, community size, length of time residing in Idaho, gender, age and formal education level, was also collected. Community size and county of residence were translated into urban, suburban and rural demographic information. Residents are considered urban, suburban, and rural, respectively, if they live in Idaho counties with more than 100,000 people, between 30,000 and 100,000 people, and less than 30,000 people. Based on 2020 census information from the USA, 4, 9 and 31 counties in Idaho were classified as urban, suburban and rural, respectively.

The survey was developed using the Dillman survey methodology and was delivered to Idaho residents via the postal service (Dillman, 2000; Salent & Dillman, 1994), aiming to obtain a sufficient number of completed surveys to achieve a sampling error of between 3% and 5% (SAS Institute Inc., Online document 9.1.3). The survey process was also designed to receive a return rate greater than 50% of completed surveys. Addresses of adult Idahoans were obtained from a social sciences survey company (SSI, Norwich, CT). The following four mailing methods were planned to achieve a return rate exceeding 50%: (a) A letter indicating the reason for conducting the survey, a copy of the survey questionnaire and a pre-stamped business reply envelope used to return the completed questionnaire were mailed in the first week of the survey process; (b) A reminder postcard to complete the questionnaire was sent in the third week; (c) Residents that had not yet completed their questionnaire were sent an additional copy with a letter emphasizing the importance of the survey in the sixth week; and (d) A reminder postcard was sent to all people that had not yet completed the questionnaire in the eighth week.

The survey mailing strategy used in this study was identical to that of twelve surveys that had been conducted in Idaho and neighboring Pacific Northwestern states between 1988 and 2023 (Mahler, 2021; Mahler et al., 2004; Mahler et al., 2005; Mahler et al., 2015; Mahler et al., 2019). A required 50% completion rate was obtained in all nine drinking water surveys in this study to achieve low sampling error.

Survey answers were coded and entered into Microsoft Excel. After excluding the missing data, the data were analyzed at two levels using SAS. The first-level analysis generates frequencies, and the second-level analysis evaluates the impacts of demographic factors on answers to the survey questions. Significance ($P < 0.05$) to demographic factors was tested using a chi-square distribution. Since similar response rates to survey questions were observed in the nine survey years, data analysis procedures were identical for each sampling.

When the survey study was first established in 1988, it was determined that the major statistical goal was to determine short- and medium-term trends over time about consumer opinions of drinking water quality. Thus, an emphasis was placed on the comparison of data over the different sampling years. Since the SAS was used to determine these trends, more complex methods of data analysis were not considered in the initial experimental plan.

3. Results

The survey methodology was designed to compare Idahoan responses to drinking water over time to generate useful information on trends. The response rates of Idahoans to the surveys were 51.8%, 52.6%, 53.3%, 58.1%, 51.9%, 52.6%, 53.0%, 54.3% and 52.8% in 1988, 1993, 1998, 2002, 2005, 2010, 2015, 2018 and 2022, respectively. These high response rates resulted in a sampling error of less than 4.6%.

When this survey was first initiated in 1988, the population of Idaho was 986,000 (Wetrogan, 1988). However,

by 2022, Idaho's population had grown to 1,900,000. This 97% increase in population resulted in Idaho becoming more urban over the 35-year study period. In fact, 59% of Idaho's population resides in just four of the 44 counties in the state. On a numerical basis, the urban population was 1,113,000 (four counties) in 2024, while the suburban population was 399,675 (nine counties), and the rural population was 379,575 (31 counties). Based on the 2024 census data and the definitions of urban, suburban, and rural described in the method section, 59% of Idaho is currently urban, 21% suburban, and 20.0% rural.

3.1 Sources of Drinking Water

City water systems (including water from community wells) and private wells were the primary sources of drinking water in Idaho residences between 1988 and 2022 (Table 1). The percentage of Idahoans using city water as their primary drinking water source increased from 67.5% in 1988 to 82.2% in 2022, probably due to the 97% population increase in Idaho between 1988 and 2022. Idaho's population greatly increased during this 35-year survey study and most of this growth occurred in urban areas of the state rather than in suburban and rural counties. The growth in city water for drinking compared to drinking water from private wells is in no way related to water quality differences between the two water sources.

Table 1. The primary source of drinking water in Idaho homes between 1988 and 2022

Year	Using City Water (%)	Using Private Wells (%)	Other Sources (%)
1988	67.5	32.5	0.0
1993	67.7	31.3	1.0
1998	69.4	29.5	1.1
2002	70.4	27.6	2.0
2005	73.5	26.0	0.5
2010	75.2	23.9	0.9
2015	76.4	21.9	1.7
2018	80.2	17.8	2.0
2022	82.8	16.3	0.9
Significance (within columns)	****	***	NS

Note: **, ***, and **** denote significance at the 0.05, 0.01, and 0.001 levels of probability, respectively, while NS indicates non-significance.

Although not as important as city water systems, private wells are still an important source of drinking water for many Idahoans. This is particularly true for residents living in rural and suburban counties. During this 35-year survey study, the portion of Idahoans obtaining their drinking water from private wells decreased from 32.5% in 1988 to 16.3% in 2022. This decreasing trend is significant and will likely continue as Idaho's urban population may expand faster than the suburban and rural populations over the next 25 years.

The column of "other sources" in Table 1 represents that Idaho residents largely depend on surface water ponds, small springs or purchased bottled water as their primary source of drinking water. Less than 3% of Idahoans rely on these three sources for their drinking water supply.

3.2 Safety of Drinking Water

In general, city water, regulated community water systems and private wells (groundwater) provide excellent drinking water for Idaho citizens. This high level of satisfaction is shown in Figure 1, as over 80% of Idahoans considered their tap water safe to drink during the 35-year domestic survey study. The highest satisfaction with tap water quality was at 90.2% in 1988. Over time, the satisfaction level with drinking water safety fell from 90.2% to 80.2% in 2022. Over the 35-year study, the percentage of people that think the tap water at home is safe to drink significantly decreased. Despite this significant decrease in the public perceptions of drinking water safety, still more than 80% of the public think that their drinking water is safe. Idahoans are more likely to consider their drinking water safe to drink than residents of Washington and Oregon (Mahler et al., 2015).

There are at least four explanations for the Idaho public to be more skeptical about the safety of the tap drinking water in 2022 than in 1988. First, the marketplace has become crowded with in-home water filters in the last 20 years. These filters have been marketed through media outlets that the typical Idaho residents are often exposed to. The fact that the public is continually bombarded about potential contaminants in drinking water and the availability of in-home filters to make drinking water safer may have caused a significant portion of the public to be more wary of the water safety.

Second, the local media have been more prone to highlight drinking water contamination in parts of Idaho over the last 25 years. Hot spots of contamination have been highlighted on local, state and national news and initially addressed with local boil water orders until the water is again deemed safe. Approximately, at least one boil water order has been issued for 25% of city water systems in Idaho in the past 35 years.

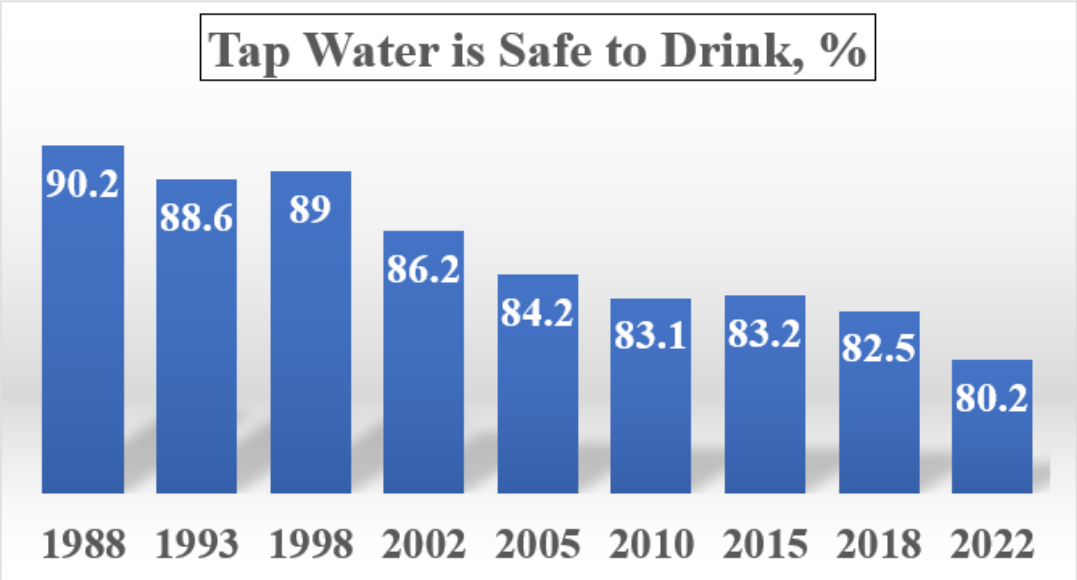

Figure 1. Percentage of Idahoans considering their tap water in their residence safe to drink

Third, major stories about contaminated drinking water have been highlighted on national media outlets. A good example was the Flint, Michigan, water supply contaminated with lead (Butler et al., 2016). Another major national story happened in Milwaukee, Wisconsin (Mac Kenzie et al., 1994). In 1993, the water was contaminated with the pathogen *Cryptosporidium*. This pathogen resulted in 400,000 people being sickened in southeast Wisconsin. These two events are examples of two water safety problems in other parts of the USA which may have impacted people's views of local drinking water safety in Idaho.

Fourth, Idaho residents that drink water from their own private wells receive continuing education about protecting their well water source from local health districts, cooperative extension, non-profit environmental groups and the well-drilling industry. Thus, the public is aware of practices such as shock chlorination and the use of the best management practices to protect their wellhead from contamination. This education may fuel cautions and/or worries from well owners.

3.3 Use of Secondary Water Filters

The use of secondary water filters in Idaho homes between 1988 and 2022 is shown in Figure 2. Over 90% of the installed secondary filters were associated with water use in the kitchen. Over 62% of the secondary filters were plumbed into the home, while the other 37% of them were simple, manually operated devices used for water purification. There is a significant trend for the increasing use of secondary filters over time. In this 35-year survey study, 16.2% of Idaho residents used secondary filters in 1988 and the percentage increased to 29.7% by 2022. This significant trend again is related to the successful marketing of secondary filtering devices to the Idaho public. Even though more than 80% of the Idaho public felt that their drinking water was safe, almost 30% of residents felt that the use of a secondary filter would provide them with additional water safety. Compared to residents of Oregon and Washington, Idahoans were less likely to use secondary water filters in their residences (Mahler et al., 2015).

Table 2. Influence of gender on issues concerning drinking water quality in Idaho

Issue/Answer	Male (%)	Female (%)	Significance
It is safe to drink tap water.	86.4	80.6	**
Use of in-home water filters	20.4	26.6	***
Use of bottled water	18.4	29.3	****
Testing of water once in five years	14.2	14.8	NS
Identification of at least one contaminant	16.8	29.4	***

Note: **, ***, and **** denote significance at the 0.05, 0.01, and 0.001 levels of probability, respectively, while NS indicates non-significance.

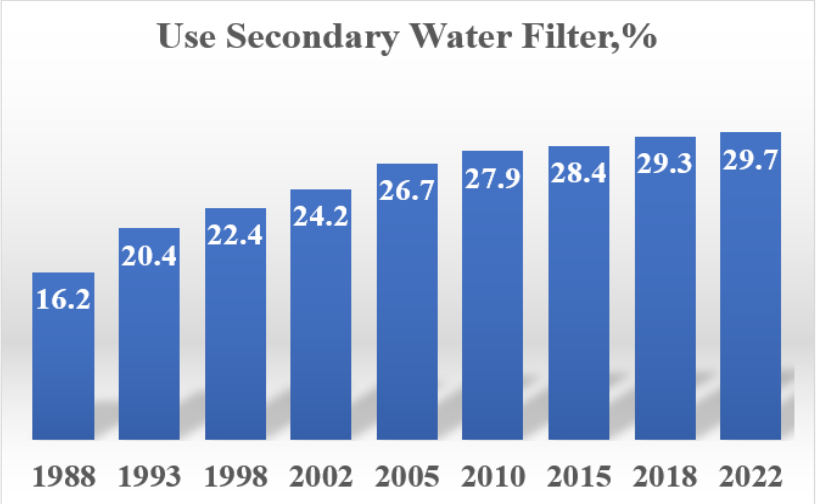

Figure 2. Percentage of Idahoans using one or more secondary water filters in their residence

According to the data pooled from the nine survey years, the demographic factors of gender, age, formal education level, community size and Idaho county demographics impact the use of secondary water filters. Females (26.6%) were significantly more likely to use secondary water filters than males (20.4%), as shown in Table 2. Age significantly impacts how Idahoans view the safety of tap water. According to Table 3, 93% of Idaho residents older than 70 thought that their tap water was safe to drink, while only 71% of people younger than 30 years old thought so. Idaho residents with a high school diploma or college education were more likely to use secondary water filters than those without a diploma (Table 4). Idahoans living in communities with less than 7,500 people were more likely to use in-home secondary water filters than those of larger communities (Table 5). In addition, residents of rural counties in Idaho were most likely to use in-home secondary water filters (Table 6).

3.4 Use of Bottled Water

The use of bottled water by Idahoans over the 35-year study period is shown in Figure 3. Bottled water was used as the primary source of drinking water by less than 1% of residents surveyed. Rather, bottled water was used as a supplement for making coffee and in filters for water-using appliances. In addition, many residents bought bottled water during their travels or as a supplementary source of drinking water for emergencies. Compared to 1988, the percentage of purchasing and using bottled water dropped by more than 54% in 2022 (Figure 3). Public education is the probable reason for the reduced use of bottled water as Idaho consumers became aware of the environmental impact of plastics associated with bottled drinking water. The use of bottled water peaked at a rate of 33% in 2010 before declining in subsequent years.

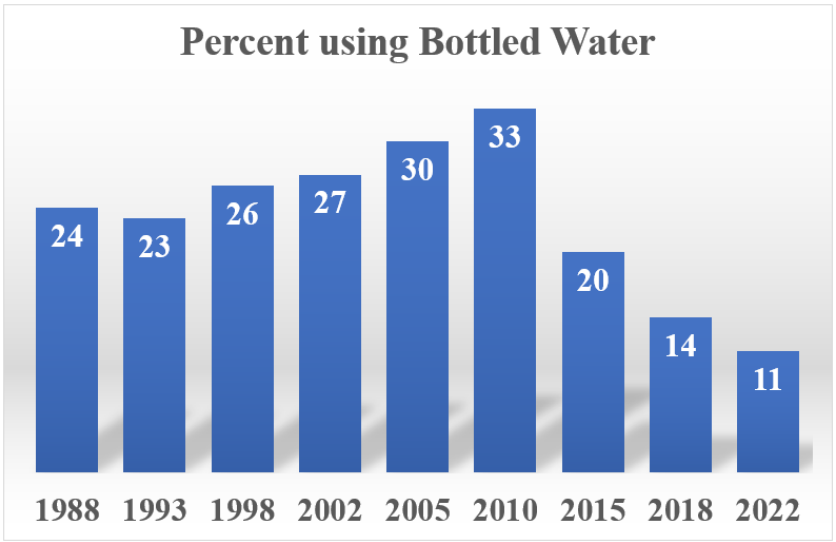

Figure 3. Percentage of Idahoans using bottled water in their residence

Table 3. Influence of age on issues concerning drinking water quality in Idaho

Issue/Answer	Age (%)				Significance
	<30	30-50	50-70	>70	
It is safe to drink tap water.	71.5	84.6	88.3	93.5	****
Use of in-home water filters	18.2	24.0	25.1	29.4	****
Use of bottled water	22.5	22.4	18.9	14.6	**
Testing of water once in five years	8.0	17.3	20.4	26.5	****
Identification of at least one contaminant	7.8	11.4	6.9	6.2	NS

Note: **, ***, and **** denote significance at the 0.05, 0.01, and 0.001 levels of probability, respectively, while NS indicates non-significance.

The demographic factors also impact the use of bottled water. Females (29.3%) were significantly more likely to use bottled water than males (18.4%), as shown in Table 2. Younger residents were more likely to use bottled water than older ones (Table 3). Idaho residents with a high school diploma or college education were more likely to use bottled water than those without a diploma (Table 4). The interpretation of this data suggests that Idahoans without high school diplomas were less aware of the harmful impacts of bottled water on the environment, leading to a higher rate of using bottled water. Conversely, Idahoans with college education were more likely to understand the problems associated with the use of bottled water in plastic containers, and thus were less likely to use bottled water.

Table 4. Influence of formal education level on issues concerning drinking water quality in Idaho

Issue/Answer	Education Level (%)				Significance
	<HS	HS	C 1-3	C 3+	
It is safe to drink tap water.	76.5	80.1	82.5	88.4	****
Use of in-home water filters	24.2	27.1	23.9	28.5	NS
Use of bottled water	22.1	30.3	29.2	18.6	***
Testing of water once in five years	8.9	12.2	23.0	22.1	****
Identification of at least one contaminant	8.6	16.3	29.0	32.4	****

Note: **, ***, and **** denote significance at the 0.05, 0.01, and 0.001 levels of probability, respectively; NS indicates non-significance; <HS indicates no high school diploma; HS indicates high school diploma; C 1-3 indicates one to three years of college; and C3+ = indicates three years of college.

Residents in communities of over 25,000 people were more likely to use bottled water than those in towns with a smaller population (Table 5). Idahoans residing in urban counties were also more likely to use bottled water than those from suburban and rural counties. Residents in Washington and Oregon were more likely to use bottled water than Idahoans, which is a significant difference (Mahler et al., 2005), maybe because both Washington and Oregon are both more urbanized than Idaho. Actually, as for Idahoans living in the four urban counties of the state, their habit of using bottled water was more closely related to that of residents in Oregon and Washington compared with Idahoans in rural counties.

Table 5. Influence of community size on issues concerning drinking water quality in Idaho

Issue/Answer	Community Size (%)				Significance
	>75K	25-75K	7-25K	<7K	
It is safe to drink tap water.	80.4	86.4	86.5	76.2	**
Use of in-home water filters	26.4	24.2	20.1	32.5	**
Use of bottled water	23.5	20.4	16.8	13.5	***
Testing of water once in five years	8.1	7.4	14.2	23.4	***
Identification of at least one contaminant	12.4	13.4	11.8	14.2	NS

Note: **, ***, and **** denote significance at the 0.05, 0.01, and 0.001 levels of probability, respectively; NS indicates non-significance; >75K indicates more than 75,000; 25-75K indicates between 25,000 and 75,000; 7-25K indicates between 7,000 and 25,000; and <7K indicates less than 7,000.

3.5 Water Testing

The percentage of Idahoans that have had their drinking water tested for contaminants at least once in the last five years ranges from 11% to 19%, depending on the survey year. Numerical differences over time were not statistically significant. The regulatory environment must be examined as 19% appears to be a low value for water testing. Residents drinking water from city water systems and community wells were under the protection of the Safe Drinking Water Act, which requires regular testing and protection of these drinking water supplies. Conversely, the residents drinking water from private sources such as wells should test their water. Since the percentage of Idahoans drinking water from private wells varies between 16.3% and 32.5% and most people that

had their water tested have private water sources, the actual percentage of residents that should test their water sources at least once every five years is close to 50%. Given this interpretation of the testing information, the water testing frequency is actually good.

The demographic factors also impact the testing frequency of the tap water. Gender does not impact the testing frequency (Table 2). Age impacts the testing frequency as residents over 70 were more likely to test their water in a five-year period than those less than 30 years old (Table 3). Idaho residents with college education were twice as likely to have their water tested every five years than those with less formal education (Table 4). Idahoans in communities of less than 7,000 people were most likely to have their water tested (Table 5). Conversely, residents of communities of more than 25,000 were three times less likely to have their water tested because their drinking water from the city water systems was likely protected.

Residents of rural counties were four times as likely to have their water tested as those living in urban counties (Table 6). Drinking water coming from wells in rural counties is closely related to the fact that rural residents were much more likely to test their wells on a regular basis, which can be inferred that the low water testing percentages observed in Figure 4 are not a public health problem. The Idaho public tested their water for pathogens or inorganic chemical contaminants.

Table 6. Influence of county demographics on issues concerning drinking water quality in Idaho

Issue/Answer	County Demographic (%)			Significance
	Urban	Suburban	Rural	
It is safe to drink tap water.	91.3	93.8	90.4	NS
Use of in-home water filters	20.4	22.6	26.9	**
Use of bottled water	28.9	24.3	20.1	***
Testing of water once in five years	6.9	12.4	28.7	***
Identification of at least one contaminant	27	24.7	25.3	NS

Note: **, ***, and **** denote significance at the 0.05, 0.01, and 0.001 levels of probability, respectively; NS indicates non-significance; urban indicates counties with more than 100,000 people; suburban indicates counties with between 50,000 and 100,000 people; and rural indicates counties with less than 50,000 people.

3.6 Major Contaminants in Water

Hard water was the only major complaint about drinking water in Idaho. The percentage of Idaho residents that identified hard water as a problem in their home water supply is shown in Figure 4. The lowest reported incidence of hard water by Idahoans was 15% in 1988. Conversely, almost 32% of Idahoans listed hard water as a problem in 2018. The long-term trend of increasing concerns about hard water was significant. Although hard water is not considered a health hazard, it is an inconvenience as hard water makes it difficult to remove soap scum after bathing or washing hands. Other contaminants were minor and no trends were observed over the 35-year study. The most often cited contaminants in drinking water besides hard water were iron and nitrates, which were reported by less than 4% of surveyed residents over the 35-year term of this study.

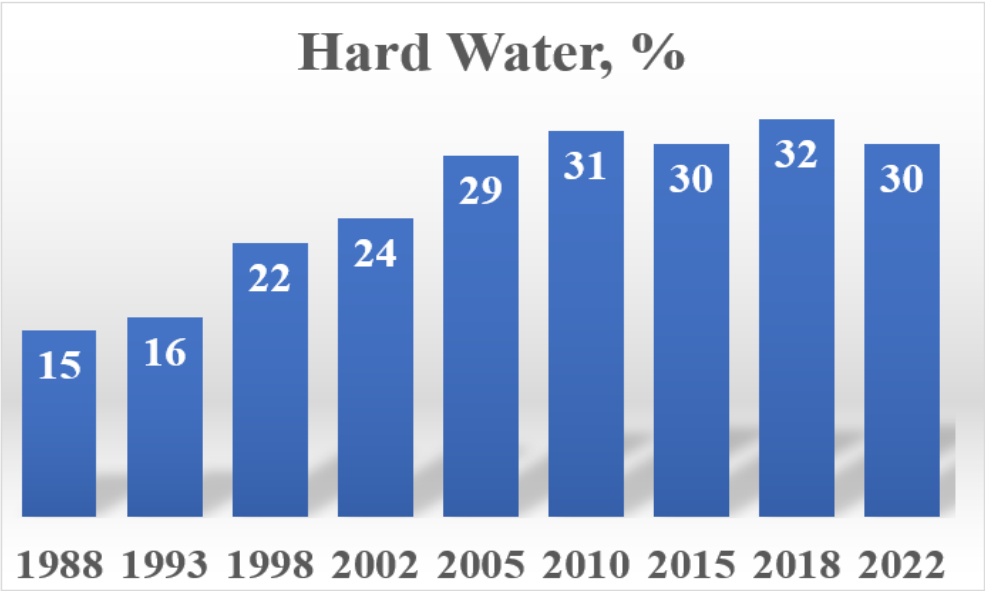

Figure 4. Percentage of Idahoans considering hard water as a problem in the tap water

4. Discussion

Public opinion of drinking water quality in Idaho is impacted by many local, state and national factors. Actual scientific results about water quality are not as important as media coverage of instances, where drinking water is considered unsafe due to specified problems. For instance, whenever a public water system fails to meet a required drinking water standard, this information is relayed by the media to the public, advising the public to boil their water before drinking to remove microbial pathogens. People served by the public water supply system receive safe drinking water 99.999% of the time. However, it is the 0.0001% when a contaminant was found in drinking water that the public remembers. Communities store water for distribution to consumers in a large tank above ground, which is a common example of contaminated drinking water. On occasion, a bird breaks into the tank and taints the water with *E. coli*, the contaminant is identified during frequent routine drinking water testing, which causes the public water system to treat the stored water with chlorine rapidly to destroy any indication of contamination. Meanwhile, the public is advised to boil all consumed water until the contaminant is removed from the water supply. This one instance of a boiled water order can be remembered by local citizens for a long time. This minor incident is not representative of the actual state of drinking water safety in the community.

The Idaho public is also exposed to drinking water problems in other communities when the national media focuses on a severe water contamination instance. Consequently, the public often thinks that drinking water contamination in Idaho is a more widespread problem than indicated by regulatory studies.

This repeated-measures study conducted over time was well designed. The high response rate of consumers makes the study statistically valid. However, this study has limitations in terms of sample selection and bias. The first limitation is that this survey was designed as mail-based when it was initially conducted in 1988. At that time, most people received their information via snail mail. However, as time progressed, an internet survey approach would be better than relying on mail delivery. Many of the more highly educated consumers were more internet-friendly. Therefore, the study may have under-sampled well-informed consumers in the latter years of the study. However, to compare numbers over time, the single sampling type, i.e., mail-based surveys, has to be relied on in this study. Another limitation is the potential bias in the wording of the survey questionnaires themselves. The wording used in the actual questionnaires may have been interpreted differently by younger and older survey audiences.

Even with the above limitations, this survey study provides excellent long-term data about drinking water quality and safety in Idaho.

5. Conclusions

The major findings of this 35-year survey study are as follows:

-Over 80% of Idaho residents considered drinking water at their home tap safe. However, the trends indicate that the perceived safety of drinking water declined from 90.2% in 1988 to 80.2% in 2022. Media coverage about drinking water problems in other areas of the USA has contributed to this slight decline in water satisfaction over time in Idaho.

-The use of secondary in-home water filters in Idaho significantly increased from 16.2% in 1988 to 29.7% in 2022.

-The use of bottled water peaked in Idaho in 2010 at 33%. However, the percentage declined and was less than 11% in 2022. The decrease is tied to public education, which shows that drinking water at the tap in Idaho is safe and water packaged in plastics is the potential harm to the environment.

-There are no apparent long-term trends in drinking water testing by residents. The data shows that urban and suburban residents are less likely to have their drinking water tested because their water is protected by the Safe Drinking Water Act. Conversely, rural residents are much more likely to do so because their primary water source is private wells that are not required to be tested on a regular basis.

-Hard water is the only major contaminant in drinking water complained about by Idahoans with regularity. The complaint about hard water has been increasing over time, with the percentage increasing from only 15% in 1988 to at least 29% in 2005.

-Contaminants such as microbial pathogens, heavy metals, organic chemicals, iron, and nitrates were cited as problems in drinking water by less than 5% of Idahoans.

The demographic factors of gender, age, formal education level, and community size often impact the responses of residents to survey questions. However, in the major findings summarized above, significant trends about drinking water were observed over the last 35 years in this survey study, which is the most important. It was concluded that the state of drinking water in Idaho is good to excellent.

This 35-year study is innovative because long-term research on public opinions about drinking water quality is rare. The results of this study have been widely distributed to the public, professionals and policymakers in Idaho. This study has been used as a model to conduct public opinion surveys about drinking water in 35 other states within the USA and on six Pacific Island entities with a formal association.

This survey study should continue to delve into the medium-term future using the six basic survey questions identified in the methodology section with additional questions as new issues become relevant and impact drinking water. One important change in the future would be to make the survey process internet-friendly.

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Data Availability

The data used to support the research findings are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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