Public Awareness of Drinking Water Safety and Contamination Accidents: A Case Study in Hainan Province, China

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Abstract: To understand public awareness about drinking water safety and water contamination accidents in rural areas of China, two rural counties of Hainan Province were selected as pilot sites for investigation. We explored the degree of public satisfaction with drinking water quality, public trust of drinking water safety, and public awareness about drinking water problems and solutions. The results showed that 80.3% of respondents were satisfied with the quality of their drinking water. About 78.8% of respondents paid special attention or comparatively high attention to drinking water quality and contamination accidents, especially regarding potential damage to the human body and health, the influence scope, and the causes of accidents. A total 52.4% of respondents solved drinking water problems by themselves; few respondents complained to the health department or called the local telephone hotline. Age and sex did not play significant roles in the degree of public satisfaction with water quality or in the public perception of water pollution accidents; however, residents in rural areas within a drinking water quality monitoring network were more satisfied with their drinking water quality and more aware of drinking water contamination accidents than in areas outside of such a network. Respondents with higher education levels had greater awareness than those with lower education levels with respect to water quality and water pollution accidents.

Keywords: public awareness; rural areas; drinking water safety; water contamination accidents; China

1. Introduction

Access to safe drinking-water is important as a health and development issue at national, regional and local levels [1]. China has experienced many drinking water pollution accidents in the past several decades [2]. There has been great effort made from government, industry, academia, and nongovernmental organizations in China to face the challenges of drinking water pollution events [3,4]. However, owing to the governing structure of Chinese society, public participation has not been well-developed with respect to environmental protection [5]. Municipalities and educators have learned that it is not enough to just provide safe drinking water to consumers. Doria suggested the general public is an important factor in water management [6]. IWA declared standards should be based on the protection of human health and consumer acceptability [7]. Public acceptability of drinking water also forms part of the World Health Organization’s guidelines for drinking water quality [1]. Thus, the public perceptions about drinking water safety and contamination accidents must not be dismissed [8,9]. The success of public environmental participation is based upon
sufficient awareness of environmental issues [10,11]. Many studies have found that increasing public environmental awareness and knowledge is crucial to the success of pollution prevention [5,12–14]. The public awareness of drinking water safety is relevant to promotion of household water treatment, to household choices over drinking water sources, and to the prevention of water contamination accidents [15].

In several countries, some scholars identified and evaluated the public awareness of drinking water, for example, in the Pacific Northwest, USA, Mahler et al. evaluated the drinking water issues and concerns of the urban public and found the urban public is satisfied that their home drinking water is safe [8]. In Ankara, Turkey, Calicioglu et al. used the contingent valuation method to determine the public perception and willingness to pay for improvements on water quality [16]. In Austria, Fröhler and Elmadfa investigated the public perception of drinking water quality and found 75% of respondents were completely satisfied with the quality of drinking water [17]. These studies showed that quality perception, service satisfaction and the selection of water sources were very important for evaluating public awareness of drinking water safety and accident. A better understanding of the factors that influence public awareness of drinking water can contribute to improvements in water management, consumer services and water pollution accident prevention and control. Many factors have been found to be involved in the public awareness of drinking water quality. Water sources, water treatment processes, and water supply networks can easily affect drinking water quality and safety [1]. Water quality has a close relationship with people’s livelihood, and access to safe drinking water is essential to health [1]. The awareness of water quality and risk resulted from a complex interaction of diverse factors including water taste, odor, clarity, socio-economic characteristics, demographic characteristics, water treatment, geographic location in the distribution system and information provided by the local media [15,18,19]. For operating drinking water supply systems, the quantity of water, water pressures and breakdowns could also affect drinking water quality [20]. However the recent studies of drinking water safety awareness have been particularly focused around bottled water consumption, municipal water and recycled water. There are limited studies on public awareness about drinking water safety and the relationship between public awareness and prevention of drinking water accidents in rural areas. Thus, this study was designed to investigate the facts about public awareness of drinking water safety and water pollution accidents in Hainan Province, China, and to evaluate information about public awareness and attitudes of drinking water and water pollution. The knowledge provided by this study will contribute to the prevention of drinking water contamination and improvements in water management, especially from the perspective of public participation.

2. Materials and Methods

Hainan Province is the smallest and southernmost province of China. There are a total of nine cities and ten counties in Hainan Province. At the end of 2016, the total population in Hainan province stood at 9.17 million. Hainan’s climate is tropical monsoon, characterized by hot, humid summers and mild, pleasant winters. Temperatures usually range from 24 °C to 35 °C in summer and 19 °C to 25 °C in winter. The province is currently being promoted as “China’s Hawaii”. Water resources are abundant, with annual average precipitation 1500 mm to 2000 mm. However, many residents of Hainan have had problems with their drinking water as a result of flooding and typhoons, which destruct the water pipeline and pump house. As shown in Figure 1, two rural counties (Ding’an and Ledong) were selected as pilot sites for investigation by using simple random sampling method. Ding’an County, an agricultural region, is located in the northeast of Hainan Province, and covers an area 1189 square kilometers in size. The administrative divisions include 10 towns, and the population is 342,000. The main disaster is prone to flooding. The water resource is rich, the annual average precipitation is 1953 mm, and the total water resources are 1.59 billion cubic meters. Ledong County, located in southwest Hainan, has many activities of agriculture and fishery, with an area of 2763.2 square kilometers. The county consists of 11 towns, and the population is 520,000. The main disasters are
flooding and typhoon. The water resource is also rich, and the annual average precipitation is between 1400 and 1800 mm. There are eight drainages, 115 reservoirs in the county, and the total reservoir capacity is 504.4 million cubic meters. Research into residents’ attitudes towards water safety and pollution accidents in rural areas of Hainan Province is of great importance because the results could provide a valuable reference for drinking water control and prevention in other rural areas of China as well as in other developing countries.

![Figure 1. Map of study areas.](image)

In order to investigate public awareness about drinking water contamination accidents, a questionnaire survey was conducted in the two pilot counties from August to September 2013. The specific survey questions covered in this questionnaire deal with responses to questions about drinking water safety and contamination accidents. These questions included the demographic information of respondents, their awareness about drinking water safety (types of household drinking water, satisfaction with drinking water quality, degree of trust in drinking water safety, common problems with tap water and solutions, and awareness about local water quality), and awareness about drinking water contamination accidents (awareness about water pollution events and measures to prevent these accidents). There are 17 questions in the questionnaire. The main questions are shown in Table 1. The demographic information including age, sex, country of residence, and level of education were also provided by respondents. Each questionnaire only takes about 5 min to finish. The responses were collected at the time of interviews.

A town to town survey was conducted in two counties. Respondents were randomly selected from both counties. All interviews were conducted face to face. About 20 residents were selected in each town. Four-hundred-and-twenty questionnaires were distributed, and 410 questionnaires were returned (97.6% response rate), with 201 from Ding’an County and 209 from Ledong County. Ding’an County is within a China drinking water quality health monitoring network (CDWQHMN) and Ledong County is out of CDWQHMN. Data from the surveys were collected, coded and entered into EpiData. The statistical analysis of data was performed using IBM SPSS Statistics for Windows.
Significant differences in public awareness between the two groups of respondents were analyzed by multinomial logistic regression analysis.

### Table 1. The main questions of the questionnaire.

| No. | The main questions                                                                                                                                                                                                 |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | What kind of water do you use as the main source of your drinking water?                                                                                                                                             |
| 2   | Do you pay attention to local drinking water quality?                                                                                                                                                                  |
| 3   | Are you satisfied with your drinking water quality?                                                                                                                                                                   |
| 4   | Do you trust the safety of your drinking water?                                                                                                                                                                      |
| 5   | Do you have any problems with your tap water quality?                                                                                                                                                                   |
| 6   | When you have problems with your drinking water (such as water quality abnormal, pipeline damage, faucet water leakage, etc.), how do you solve these problems? |
| 7   | What factors can affect the quality of tap water?                                                                                                                                                                     |
| 8   | Do you pay attention to the water pollution events reported on TV or in the newspaper?                                                                                                                                 |
| 9   | What kind of water pollution events do you pay attention to?                                                                                                                                                          |
| 10  | What information do you mainly pay attention to the water pollution events?                                                                                                                                            |
| 11  | Who do you think as the main emergency response provider during drinking water contamination accidents?                                                                                                               |
| 12  | What do you think should be strengthened at the emergency disposal process?                                                                                                                                             |
| 13  | What do you think should be done to reduce pollution emergencies?                                                                                                                                                     |

### 3. Results and Discussion

#### 3.1. Demographic Information of Respondents

The demographic composition of the sample is presented in Table 2. Respondents were predominantly female (59.3%), with age groups of 35–50 years and 20–34 years, with college and high school educational levels. These results were consistent with the demographic characteristics of gender, age and education of these two counties.

### Table 2. Demographic composition of the sample.

| Total | Ding’an County | Ledong County |
|-------|----------------|---------------|
|       | Number  | Percent | Number | Percent | Number | Percent |
|       | Age     |         |        |         |        |         |
|       | >50      | 72      | 17.6%  | 43      | 21.4%  | 29      | 13.9%  |
|       | 35–50    | 163     | 39.8%  | 71      | 35.3%  | 92      | 44.0%  |
|       | 20–34    | 162     | 39.5%  | 79      | 39.3%  | 83      | 39.7%  |
|       | <20      | 13      | 3.2%   | 8       | 4.0%   | 5       | 2.4%   |
|       | Sex      |         |        |         |        |         |
|       | male     | 167     | 40.7%  | 95      | 47.3%  | 72      | 34.4%  |
|       | female   | 243     | 59.3%  | 106     | 52.7%  | 137     | 65.6%  |
|       | Education level |     |        |        |        |        |
|       | bachelor and above | 74 | 18.0% | 46 | 22.9% | 28 | 13.4% |
|       | college   | 112     | 27.3%  | 48      | 23.9%  | 64      | 30.6%  |
|       | high school | 156    | 38.0%  | 64      | 31.8%  | 92      | 44.0%  |
|       | middle school | 57   | 13.9%  | 35      | 17.4%  | 22      | 10.5%  |
|       | primary school and below | 11 | 2.7%  | 8       | 4.0%   | 3       | 1.4%   |
3.2. Public Awareness about Drinking Water Safety

3.2.1. Household Drinking Water Sources

Household water security is a key part of the United Nations’ International Children’s Emergency Fund (UNICEF) efforts in the WASH (water, sanitation and hygiene) sector [21]. Survey results regarding sources of household drinking water are shown in Table 3. Tap water was the main type of drinking water reported by respondents (70.7%), followed by well water (22.8%). The consumption of barreled or bottled water was very small (5.2%). These are different from some developed countries and some wealthy city in China. Bottled or barreled water consumption in these areas has greatly increased in the past decade [22,23]. Based on 2016 Hainan Environmental Status Bulletin, the water quality of surface water and ground water is good, and the qualified rate of water quality of surface water is 90.1% (and is considered as excellent by local authorities, which can be questioned), and there are not many accidental water pollution events in Hainan province except flooding and typhoons [24]. Thus, at the two pilot sites, many small tap water utilities have been established, and tap water and well water are popular in these areas. A few respondents used barreled or bottled water as their main household drinking water sources. Some studies have shown that when consumers are dissatisfied with the tap water provided by municipalities they often turn to bottled or barreled water [22,23]. Barreled and bottled water quality is regulated by the China Food and Drug Administration, but many local residents are peasants or fishermen who are not wealthy, thus, relatively expensive barreled or bottled water is not commonly purchased and used.

Table 3. Statistical analysis of public awareness of drinking water safety.

| Sources of household drinking water | Total | Ding’an County | Ledong County |
|-------------------------------------|-------|----------------|---------------|
| tap water                           | 313   | 175 (50.3%)    | 138 (51.3%)   |
| barreled or bottled water           | 23    | 7 (3.2%)       | 16 (3.1%)     |
| well water                          | 101   | 33 (32.6%)     | 68 (37.2%)    |
| spring water                        | 5     | 3 (3.0%)       | 2 (1.2%)      |
| others                              | 1     | 0 (0.0%)       | 1 (1.0%)      |
| Public attention of local water quality |       |                |               |
| special attention                   | 93    | 35 (38.0%)     | 58 (27.8%)    |
| comparatively high attention        | 230   | 117 (50.8%)    | 113 (45.1%)   |
| no concerned                        | 67    | 44 (65.7%)     | 23 (34.3%)    |
| no answer                           | 20    | 5 (25.0%)      | 15 (75.0%)    |
| The degree of public satisfaction with drinking water quality |       |                |               |
| very satisfied                      | 84    | 71 (85.0%)     | 13 (26.5%)    |
| relatively satisfied                | 245   | 109 (44.2%)    | 136 (54.1%)   |
| dissatisfied                        | 75    | 21 (28.0%)     | 54 (25.5%)    |
| no answer                           | 6     | 5 (83.3%)      | 1 (16.7%)     |
| The degree of public trust in the safety of drinking water |       |                |               |
| confident                           | 70    | 64 (91.4%)     | 6 (9.0%)      |
| relatively confident                | 173   | 85 (49.1%)     | 88 (49.1%)    |
| somewhat worried                    | 143   | 43 (30.0%)     | 100 (66.7%)   |
| extremely worried                   | 21    | 8 (38.1%)      | 13 (61.9%)    |
| no answer                           | 3     | 1 (33.3%)      | 2 (66.7%)     |
| Public awareness of problems with their tap water |       |                |               |
| never had problems                  | 258   | 155 (60.1%)    | 103 (40.7%)   |
| had problems once or twice a year   | 106   | 34 (32.1%)     | 72 (69.2%)    |
| had problems frequently             | 18    | 8 (44.4%)      | 10 (55.6%)    |
| no answer                           | 28    | 4 (14.3%)      | 24 (85.7%)    |
| The measures taken to solve problems that arise with tap water |       |                |               |
| solve problems by themselves        | 206   | 108 (52.4%)    | 98 (47.6%)    |
| help by local water utility         | 68    | 35 (51.5%)     | 33 (48.5%)    |
| complain to the local department of health | 166 | 87 (52.0%)    | 79 (48.0%)    |
| help by the residential property maintenance staff | 86 | 52 (60.5%) | 34 (39.5%) |
| call the local government telephone hotline for help | 7 | 4 (57.1%) | 3 (42.9%) |

Note: Bold: the same respondent ticked more than one alternative.
3.2.2. Public Attention of Local Drinking Water Quality

As can be seen in Table 3, survey results about public attention of local drinking water quality revealed that 22.7% of respondents paid special attention to local water quality, 56.1% paid comparatively high attention, and 16.3% were not concerned about local drinking water quality. The technologies used in water-supply systems are considered in sequence, from the water source to the points of supply: water sources and intakes, water-lifting devices, power technologies, water treatment, storage and distribution. The technologies for each these subsystems must function properly to ensure a reliable water supply and a safe water quality [25]. A safe and convenient water supply plays a vital role in public and well-being of society [26]. Most water treatment plants in two pilot counties are very small, with mainly centralized (or sometimes decentralized) township and rural water supplies, and the water supply ability is less than 1000 m$^3$/d. The water treatment equipment is relatively simple and crude, even, there is not water treatment equipment in these water utilities, and the purification capacity is thus very limited and some contaminants should not be removed at these treatment facilities. And many residents were eager to know whether their drinking water is clean or not, therefore, most of respondents paid high attention to the quality of drinking water.

The residents think that the main related factors influencing drinking water quality include water source quality, water pipe network and water treatment technology, and with the ratios of 70.1%, 51.4% and 51.1%, respectively. And only 12.5% of residents regard usage of tap water as main influencing factors.

3.2.3. Public Satisfaction with Drinking Water Quality

Survey responses regarding the degree of public satisfaction with drinking water quality are shown in Table 3. A total 20.5% of respondents were very satisfied with the quality of their drinking water, 59.8% were relatively satisfied, and 18.3% of them felt dissatisfied with their current drinking water quality. Correlation analysis between drinking water type and degree of public satisfaction revealed that people whose main drinking water source was barreled or bottled water had the highest degree of satisfaction (Figure 2), with a proportion as high as 100%; this was followed by tap water and well-water sources, with satisfaction degree of 87.1% and 62.5%, respectively. Those with spring water as their main water source reported the lowest satisfaction levels of only 40.0%.

![Figure 2](image.png)

*Figure 2*. Degree of public satisfaction of different drinking water sources quality. Note: the same respondent ticked more than one alternative.

Consumer satisfaction with drinking water quality has been measured in several studies [27,28]. Many factors including availability and safety of water sources, flavor, attitudes toward chemicals often found in drinking water have mainly been found to be involved in the public perception of
drinking water quality [6,15,29]. A few residents used barreled or bottled water, but they often imagine that bottled water is a pure and safe product, and this could explain the satisfaction of 100% for barreled or bottled water. Tap water often comes from centralized water supply, but for the simple and crude water treatment, only 87.1% of tap water sources users were satisfied with the quality of their drinking water. Well water and spring water are derived from decentralized water supplies which are directly from the water source, without any facilities or only simple facilities. Thus, only 62.5% and 40.0% of residents were satisfied with the quality of well water and spring water. The main reasons for respondents’ dissatisfaction were related to sensory properties such as water turbidity, rust color, or unpleasant taste and odor. China’s drinking water quality standard includes 106 water quality indicators, and sensory indicators are only part of them. If the residents fully understood the water treatment process and the value of all water quality indicators of their drinking water, their satisfaction degree of drinking water quality is likely to change.

3.2.4. Public Trust in the Safety of Drinking Water

Results regarding the degree of public trust in the safety of drinking water are shown in Table 3. A total 17.1% of respondents felt confident about the quality of their drinking water and 42.2% felt relatively confident; Water resources and water quality have been identified as the important parts of public trust in the safety of drinking water [30]. 34.9% of respondents reported feeling somewhat worried about the safety of their drinking water and 5.1% felt extremely worried. The result of about 40% residents didn’t feel confident that may be due to the simple or crude water treatment in these two counties. In rural areas of China, there are not regulations for the communication of drinking water quality, and water treatment plants seldom report values of drinking water quality indicators. Residents occasionally obtain information about drinking water quality from television, newspapers, or the Internet. Research has shown that a little information and a few reports are not enough to effectively change public perception [31]. Thus, many residents have become increasingly attention to the quality and safety of local drinking water at the two pilot sites and some residents are worried about drinking water safety.

3.2.5. Public Awareness of Tap Water Common Problems and Solutions

People often face a number of drinking water taste, odor, smell and appearance problems, for example, water which is initially clear but produces brown, orange or red-dish stains or sediment, metallic tasting water. As shown in Table 3, 62.9% of respondents said that they had never had problems with their tap water quality; 25.9% reported having problems once or twice a year, and 4.4% reported frequent tap water issues, and 6.8% had no answer. Reasons for problems with tap water at the two pilot sites is that these areas are prone to typhoons and flooding, which sometimes adversely affect local water quality and water supply [32]. Issues with drinking water include the appearance of white foam, rust color, unpleasant smell, turbidity, red worms, or other impurities. Problems with the water supply include water shortages and occasional lack of water. However, there are many other water quality problems that can’t be seen, and respondents do not fully understand most of water quality indicators of their drinking water, so most of respondents reported no problems or few problems of tap water.

Table 3 also shows results regarding respondents’ awareness about ways to solve problems that arise with tap water including water quality abnormal, pipeline damage, faucet water leakage, and so on. A total 52.4% of residents solved such problems by themselves, they repaired pipe and faucet by themselves and filtrated the unclean water by home water purifier; 42.2% relied on the local water utility, 21.9% of respondents complained to the local department of health, 17.3% sought to the residential property maintenance staff to solve the problem, and only 1.8% of respondents called the local government telephone hotline for help. These results reveal that the most common means used by residents to solve issues with their drinking water was to solve problems by themselves, followed by seeking help from the local water utility. Public information about drinking water problems and
solutions is scarce in rural areas and many residents solve problems with their water themselves and do not seek help from water treatment plants or monitoring departments. The main reason is when residents turn to local water utilities or monitoring departments for help, these departments could not solve their problem in time. Even, some residents don’t know how to contact these departments at all. Few residents know the number for the government public service hotline (12320).

3.3. Public Awareness about Water Contamination Accidents

3.3.1. Public Awareness about Water Pollution Events

A total 32.0% of respondents said they pay special attention to reports of water pollution events on television or in the newspaper; 53.2% reported following such events when they have free time, and 14.8% of respondents said they were not concerned about water pollution accidents. In recent years, serious water contamination accidents, including heavy metal contamination, algal blooms, organic chemical spills, and microbial contamination, have raised concerns among the public [33,34]. Most of public often like to care about what happened on them, but based on the information provided by Hainan province environmental information public publishing system, there are almost no polluters in Ding’an and Ledong County and not many water pollution events in Hainan province except flooding and typhoons [35].Thus, there are not large amount of people to pay special attention to water pollution events. In the question, “What kind of water pollution incident do you pay attention to?” some residents were eager to know whether the long-term drinking of barreled or bottled water is harmful to the human body, and what diseases could be caused by drinking unclean water for a long time.

3.3.2. Public Knowledge about Water Pollution Accidents

Results of public knowledge about water pollution accidents are displayed in Figure 3. A total 77.1% of respondents were knowledgeable about the potential damage to human health caused by water pollution accidents. Around 55% of respondents focused on the influence scope of water pollution accidents and the causes of accidents; about 40% had some degree of knowledge, gained from information in government publications, about water contamination accidents and accident treatment procedures.

![Figure 3. Public knowledge about water pollution accidents. Note: the same respondent ticked more than one alternative.](image-url)

As shown in Figure 4, 88.5% of respondents regarded the local health department as the main emergency response provider during drinking water contamination accidents, followed by the local departments of environmental protection, water resources, and propaganda. About 65% of respondents
believed that during the process of emergency response, all related departments should improve public information and education and share responsibility.

![Bar chart](chart1.png)

**Figure 4.** Emergency response provider during drinking water contamination accidents. Note: the same respondent ticked more than one alternative.

Water pollution could cause environmental and economic damage as well as public concern and the potential for social problem [36]. Most water pollution events in China could cause ecosystem disturbance and have a key environment impact-damage on creature’s health even threaten their lives [33]. Thus, most of respondents paid attention to the knowledge of the potential health impacts of water pollution and regarded the health department as the main emergency response provider for drinking water pollution.

### 3.3.3. Measures Taken for Preventing Water Pollution Accidents

Results regarding the main measures taken for preventing water pollution accidents are displayed in Figure 5. About 80% of respondents believed that improving supervision, monitoring, and resource management can effectively reduce the occurrence of contamination accidents. About 50% of respondents said they believed that increased public information and education as well as increased penalties for polluters can also help to reduce pollution accidents.

![Bar chart](chart2.png)

**Figure 5.** Main measures to prevent water pollution accident. Note: the same respondent ticked more than one alternative.

At present, China maintains water quality monitoring networks with thousands of monitoring sites. Despite the impressive numbers, however, spatial coverage remains sparse due to the size of the
Environmental advocates in China state that punishments laid down by the Ministry of Environmental Protection, in many cases related to pollution and unlawful practices, are simply not strict enough. Such laws show determination of the government, but are not strong enough to raise fear. In order to apply these laws, some departments are authorized to supervise the water source and water utilities. The health supervision department is authorized to supervise the water treatment plants. When the water treatment plant is unqualified, it should be punished to improve the water treatment technique and strengthen the construction of the water network system for improving the water quality. The environmental protection department is authorized to supervise and manage the water source and water environment to ensure drinking water is clean and not contaminated by anything. Increasing rigorous punishment would help to stop illegal sewage discharges, strengthening supervision and monitoring would ensure the effectiveness of disposal of pollution incidents. Thus, respondents regarded supervision, monitoring and resource management as effective measures for controlling water pollution.

3.4. Comparison between Ding’an County and Ledong County

Based on survey results, two counties residents have some different public awareness about drinking water issues. These differences are also shown in Table 3. Ding’an County is a pilot county belonging to China drinking water quality health monitoring network (CDWQHMN), and Ledong County is out of CDWQHMN. Drinking water in the areas within network could have been tested more regularly. Furthermore, Ledong County is poorer than Ding’an County, and the per capita disposable income of households are 15,109 Yuan and 17,175 Yuan respectively, and total annual volume of water supply for residential use is higher in Ledong County than in Ding’an County (2,110,000 cu.m vs. 3,110,000 cu.m) [38]. Because of these, Ledong residents think their drinking water is not safe enough and have to be more vigilant and proactive about their drinking water than residents in Ding’an County. Thus, for drinking water sources, tap water using in Ding’an is higher than that of Ledong (80.3% vs. 61.3%), but Ledong residents were more likely to use barreled or bottled water than that of Ding’an (7.1% vs. 3.2%). In the public perception of drinking water safety, residents in Ledong paid more special attention to the local drinking water quality (27.8% vs. 17.4%). And in drinking water satisfaction degree, residents in Ledong were less very satisfied (6.2% vs. 35.3%) but more dissatisfied (25.8% vs. 10.4%) with their drinking water quality. For public trust of the safety of drinking water, Ledong residents were lower level of confidence but more worried about the safety of drinking water. These indicated residents in Ledong County are more likely to consider their drinking water less safe and they are less satisfied with their drinking water. For drinking water problem, Ledong residents had more problems with their drinking water than residents in Ding’an. However, there are no significant differences between Ding’an and Ledong of the public awareness on the main factors influencing drinking water quality and the measures taken to solve problems that arise with tap water.

3.5. Influencing Factors of Public Awareness about Drinking Water Safety and Pollution Accidents

3.5.1. Influencing Factors of Public Satisfaction with Drinking Water Safety

We used a multinomial logistic regression model to determine the relationships between degree of public satisfaction with drinking water quality and its influencing factors. As shown in Table 4, age, sex, and education level did not have significant relationships with the degree of satisfaction in drinking water quality. However, residential area had a statistically significant role in differentiating between two groups of respondents: those who felt between very satisfied and dissatisfied with the quality of their drinking water and those who felt between satisfied and dissatisfied ($p = 0.000 < 0.05$, $p = 0.036 < 0.05$, respectively). Survey respondents who lived in Ding’an County, which is within the CDWQHMN, expressed greater satisfaction with their drinking water quality than those who lived in a county outside of the network.
Table 4. Results of multinomial logistic regression analysis for degree of public satisfaction with drinking water quality and its influencing factors.

| Degree of Public Satisfaction with Drinking Water Quality | B       | Std. Error | Wald df | Sig. | Exp (B) | 95% Confidence Interval for Exp (B) |
|---------------------------------------------------------|---------|------------|---------|------|---------|-----------------------------------|
| very satisfied                                          | intercept | 0.939      | 1.544  | 0.370 | 0.543   | 0.024, 0.824, 0.117, 5.783          |
|                                                          | >50      | 0.194      | 0.994  | 0.038 | 0.846   | 0.084, 1.218, 0.333, 13.603         |
|                                                          | 35–50    | 0.755      | 0.946  | 0.637 | 0.425   | 0.271, 2.128, 0.115, 4.781          |
|                                                          | <20      | -0.301     | 0.952  | 0.100 | 0.752   | 0.372, 0.740, 0.115, 4.781          |
|                                                          | male     | 0.349      | 0.391  | 0.798 | 0.372   | 0.322, 1.418, 0.659, 3.048          |
|                                                          | female   | 0.000      | 0.000  | 0.000 | 0.000   | 0.000, 0.000, 0.000, 0.000          |
| satisfied                                               | bachelor and above | 0.141     | 1.327  | 0.011 | 0.915   | 1.151, 0.085, 15.507               |
|                                                          | college  | -0.754     | 1.266  | 0.354 | 0.592   | 0.471, 0.039, 5.625                |
|                                                          | high school | -1.018   | 1.236  | 0.678 | 0.410   | 0.361, 0.032, 4.074                |
|                                                          | middle school | -0.965  | 1.264  | 0.584 | 0.445   | 0.381, 0.032, 4.533                |
|                                                          | primary school and below | 0.000 | 0.000  | 0.000 | 0.000   | 0.000, 0.000, 0.000, 0.000        |
|                                                          | within CDWQHMN | 2.627  | 0.413  | 40.552| 1.000   | 13.633, 6.163, 31.051              |
|                                                          | outside of CDWQHMN | 0.000 | 0.000  | 0.000 | 0.000   | 0.000, 0.000, 0.000, 0.000        |

Note: The reference category is dissatisfied.

A multinomial logistic regression model was also used to analyze the relationship between public attention to local water quality and its influencing factors. As shown in Table 5, age and sex did not have significant relationships with awareness about water quality; however, residential area and education were statistically significant in differentiating the two groups in this regard. Survey respondents with higher education levels had greater levels of awareness than those with lower education levels. However, survey respondents living in Ding’an County, which is within the CDWQHMN, had less awareness about local water quality than those living outside of the network.

Table 5. Results of multinomial logistic regression analysis for public attention to local water quality and its influencing factors.

| Public Attention to Local Water Quality | B       | Std. Error | Wald df | Sig. | Exp (B) | 95% Confidence Interval for Exp (B) |
|----------------------------------------|---------|------------|---------|------|---------|-----------------------------------|
| extremely concerned                    | intercept | 0.125      | 1.237  | 0.010 | 0.920   | 0.015, 1.720, 0.814, 3.636          |
|                                       | >50      | 0.210      | 0.921  | 0.052 | 0.819   | 0.081, 1.333, 4.930                |
|                                       | 35–50    | 0.590      | 0.871  | 0.459 | 0.498   | 0.054, 1.010, 3.057                |
|                                       | <20      | -1.009     | 0.880  | 1.314 | 0.252   | 0.035, 0.063, 2.047                |
|                                       | male     | 0.334      | 0.315  | 1.330 | 0.788   | 0.381, 0.754, 2.588                |
|                                       | female   | 0.000      | 0.000  | 0.000 | 0.000   | 0.000, 0.000, 0.000, 0.000        |
| concerned                              | bachelor and above | 0.943     | 1.235  | 0.583 | 0.445   | 0.256, 2.568, 8.915               |
|                                       | college  | 0.086      | 1.172  | 0.005 | 0.941   | 1.090, 0.110, 10.830              |
|                                       | high school | -0.420   | 1.132  | 0.133 | 0.715   | 0.657, 0.699, 6.277               |
|                                       | middle school | -0.480  | 1.170  | 0.169 | 0.681   | 0.619, 0.692, 6.123               |
|                                       | primary school and below | 0.000 | 0.000  | 0.000 | 0.000   | 0.000, 0.000, 0.000, 0.000        |
|                                       | within CDWQHMN | 0.633   | 0.302  | 4.360 | 0.036   | 1.863, 1.041, 3.405               |
|                                       | outside of CDWQHMN| 0.000 | 0.000  | 0.000 | 0.000   | 0.000, 0.000, 0.000, 0.000        |

Note: The reference category is no concerned.
3.5.2. Influencing Factors of Public Awareness about Drinking Water Pollution Accidents

The relationship between public awareness of drinking water pollution accidents and its influencing factors was also analyzed using the multinomial logistic regression model. As shown in Table 6, age and sex did not play significant roles in awareness about drinking water contamination events; however, county of residence and education had statistically significant roles in differentiating awareness levels between groups. Survey respondents with higher education levels were more aware about contamination accidents than those with lower education levels, but survey respondents living within the CDWQHMN had lower such awareness than those living outside of the network.

Table 6. Results of multinomial logistic regression analysis for public awareness of water pollution accidents and influencing factors.

| Public Awareness of Water Pollution Accidents | \( B \) | \( \text{Std. Error} \) | \( \text{Wald} \) | \( df \) | \( \text{Sig.} \) | \( \text{Exp (B)} \) | 95% Confidence Interval for \( \text{Exp (B)} \) | \( \text{Lower Bound} \) | \( \text{Upper Bound} \) |
|---------------------------------------------|--------|------------------|----------------|------|----------------|-----------------|-------------------------------------------------|----------------|----------------|
| extremely concerned                         |        |                  |                |      |                |                 |                                                 |                |                |
| intercept                                   | −1.092 | 1.229            | 0.789          | 1    | 0.374          | 1.330           | 0.216              | 8.171           |                |
| >50                                         | 0.285  | 0.926            | 0.095          | 1    | 0.708          | 1.310           | 0.216              | 8.171           |                |
| 35–50                                       | −0.310 | 0.847            | 0.134          | 1    | 0.714          | 0.733           | 0.139              | 3.860           |                |
| 20–34                                       | −0.324 | 0.860            | 0.142          | 1    | 0.706          | 0.723           | 0.134              | 3.901           |                |
| <20                                         | 0.000  |                  | 0              |      |                |                 |                                                 |                |                |
| male                                        | 0.791  | 0.378            | 4.370          | 1    | 0.037          | 2.206           | 1.051              | 4.630           |                |
| female                                      | 0.000  |                  | 0              |      |                |                 |                                                 |                |                |
| bachelor and above                          | 2.999  | 1.032            | 8.214          | 1    | 0.004          | 19.272          | 2.548              | 145.768         |                |
| college                                     | 2.606  | 0.963            | 7.840          | 1    | 0.005          | 14.813          | 2.245              | 99.773          |                |
| high school                                 | 2.107  | 0.923            | 5.136          | 1    | 0.023          | 8.223           | 1.234              | 59.681          |                |
| middle school                               | 1.502  | 0.942            | 2.543          | 1    | 0.111          | 4.490           | 0.709              | 28.432          |                |
| primary school and below                    | 0.000  |                  | 0              |      |                |                 |                                                 |                |                |
| within CDWQHMN                              | −0.739 | 0.340            | 4.733          | 1    | 0.030          | 0.477           | 0.245              | 0.929           |                |
| outside of CDWQHMN                          | 0.000  |                  | 0              |      |                |                 |                                                 |                |                |
| fairly concerned                            |        |                  |                |      |                |                 |                                                 |                |                |
| intercept                                   | −1.103 | 1.113            | 0.982          | 1    | 0.322          | 1.322           | 0.451              | 13.101          |                |
| >50                                         | 0.888  | 0.860            | 1.067          | 1    | 0.302          | 2.430           | 0.451              | 13.101          |                |
| 35–50                                       | −0.193 | 0.786            | 0.060          | 1    | 0.806          | 0.825           | 0.177              | 3.851           |                |
| 20–34                                       | −0.091 | 0.797            | 0.013          | 1    | 0.909          | 0.913           | 0.192              | 4.351           |                |
| <20                                         | 0.000  |                  | 0              |      |                |                 |                                                 |                |                |
| male                                        | 0.326  | 0.360            | 0.820          | 1    | 0.365          | 1.385           | 0.684              | 2.806           |                |
| female                                      | 0.000  |                  | 0              |      |                |                 |                                                 |                |                |
| bachelor and above                          | 3.467  | 0.930            | 13.883         | 1    | 0.000          | 32.014          | 5.172              | 198.432         |                |
| college                                     | 2.905  | 0.862            | 11.349         | 1    | 0.001          | 18.265          | 3.370              | 98.991          |                |
| high school                                 | 2.509  | 0.823            | 9.305          | 1    | 0.002          | 12.297          | 2.452              | 61.688          |                |
| middle school                               | 1.623  | 0.830            | 3.819          | 1    | 0.051          | 3.066           | 0.995              | 25.805          |                |
| primary school and below                    | 0.000  |                  | 0              |      |                |                 |                                                 |                |                |
| within CDWQHMN                              | −0.413 | 0.318            | 1.689          | 1    | 0.194          | 0.662           | 0.355              | 1.234           |                |
| outside of CDWQHMN                          | 0.000  |                  | 0              |      |                |                 |                                                 |                |                |

Note: \( ^a \) The reference category is no concerned.

Keeping consumers informed about drinking water quality is an essential component of protecting public health [1,8,9]. Thus influencing factors of public awareness could also reflect drinking water safety and pollution accidents and to provide some valuable information to decision-making. If we disregard the fact that people of all ages and both sexes can obtain information about drinking water emergencies on television, the newspaper, and the internet, age and sex did not play significant roles in the degree of public satisfaction about water quality and public perception of water pollution accidents. Factors influencing residents’ perceptions about drinking water can vary significantly among different groups. For example, with respect to public awareness about drinking water pollution accidents, men had greater awareness than women; however, there were no significant differences between men and women with respect to taking occasional interest in contamination events.

Residents of Ding’an County often see health department staff supervising and inspecting drinking water samples, and residents can obtain information about the quality and safety of their drinking water. Access to such information is limited to television, the newspaper, and the internet for residents of Ledong County, but they are very eager for such information. Thus, people living in Ledong County were more satisfied with drinking water quality and safety than those living in Ding’an County. However, residents of Ding’an were more interested in drinking water contamination accidents than those in Ledong County.

Similar to other environmental studies [5,39,40], education played a vital role in respondents’ perceptions and behavior. Survey respondents with higher education levels showed greater
awareness than those with lower education levels with respect to local water quality and water contamination accidents.

4. Conclusions

We surveyed public awareness about drinking water safety and drinking water pollution accidents in a typical province of China, and also investigated the relationship between awareness of these issues and its main influencing factors. We found that respondents who have some information about their water quality are more confident in their drinking and offer stronger support for the protection of water safety and prevention of water pollution. In this study, most respondents feel they have a high degree of awareness about drinking water quality and safety and drinking water pollution accidents. About 79% of respondents paid attention to local water quality (special attention 22.7% and comparatively high attention 56.1%). Only 20.5% of respondents were very satisfied with their drinking water quality, and 59.8% were relatively satisfied. Educational level and drinking water quality health monitoring could influence public awareness about drinking water safety and contamination accidents. The knowledge provided by this study will inform the decision-making to strengthen drinking water quality monitoring to ensure drinking water safety. It also informs them to enhance public awareness of drinking water quality, to strengthen education and increase knowledge about drinking water safety, and to improve emergency response for drinking water pollution accidents. Public satisfaction could be increased by publicizing the importance of the annual drinking water quality report provided by local government to the public using local television and print media.

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