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A Comparative Analysis of Public Awareness Level about Drinking Water Quality in Guangzhou (China) and Karachi (Pakistan)

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Abstract: Safe drinking water is fundamental for the existence of life. The establishment of public awareness about drinking water quality is a most significant issue in the protection of health and the wellbeing of humans. The present study focuses on the assessment of community awareness level of, as well as public trust in, the government-provided information about drinking water quality in two highly populated underrepresented megacities of Asia, i.e., Guangzhou (China) and Karachi (Pakistan). The study was conducted to explore the respondents' knowledge about the existing quality issues and the practices to remove the contaminants in drinking water in both cities, which was determined by numerical analysis using the scoring method system and multinomial regression model. The results show that the respective respondents' percentage awareness level and positive attitude in Guangzhou were 46.2% and 30.0% compared with 23.1% and 7.4% in Karachi, respectively. The respective percentage of respondents' trust in media stories/reports about water pollution accidents was 76.0% and 70.8%, while the trust in government-provided information was 79.3% and 39.7% in Guangzhou and Karachi, respectively. The *p*-values for drinking water quality according to public approval based on sociodemographic parameters (gender, age, family members, household income/month, education, etc.) of respondents in both cities were <0.05, which supports that the variations in acquired results were significant. The study advocates that increased awareness campaigns by government agencies and nongovernmental organizations (NGOs) in educational institutes and/or community centers can improve the public awareness level, which would subsequently help the governments to enhance the public trust, especially in Karachi. Moreover, the study's findings have national significance and a worldwide scope, particularly in low- and middle-income regions.

Keywords: drinking water quality; water contaminants; water pollution accidents; public trust; environmental awareness

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1. Introduction

The World Health Organization (WHO) states that approximately 2.2 billion people worldwide do not have direct access to safe drinking water [1]. The drinking water may comprise countless biological, chemical, and physical impurities; however, the increasing technological and population growths are further adversely affecting the drinking water quality worldwide [2]. Water contamination arises from direct mixing, contact, runoff, or the leaching of toxic chemicals and micro-organisms from industries and domestic wastes in surface water, groundwater, and freshwater resources, which are collectively termed water pollution accidents [3]. Water pollution accidents are the combination of anthropogenic and natural events [4]. Therefore, the recognition of public awareness level about drinking

water quality and the level of public trust in government-provided information about water pollution accidents are highlighted topics of worldwide concern. Hence, establishing awareness about these parameters is most significant for protecting the overall wellbeing of humans [5].

Furthermore, the WHO guidelines also state that the quality of drinking water provided to the public must be acceptable [6], which necessitates the public awareness about water quality. Public involvement in the studies concerning environmental parameters has been a valuable tool for environmental scientists because the research dependent on public involvement is economical and efficient [7]. Public involvement is generally based on awareness of the concerns under investigation [8]. It has been reported that increasing public environmental awareness is significant in accomplishing pollution anticipation [9–11]. Public awareness of drinking water quality and pollution accidents applies to the public selection of the drinking water source, the advancement of household water treatment, and the preclusion of water pollution accidents [12]. Due to its significance, researchers have determined the public awareness about the quality of drinking water. For instance, during the estimation of the urban public's drinking water problems and concerns in the Pacific Northwest (USA), it was observed that the public was satisfied with the quality of their household drinking water [13].

In Austria, an exploration of the public awareness of drinking water quality showed that 75.0% of respondents were delighted with the quality of their drinking water [14]. Many parameters regarding the water quality can be significant, which should be considered during the assessment of public awareness. However, service approval, quality observation and the choice of water sources are significant for assessing the public awareness about drinking water quality and pollution accidents. Furthermore, water sources, water supply networks, and water treatment processes are also significant because they can easily affect the drinking water quality, resulting in the occurrence of water pollution accidents [12]. Similarly, the sociodemographic characteristics, as well as the geographic location, can be considered important parameters during the assessment of public awareness about drinking water quality [15,16]. Consideration of the issues impacting the public awareness of drinking water quality and the occurrence of pollution accidents can improve the consumer facilities, water organization, and the anticipation and control of water pollution accidents [17]. Therefore, past research studies have been predominantly attentive to municipal, recycled, and bottled water as the consumption sources of drinking water during the assessment of public awareness about drinking water quality [18,19].

Guangzhou is a southern metropolis of China with a population of 13.96 million people [20,21], whereas Karachi is a southern metropolis of Pakistan, home to 16.8 million people [22]. The climate of both cities is generally humid; however, the degree of humidity varies along the different months of each year [23–25]. Both Guangzhou and Karachi are port cities with high industrialization and urbanization rates; the trade of both countries with rest of the world is majorly carried out through the ports of both cities [26,27]. Both Guangzhou and Karachi are densely populated cities, and the existing population in the two cities comprises local residents and immigrant workers from around China and Pakistan, respectively, due to more job opportunities and high living standards. Moreover, the ever-growing local population and the increasing number of immigrant workers each year may affect the standards of drinking water quality, resulting in an enhanced occurrence of pollution accidents [23,26,28–30]. Industrial development in Guangzhou has been fast, leading to a considerable amount of pollutant-laden water, as well as postprocessed wastewater discharge, being added to its water source, resulting in subsequent deterioration of drinking water quality [31]. Similarly, Karachi, the largest, most industrialized, and most densely populated metropolis of Pakistan, is also facing the issue of water pollution [32].

Meanwhile, assessing the individual awareness about the standards of drinking water quality and the potential occurrence of pollution accidents is also significant in policy framing and resource management, especially in metropolitan cities such as Guangzhou or Karachi with an ever-increasing number of immigrant workers of different environ-

mental awareness levels. It has previously been reported that there are limited studies on public awareness in megacities about drinking water quality, water contaminants, and the public trust in government-provided information about water pollution accidents [12,19]. However, analyzing the public awareness about drinking water quality standards and the occurrence of pollution accidents is significant.

Therefore, this study was carried out to analyze the public awareness level about drinking water quality, more specifically, the knowledge about water contaminants and the level of public trust in government-provided information about water quality and pollution accidents in two megacities of Asia, i.e., Guangzhou (China) and Karachi (Pakistan). The study assessed the positive attitudes of populace in both cities, as well as the practices employed by them to achieve good drinking water quality. The study provides unique baseline information in policy framing to improve the public awareness level about drinking water quality and subsequent minimization of the water pollution accidents in both cities. Moreover, it can also act as a baseline for similar worldwide studies regarding the assessment and the improvement of public awareness levels about drinking water quality and the minimization of the occurrence of pollution accidents.

2. Materials and Methods

2.1. Study Areas

Guangzhou (23.13° N, 113.26° E), located in Pearl River Delta, is the capital of Guangdong province in southern China [21] (Figure 1). Guangzhou's climate is mainly subtropical with scorching summers and mild winters [23,25]. The average temperature in Guangzhou in the summer is 28.6 °C, while the average temperature in the winter is 14.9 °C [33]; the average rainfall in Guangzhou is 1900 mm/annum. The main source of natural water in Guangzhou is Pearl River [34]; however, the residents of Guangzhou also use bottled water for direct consumption. Karachi (25°4′12.15″ N, 67°17′5.23″ E), the capital of Sindh province in Pakistan, expands from the Indus River to the Arabian Sea [26]. Karachi also has a subtropical climate with extreme summers and mild winters [26]. It has average rainfall of 256 mm/annum; the average low and high temperatures in the winter and summer are 20.3 and 31.7 °C, respectively [35]. The primary source of natural water in Karachi is Keejhar Lake and Hub dam is a secondary source of drinking water [36].

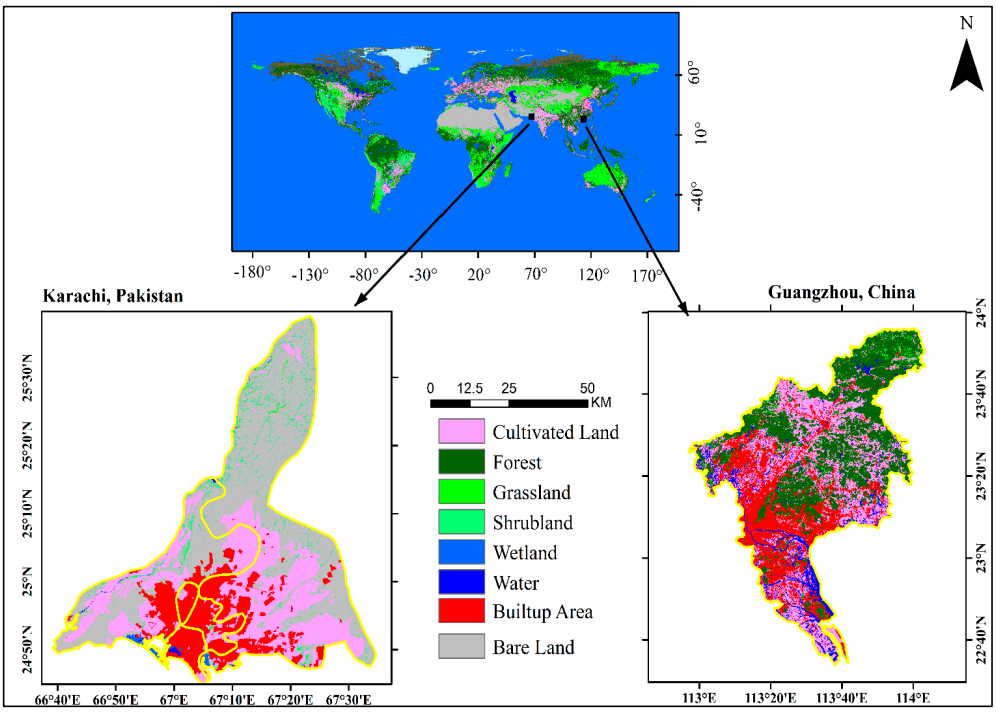

Figure 1. The study areas, i.e., Karachi (Pakistan) and Guangzhou (China).

2.2. Methodology

The information about the location, climate, population, and water resources of both Guangzhou and Karachi were collected from the previously published literature. The level of public awareness in Guangzhou and Karachi was determined by conducting questionnaire-based surveys [12,19] over 6 months through web-based/online surveys and direct oral interviews [37]. The surveys were conducted from April to July 2022 in Karachi and from August to October 2022 in Guangzhou. The main questions are summarized in Table 1 (presented for easy understanding by non-specialist readers). Before employing the questionnaires to gather information from respondents in the field, the questionnaires were pretested and tailor-made to ensure that the respondents could understand and recognize the contents and context of the questionnaires. The pretesting of questionnaires was conducted through surveys with 70 respondents from Guangzhou and 50 respondents from Karachi as the participants. The reliability of the questionnaire was analyzed through the Cronbach alpha test [21,38] by considering the reliability coefficient (0.67). The language of all questionnaires was English; however, the questionnaires used for data collection in Guangzhou had Chinese subtitles and those used for data collection in Karachi had Urdu subtitles for easy understanding of respondents in both cities.

Table 1. The key questions of the questionnaires used for data collection.

• Which of the following types of drinking water does your household use?
• Do you have drinking water quality issues in your home?
• What is the color of public tap water in your home?
• What quality of drinking water do you use?
• Do you know what water contaminants are?
• Does the drinking water you use have contaminants that can be harmful to you?
• Do you know water contaminants that are harmful to humans?
• Can boiling tap water for drinking reduce all contaminants?
• Can normal/traditional filter plants reduce all contaminants in drinking water?
• Is there any public awareness event/organization about the drinking water quality in your city?
• Do you recognize the drinking water source provided by the city government/provincial government?
• Which of the following sources of drinking water are provided by the city government/provincial government?
• Are river and rainwater clean sources for drinking water compared to other sources?
• Do you pay attention to news stories on water pollution, that are reported on TV, on the radio, in newspapers, or elsewhere?
• What types of incidents involving water contamination do you follow?
• The data provided by the EPA/Ministry of Environment protect water pollution accidents and their solution. Do you trust them?

After immediate completion of the surveys, the gathered data were statistically analyzed, focusing on assessing the findings of public awareness, attitude, and practices using the scoring method [38,39]. Furthermore, the factors influencing respondents' opinions about drinking water quality and a likelihood ratio test were considered for defined parameters through the multinomial regression model [12,19]. On the basis the conducted survey, the public degree of satisfaction (acceptability) about drinking water quality was specified as "very satisfied" or "dissatisfied". The public awareness variable about the likely occurrence of water pollution accidents was also assessed by considering the responses of surveyees as "yes" or "no" parameters.

2.3. Questionnaires

Each questionnaire was divided into three parts. The first part was based on questions regarding the sociodemographic characteristics of respondents (name, age, education, household income, etc.). The second part included questions about water resources, water quality, and existing water contaminants [12]. The last part comprised questions related to the respondents' trust in information disclosed by the environmental protection agencies (EPAs) of their particular governments. All questions had multiple-choice responses except for two: (i) the name and details of the contaminants existing in water used by respondents; (ii) the major factors responsible for the noninvolvement of respondents in public awareness events.

The scoring method developed by [38] was used to measure the level of respondents' awareness about drinking water quality. In the awareness assessment, the positive responses of respondents showing public awareness were scored as 1, whereas the negative responses showing no awareness were scored as 0. For the assessment of attitude and good practice, the respondents' answers depicting positive attitudes and good practice were scored as +1, while those depicting negative attitudes and poor practice were scored as −1 (more details are available in Section 3). Following the calculations for each variable, the percentage responses of respondents for awareness, attitudes, and practices are shown in "tabulated form" in Section 3 [38]. Additionally, the existing chemical impurities in tap water (used as drinking water) were assessed using the color card option (Figure 2), where the selection of A by respondents denoted the possible presence of boron, while the selection of B, C, and D represented the likely presence of arsenic, mercury, and zinc, respectively [40].

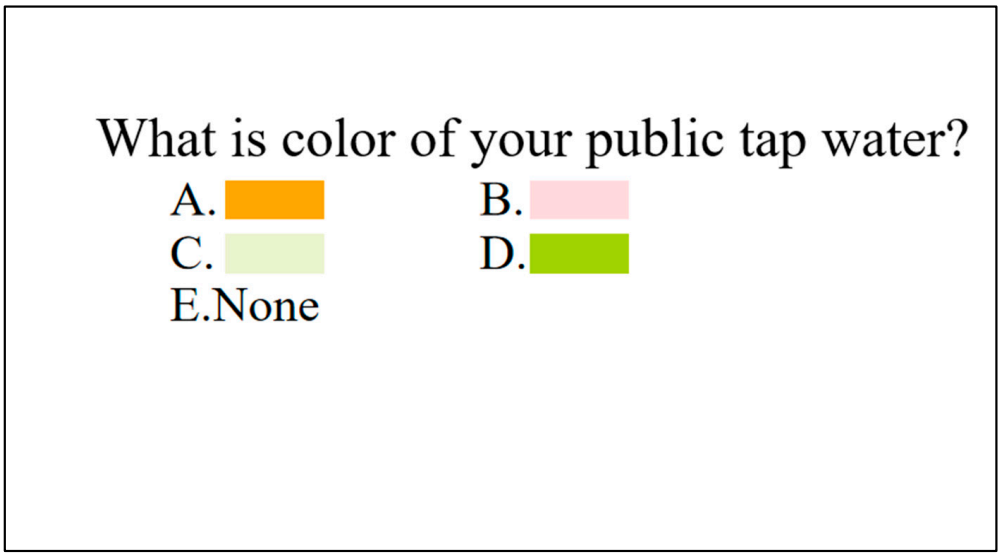

Figure 2. Example of color card choices.

The age of respondents in both cities was generally kept above 18 years to ensure that all respondents in both cities would at least have some knowledge about drinking water quality. The data were collected following the frameworks designed by professional survey firms using panels representative of each city's population regarding age, gender, education level, and income [21] (i.e., 800 and 1000 persons in Karachi and Guangzhou, respectively). All respondents knew that the data were being collected solely for research purposes; hence, some respondents were not committed to respond to the questionnaires without financial reimbursement. The response rate was 75.9% in Karachi and 82.9% in Guangzhou. Hence, the data were considered adequate and taken for further analyses, as outlined in Figure 3.

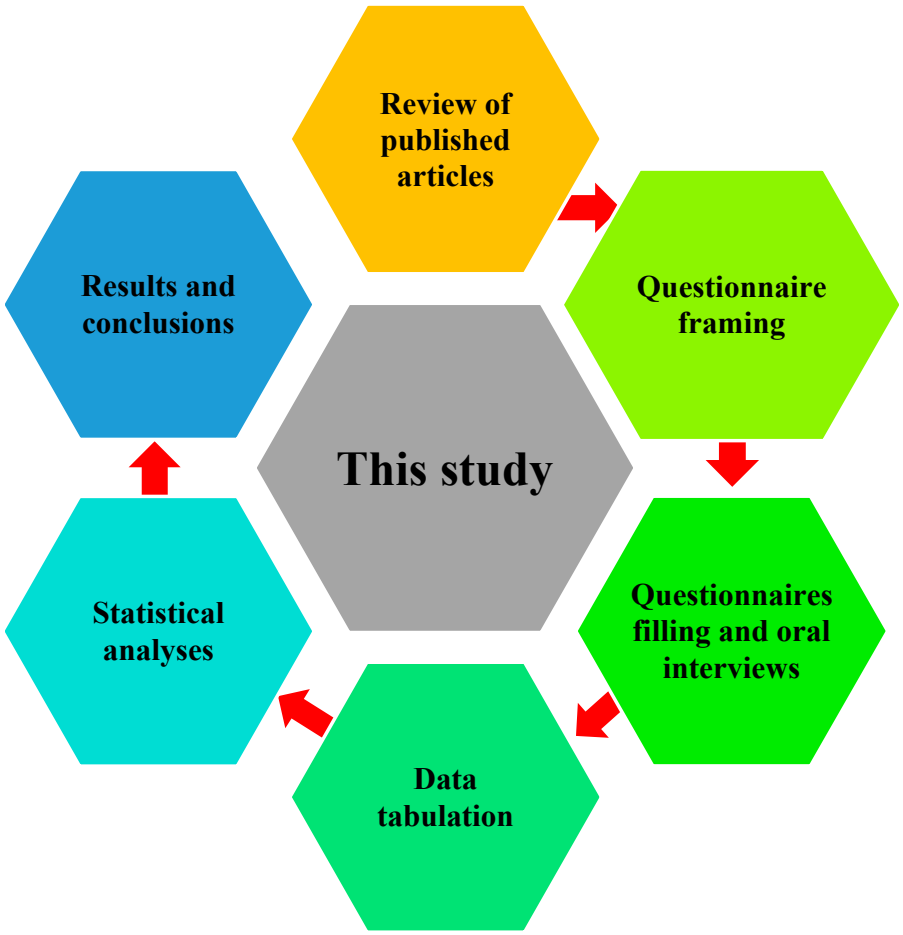

Figure 3. A generalized overview of the main steps involved in the present study.

3. Results and Discussion

3.1. The Sociodemographic Characteristics of Respondents in Guangzhou and Karachi

Table 2 summarizes the details of respondents who participated in this study. Out of 1000 surveyees/interviewees in Guangzhou, only 829 (constituting 82.9%) responded during data collection. Overall, 60.7% (503 out of 829) of respondents in Guangzhou were female. The highest age group of respondents in Guangzhou was 18–29 years, constituting 42.8% of respondents. In comparison, the lowest age group was >50 years, i.e., 11.6% of respondents. Moreover, 48.1% of respondents had a monthly income of >1000 USD/per household. The people with such a high level of income can be considered "wealthy people" because it has been reported that the residents of Guangzhou are "relatively richer" than the people residing in other cities of Guangdong province [41]. The major household size in Guangzhou was "small" (1–4 persons/family) constituting 82.3% of the household size of respondents. Most respondents in Guangzhou had completed "university education", followed by "school completers" and "college graduates" constituting 84.0%, 8.2%, and 7.0% of respondents, respectively. These findings are similar to the findings of previous studies conducted in China; for instance, the authors in [37] conducted a research study on environmental information on citizens' protest attitudes and choice behaviors.

Out of 800 surveyees/interviewees in Karachi, 607 (constituting 75.9%) responded during data collection. Most respondents in Karachi were male, accounting for 59.3% of respondents; moreover, 8.9% of respondents were >50 years old. However, the major age group was 18–29 years, constituting 45.6% of respondents. More than half respondents in Karachi had a monthly income <200 USD/household, followed by a monthly income of 201–500 USD/household, constituting 50.2% and 31.3%, respectively. The proportion of "small-sized" (1-4 persons/family) and "medium-sized" (5–7 persons/family) house-

holds of respondents in Karachi was almost similar, while the household size of 23.2% of respondents was big, i.e., >7 persons/family. It was observed that 56.2% of respondents in Karachi had "university-level" education, followed by "college graduates" with a proportion of 21.4%.

Table 2. Socio-demographics of respondents in both cities.

	Guangzhou		Karachi	
	N	**%age**	**N**	**%age**
Total	1000		800	
Nonrespondent	171	17.10	193	24.12
Respondent	829	82.90	607	75.88
Gender				
Male	326	39.30	360	59.30
Female	503	60.70	247	40.70
Age (years)				
50 and above	96	11.6	54	8.9
40–49	162	19.5	115	18.9
30–39	216	26.1	161	26.5
18–29	355	42.8	277	45.6
Monthly household income (USD)				
<200	81	9.80	305	50.20
201–500	51	6.20	190	31.30
501–1000	298	35.90	96	15.80
>1000	399	48.10	16	2.60
Household size (persons/family)				
1–4 (small)	682	82.30	242	39.90
5–7 (medium)	147	17.70	224	36.90
>7 (big)	0	0.00	141	23.20
Education level				
No education	7	0.80	50	8.20
School	68	8.20	86	14.20
College	58	7.00	130	21.40
University	696	84.00	341	56.20

The percentage of responding interviewees/surveyees in Guangzhou was higher than that in Karachi, showing a higher public awareness level toward individual responsibilities in society among the residents of Guangzhou. The higher public awareness level can be attributed to the relatively higher educational levels (mostly university graduates) of surveyees/interviewees in Guangzhou compared with Karachi because an increased literacy rate will result in increased innovation and awareness among people [42]. The results are also in line with the findings of [43], who observed that environmental awareness among fifth-year university students was higher than that among first-year students. The ratio of female respondents was higher in Guangzhou than in Karachi, which can be attributed to the fact that more educated females may have preferred to respond on behalf of their families, contributing to the healthy representativeness of qualified respondents in the study [37].

Most respondents in both cities comprised young people aged 18–29 years, who typically participate actively in survey studies [19,21]. However, the ratio of this age group was slightly higher in Karachi, which may be beneficial for the city's future development because this age group is considered the most economical within the populace of various communities [44]. These findings are similar to the results in [12], which assessed the public awareness regarding drinking water safety and contamination accidents in Hainan province, China. The literacy rate and financial status of respondents were higher in Guangzhou compared with those in Karachi, with most respondents in Karachi living near or below the poverty line. Hence, the results are in line with the findings of previous study, which stated that 22.0% of the population in Karachi lives below the poverty threshold of 1.25 USD/day [45]. The lower literacy rate in Karachi can be attributed to the lower monthly income and the lower awareness about individual responsibilities in society development. However, the proportion of "medium-sized" and "big-sized" households was higher in Karachi than in Guangzhou, which can be attributed to lower awareness about family planning/population control in Karachi.

3.2. Public Awareness about Drinking Water Quality, Attitude, and Practices

Public awareness plays a crucial role in behavioral practices toward improving the drinking water quality [46,47]. Table 3 summarizes the awareness score depicting the respondent's behavior toward drinking water quality. Overall, 46.2% and 23.1% of respondents in Guangzhou and Karachi respectively knew about the "good/bad drinking water quality". The levels of respondents' awareness based on scoring in Guangzhou and Karachi were higher than in a previously reported study in Kajang Malaysia, where the percentage of respondents with good awareness scores was about 18.0% [38]. However, the level of good awareness of respondents was lower than in Putrajaya, Malaysia (44.5%) [48] in the case of Karachi, but higher in the case of Guangzhou. Furthermore, 53.8% and 76.9% of respondents in Guangzhou and Karachi had a "poor level of awareness" about drinking water quality; while, 87.2% of respondents in Guangzhou and 65.6% in Karachi had "minute knowledge" about various contaminants in drinking water.

Similarly, 76.6% of respondents in Guangzhou and 41.5% in Karachi were aware of the names and relevant details of contaminants. However, the lack of awareness among the remaining respondents shows that the respective respondents in both cities are at high risk [12] of water-borne diseases. These results may be associated with the finding that 73.3% of respondents in Guangzhou and 81.7% of respondents in Karachi were less educated about the quality of drinking water and the substantial harmful effects of lower-quality drinking water. Hence, the results are in alignment with the findings in [38], in which 70.8% of respondents responded that "the quality of drinking water was not explained to them", considered the leading cause of lower awareness in Kajang. The majority of respondents in Guangzhou (83.2%) and Karachi (80.1%) were aware of the fact that rivers and rain are clean sources of drinking water supplied by the governments to residents compared with groundwater [49].

Additionally, 11.6% of respondents in Guangzhou and 60.0% of respondents in Karachi had minor information about seminars or other related activities conducted at the community/regional levels to improve awareness about safe drinking water quality (Figure 4). Meanwhile, 75.4% of respondents in Guangzhou and 25.2% in Karachi did not consider "drinking water quality" a significant or severe problem in their respective city. It can be seen from the findings (in Table 3 and Figure 4) that most respondents were aware of clean drinking water or improved drinking water quality; however, because of the low household income (especially in Karachi), respondents were often unable to pay attention to the trace contaminants during the consumption of drinking water [38,49,50]. Therefore, government agencies and nongovernmental organizations (NGOs) should strengthen the awareness and health concerns about drinking water quality among the general public.

Table 3. Respondent awareness scores for drinking water quality.

	Guangzhou		Karachi		Given Score
Variables	**N**	**%age**	**N**	**%age**	
Do you know that drinking water may contain water contaminants?					
Yes	723	87.20	398	65.60	1
No	48	5.80	111	18.30	0
Not sure	58	7.00	98	16.10	0
Do you know the names and details of drinking water contaminants with harmful effects on humans?					
Do not know	194	23.40	355	58.50	0
Contaminants' names and details	635	76.60	252	41.50	1
Do you know the source of drinking water provided by the city/provincial government?					
Yes	691	83.40	470	77.40	1
No	1	0.10	38	6.30	0
Not sure	137	16.50	99	16.30	0
Which of the following sources of drinking water are provided by the city/provincial government?					
River/rain water	690	83.20	486	80.10	1
Ground water	0	0.00	0	0.00	1
Not sure	139	16.80	121	19.90	0
Have you acquired knowledge regarding the standard of drinking water? (Note: assessment of drinking water quality awareness events)					
Yes	221	26.66	111	18.30	1
No	608	73.34	496	81.70	0
Do you know the drinking water quality standards of your country?					
Yes	416	50.20	272	44.80	1
No	346	41.74	309	50.90	0
Not sure	67	8.06	26	4.30	0
Do you know the responsibilities of the environmental protection agency (EPA) of your city?					
Yes	619	74.70	432	71.20	1
No	210	25.30	175	28.80	0
Total given score			7		
Total mean score (SD)	5.687 (3.56)			3.9885 (1.78)	
% good awareness (score $\geq$ 6)	46.20%			23.10%	
% poor awareness (score $\leq$ 5)	53.80%			76.90%	

Table 4 illustrates the score obtained by different respondents according to their attitude and practice toward clean or contaminated drinking water; where, the positive scores indicated greater exposure to contaminated drinking water. The highly positive attitude toward good practices scored six out of 11 in both cities, accounting for 30.0% of the respondents in Guangzhou and 7.4% of the respondents in Karachi. Specifically, the respondents in Guangzhou and Karachi consumed water from bottled water (25.1% and 18.6%), tap water (71.7% and 73.3%), bore wells (2.6% and 6.6%), and community wells (0.6% and 1.5%) for drinking (Figure 5). The results showing the higher proportion of utilization of tap water for drinking in Guangzhou are in line with the findings of a previous study stating that tap water is a core category of household drinking water

in some middle-income cities of China (i.e., Hainan, where it was utilized by 70.7% of respondents, in contrast to 5.2% respondents who utilized bottled water) [12]. However, Guangzhou is home to wealthy people in China; thus, the selection of bottled water as a second choice for drinking after tap water can be attributed to the higher purchasing power of respondents. Similarly, the results depicting the higher utilization of tap water (as drinking water) in Karachi are similar to the findings in [51], which observed that 60.0% and 92.0% of respondents in two towns of Karachi utilized the tap water for drinking purposes, while 4.0% and 0.0% of respondents used bottled water for drinking. Moreover, the consumption of mineral/bottled water has increased in some developed cities of China in the past decade [52,53], which also supports the findings of our study.

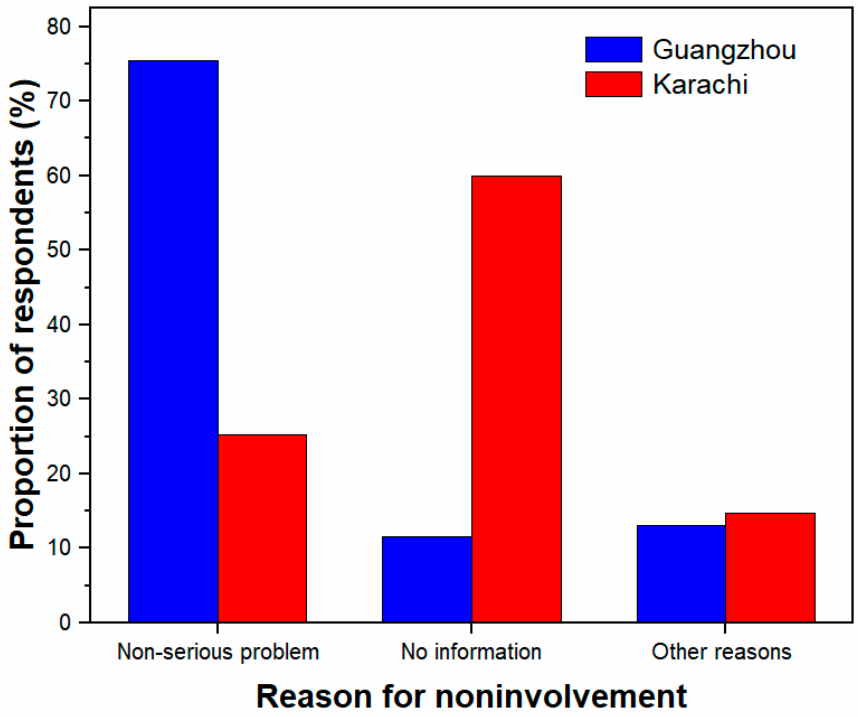

Figure 4. The major factors responsible for noninvolvement of public in awareness events.

Table 4. Attitude and practice scores for drinking water quality and water pollution accidents.

Variables	Guangzhou		Karachi		Given Score
	N	%age	N	%age	
Type of drinking water used in household					
Bore well/hand pump/community well water/public tap water	621	74.9	494	81.40	−1
Bottled water/mineral water	208	25.1	113	18.60	+1
Degree of public satisfaction regarding drinking water quality					
Very satisfied	99	11.9	131	21.6	+1
Satisfied	618	74.5	279	48.9	+1
Dissatisfied	112	13.5	179	29.50	−1
Drinking water issues in home					
Odor	8	0.9	27	4.44	−1
Color (A, B, C, D)	5	0.6	17	2.8	−1
Taste	10	1.2	77	12.7	−1
None	806	97.3	486	80.06	+1

Table 4. *Cont.*

Variables	Guangzhou		Karachi		Given Score
	N	%age	N	%age	
Drinking water can have harmful water contaminants, which must be removed/reduced to achieve safe drinking water					
Strongly disagree/disagree	350	42.20	232	38.20	−1
Strongly agree/agree	479	57.80	375	61.80	+1
Boiling tap water can reduce all contaminants in drinking water					
Strongly agree/agree	148	17.90	191	31.50	−1
Strongly disagree/disagree	681	82.10	416	68.50	+1
Normal/traditional filter plants can reduce all contaminants in drinking water					
Strongly agree/agree	245	29.60	168	27.70	−1
Strongly disagreed/disagree	584	70.40	439	72.30	+1
Is there any public awareness event/education program about drinking water quality awareness arranged by the government/NGOs?					
No/do not know	592	71.40	484	79.70	−1
Yes	237	28.60	123	20.30	+1
What sources of drinking water are provided by the city/provincial government?					
Gound water/not sure	110	13.30	116	19.10	−1
River/rain water	719	86.70	491	80.90	+1
River and rainwater are clean sources of drinking water					
Strongly disagree/disagree	135	16.30	126	20.80	−1
Strongly agree/Agree	694	83.70	481	79.20	+1
Do you pay attention to news stories on water pollution accidents reported on TV, on radio, in newspapers, or elsewhere?					
Yes	630	76.0	481	79.2	+1
No	199	24.0	126	20.8	−1
What types of incidents related to drinking water contamination do you follow?					
Chemicals/microbial/ sewage water	517	37.6	432	71.2	+1
Do not follow	312	62.4	175	28.8	−1
Overall score			11		
Overall mean score (SD)	4.00 (3.09)			3.21 (2.64)	
% highly confident attitude and respectable practice (score $\geq$ 6)	30.0%			7.40%	
% less confident attitude and respectable practice (score $\leq$ 5)	70.0%			94.60%	

Overall, 86.5% and 70.5% respondents in Guangzhou and Karachi were collectively "very satisfied or satisfied" with the quality of drinking water. A previous study reported that 88.0% of respondents in two towns of Karachi were satisfied with the quality of their household water, which was also being used for drinking purposes [51]. Furthermore, 57.8% and 61.8% of respondents in Guangzhou and Karachi strongly agreed/agreed that drinking water quality in the particular cities should be improved. Among respondents, 17.9% in Guangzhou and 31.5% in Karachi believed that boiling water prior to utilization is enough to decontaminate tap water. Furthermore, 29.6% of respondents from Guangzhou and 27.7% from Karachi strongly agreed/agreed that using traditional water filtration plants is

suitable for decontamination. These results show similar variations among respondents' perceptions to studies conducted in Kajang (Malaysia), where 34.0% respondents trusted the boiling of tap water for decontamination. However, 77.5% of respondents also chose additional filtration techniques/devices. Some respondents disagreed that boiling and routine filtration processes could remove all contaminants from drinking water, arguing that contaminants such as chlorine residues, pesticides, chemicals, heavy metals, and microbes could not be reduced using this standard treatment [38].

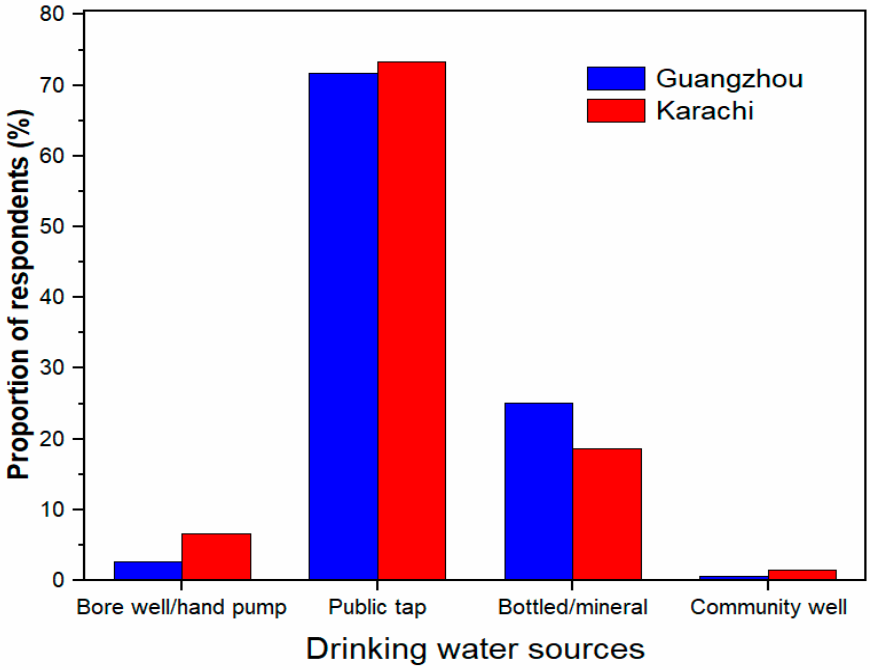

Figure 5. Types of drinking water sources at household level in Guangzhou and Karachi.

The government provides clean rain or river water for daily drinking water consumption to 86.7% of respondents in Guangzhou and 80.9% of respondents in Karachi. Interestingly, 83.7% of respondents in Guangzhou and 79.2% of respondents in Karachi strongly agreed that river and rainwater are clean sources of drinking water, which shows that the government plays a crucial role in building the positive attitudes and good practices. Regarding the minimization of pollution accidents, 28.6% and 20.3% respondents in Guangzhou and Karachi further agreed that the awareness programs about water quality arranged by the government or NGOs would educate the local communities, thereby improving their awareness of safe drinking water. These highlight the need for remarkable improvement in the respondents' positive attitudes and good practices in both cities [38]. If the competent authorities in both cities want to improve their citizens' positive attitudes and good practices, they should arrange more awareness events and campaigns.

3.3. Influencing Factors on Respondents' Opinion about Drinking Water Quality: Prediction and Likelihood Ratio Test Results

Table 5 shows that the age, income, education level, and household size of the respondents in Guangzhou had no significant influence on satisfaction with the quality of drinking water. Only gender (male) had a significant value (p = 0.00). This shows that the opinion of males about drinking water quality in Guangzhou was worse. However, regarding the water quality in Karachi, it was found that the level of education (p for school level = 0.00, p for college level = 0.00), income (p for <200 USD = 0.003), and gender (p for male = 0.00) had a significant influence on satisfaction. The predefined variables comprising the gender (male), the respondents' level of education, and the household income/month played a statistically significant role in differentiating between very satisfied and dissatisfied respondents. These results are in line with findings of previous studies. For instance, a multinomial regression

model was used to determine the associations underlying the gradation of respondents' opinions about drinking water quality in Biskra (Algeria), where only the education level of respondents was found to be significant [19].

Table 5. Summary of multinomial regression analysis for the level of public behavior of satisfaction towards drinking water quality and its influencing factors.

		Guangzhou					Karachi				
		Parameter Estimates					Parameter Estimates				
	Public Opinion about Drinking Water [a]	B	Std. Error	Sig.	95% Confidence Interval for Exp(B)		B	Std. Error	Sig.	95% Confidence Interval for Exp(B)	
					Lower Bound	Upper Bound				Lower Bound	Upper Bound
Very satisficed	Intercept	−1.902	0.560	0.001			1.441	1.228	0.241		
	Male	1.139	0.325	0.000	1.652	5.904	−0.377	0.270	0.162	0.404	1.164
	Female	0 [b]					0 [b]				
	NIL	2.243	1.235	0.069	0.837	106.056	0.680	0.417	0.103	0.872	4.468
	School	1.417	0.836	0.090	0.801	21.225	2.150	0.416	0.000	3.803	19.395
	College	1.475	0.515	0.004	1.594	11.993	1.349	0.369	0.000	1.869	7.941
	University	0 [b]					0 [b]				
	<200 USD	−0.121	0.642	0.851	0.252	3.117	−3.373	1.140	0.003	0.004	0.320
	200–600 USD	1.633	0.904	0.071	0.870	30.098	−2.625	1.136	0.021	0.008	0.671
	601–1000 USD	0.087	0.414	0.833	0.485	2.456	−2.613	1.170	0.026	0.007	0.727
	>1000 USD	0 [b]					0 [b]				
	[Small household]	0.708	0.462	0.126	0.820	5.020	0.150	0.338	0.657	0.599	2.256
	[Medium household]	0 [b]					−0.023	0.331	0.945	0.511	1.869
	[Big household]	0.361	0.614	0.557	0.430	4.785	0 [b]				
	[Age = 18–29]	0.501	0.591	0.397	0.518	5.255	1.123	0.536	0.036	1.075	8.788
	[Age = 30–39]	0.922	0.588	0.117	0.794	7.965	0.577	0.586	0.325	0.565	5.613
	[Age = 40–49]						0.244	0.604	0.686	0.391	4.169
	[Age = 50 and above]	0 [b]					0 [b]				
Satisfied	Intercept	1.018	0.340	0.003			1.285	1.127	0.254		
	Male	1.117	0.257	0.000	1.846	5.061	0.779	0.222	0.000	1.410	3.367
	Female	0 [b]					0 [b]				
	NIL	−0.192	1.186	0.871	0.081	8.436	−1.168	0.420	0.005	0.137	0.708
	School	1.768	0.711	0.013	1.455	23.594	1.380	0.380	0.000	1.886	8.377
	College	−0.051	0.474	0.915	0.375	2.409	0.813	0.298	0.006	1.258	4.046
	University	0 [b]					0 [b]				
	<200 USD	−0.684	0.498	0.169	0.190	1.339	−2.250	1.077	0.037	0.013	0.870
	200–600 USD	1.306	0.792	0.099	0.782	17.443	−1.473	1.074	0.170	0.028	1.880
	601–1000 USD	−0.226	0.305	0.457	0.439	1.449	−1.775	1.100	0.107	0.020	1.465
	>1000 USD	0 [b]					0 [b]				
	[Small household]	0.182	0.302	0.546	0.664	2.166	0.319	0.283	0.259	0.790	2.394
	[Medium household]	0 [b]					0.046	0.272	0.866	0.615	1.783
	[Big household]						0 [b]				
	[Age = 18–29]	0.153	0.426	0.720	0.505	2.685	0.408	0.376	0.277	0.720	3.143
	[Age = 30–39]	0.302	0.392	0.440	0.628	2.914	0.200	0.427	0.639	0.529	2.820
	[Age = 40–49]	0.371	0.399	0.352	0.663	3.164	0.398	0.428	0.353	0.643	3.447
	[Age = 50 and above]	0 [b]					0 [b]				

[a] The reference category was "dissatisfaction". [b] These parameters were set to zero because of redundancy.

The prediction of drinking water quality based on multinomial regression analysis is summarized in Table 6. The predicted satisfaction level of the public in Guangzhou was 100.0%, while the predicted satisfaction level of the public in Karachi was 75.1%.

Table 6. Drinking water quality prediction in both cities.

Observed	Guangzhou Predicted				Karachi Predicted			
	Very Satisfied	Satisfied	Dissatisfied	Percent Correct	Very Satisfied	Satisfied	Dissatisfied	Percent Correct
Very satisfied	0	99	0	0.00	24	85	22	18.30
Satisfied	0	618	0	100.00	19	246	32	82.80
Dissatisfied	0	112	0	0.00	6	125	48	26.80
Overall percentage	0.00%	100.00%	0.00%	74.50	8.10%	75.10%	16.80%	52.40

Table 7 illustrates the likelihood ratio test of drinking water quality utilized by respondents based on gender, education level, monthly household income, household size, and age of respondents in both cities. The values of gender, education, and household income were significant in Guangzhou, whereas household income and household size were significant in Karachi.

Table 7. Likelihood ratio test of drinking water quality utilized by respondents based on gender, education level, monthly household income, household size, and the age in both cities.

Effect	Model Fitting Criteria	Likelihood Ratio Tests			Model Fitting Criteria	Likelihood Ratio Tests		
	−2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.	−2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	340.964	37.693	2	0.000	340.964	37.693	2	0.000
Gender	324.173	20.902	2	0.000	324.173	20.902	2	0.000
Education level	314.178	10.907	2	0.004	314.178	10.907	2	0.004
Household income/month	303.842	0.571	2	0.752	303.842	0.571	2	0.752
Household size	305.747	2.476	2	0.290	305.747	2.476	2	0.290
Age	303.482	0.211	2	0.900	303.482	0.211	2	0.900

Note: The chi-square statistic is the difference in −2 log likelihood between the final and reduced model. The reduced model was formed by omitting an effect from the final model. The null hypothesis was that all parameters of that effect were 0.

3.4. Influencing Factors of Public Awareness about Drinking Water Pollution Accidents

Table 8 summarizes the association between public awareness of drinking water pollution accidents and its influencing factors as evaluated by a multinomial logistic regression model. Males played a significant role in paying attention to water pollution accidents in Guangzhou. In contrast, the education level (nil, school, and college) and monthly household income (<200 and 200–600 USD) of respondents played significant roles in paying attention to water pollution accidents in Karachi. Hence, the results corresponded to the findings of a previous study where it was observed that age and gender had no statistically significant impact on differences in awareness of drinking water contamination accidents, whereas county of residence and level of education impacted contamination accidents in Hainan. More educated respondents of the survey were more aware of contamination accidents than those with lower education levels [12].

Table 8. Summary of multinomial logistic regression analysis for public awareness of water pollution accidents and influencing factors.

Public Awareness of Water Pollution Accidents [a]		Parameter Estimates for Guangzhou						Parameter Estimates for Karachi					
		B	Std. Error	Sig.	Exp(B)	95% Confidence Interval for Exp(B)		B	Std. Error	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
						Lower Bound	Upper Bound					Lower Bound	Upper Bound
Yes	Intercept	2.071	0.321	0				18.97	0.589	0			
	Male	−0.698	0.177	0	0.498	0.352	0.705	0.743	0.278	0.007	2.103	1.221	3.624
	Female	0 [b]	.	.	.	.	.	0 [b]	.	.	.	.	.
	NIL	−22.927	0	.	1.1×10^{-10}	1.1×10^{-10}	1.1×10^{-10}	−4.804	0.548	0	0.008	0.003	0.024
	School	−0.638	0.346	0.065	0.528	0.268	1.04	−1.426	0.32	0	0.24	0.128	0.45
	College	−0.59	0.309	0.056	0.555	0.303	1.016	−1.146	0.339	0.001	0.318	0.164	0.618
	University	0 [b]	.	.	.	.	.	0 [b]	.	.	.	.	.
	<200 USD	−0.768	0.36	0.033	0.464	0.229	0.939	−17.777	0.4	0	1.90×10^{-8}	8.68×10^{-9}	4.17×10^{-8}
	200–600 USD	−0.764	0.385	0.047	0.466	0.219	0.991	−17.183	0.44	0	3.45×10^{-8}	1.46×10^{-8}	8.16×10^{-8}
	601–1000 USD	0.451	0.26	0.083	1.569	0.942	2.615	−17.163	0	.	3.52×10^{-8}	3.52×10^{-8}	3.52×10^{-8}
	>1000 USD	0 [b]	.	.	.	.	.	0 [b]	.	.	.	.	.
	[Small household]	−0.612	0.288	0.034	0.542	0.308	0.954	−0.233	0.359	0.516	0.792	0.392	1.601
	[Medium household]	0 [b]	.	.	.	.	.	−0.318	0.35	0.363	0.728	0.366	1.445
	[Big household]							0 [b]	.	.	.	.	.
	[Age = 18–29]	−0.008	0.356	0.981	0.992	0.494	1.993	1.265	0.464	0.006	3.542	1.425	8.802
	[Age = 30–39]	0.243	0.343	0.479	1.275	0.651	2.498	0.122	0.494	0.805	1.13	0.429	2.973
	[Age =40–49]	0.06	0.343	0.862	1.061	0.542	2.077	0.744	0.532	0.162	2.104	0.742	5.97
	[Age = 50 and above]	0 [b]	.	.	.	.	.	0 [b]	.	.	.	.	.

[a] The reference category was "No". [b] These parameters were set to zero because of redundancy.

3.5. Awareness about Drinking Water Quality Standard and the Role of Local Agencies in Protecting the Environment

Awareness about drinking water quality standards, household water issues, and the actions of EPAs is vital in controlling water quality issues and pollution accidents [54]. The results showed that 50.2% of respondents in Guangzhou and 44.8% of respondents in Karachi were aware of the water quality standards of their countries (Tables 3 and 4). The reported drinking water quality issues in the households of respondents in Guangzhou and Karachi were odor (0.9% and 4.4%), color (0.6% and 2.8%), taste (1.2% and 12.7%), and none (97.3% and 80.1%). It was reported that 57.3% respondents face issues of color, odor, and taste in drinking water at households in Kajang [38], which far exceeds the findings of our study in both cities.

Meanwhile, 74.7% of respondents in Guangzhou and 71.2% of respondents in Karachi were aware of the EPA and its functions. However, the results also depicted that 50.0% of respondents in both cities were unaware of or not sure about the water quality standards of the respective competent authorities. Furthermore, considering the university level of educated respondents in both Guangzhou and Karachi, <30.0% of respondents were unaware of the responsibilities of the respective EPAs.

3.6. The Level of Trust of Respondents in Services Provided by the Ministry of Environment

Gaining public trust is crucial in active statements impacting public behavior as an important goal of environmental policies [21]. The respondents in Guangzhou believed in three key sources of ecological information, which is relatively strong compared to the beliefs of respondents in Karachi. Specifically, 70.8% of respondents in Guangzhou and 39.7% of respondents in Karachi believed in their EPA/Ministry of Environment (MoE). The respondents in Guangzhou had more trust in the data provided by the MoE to regulate the quality of drinking water and to suggest solutions for problems (Figure 6). The findings in Guangzhou are similar to the results in [55], which revealed that government agencies are most trustworthy sources of environmental information. However, the respondents in Karachi did not trust in the government-provided information, mainly because of the media.

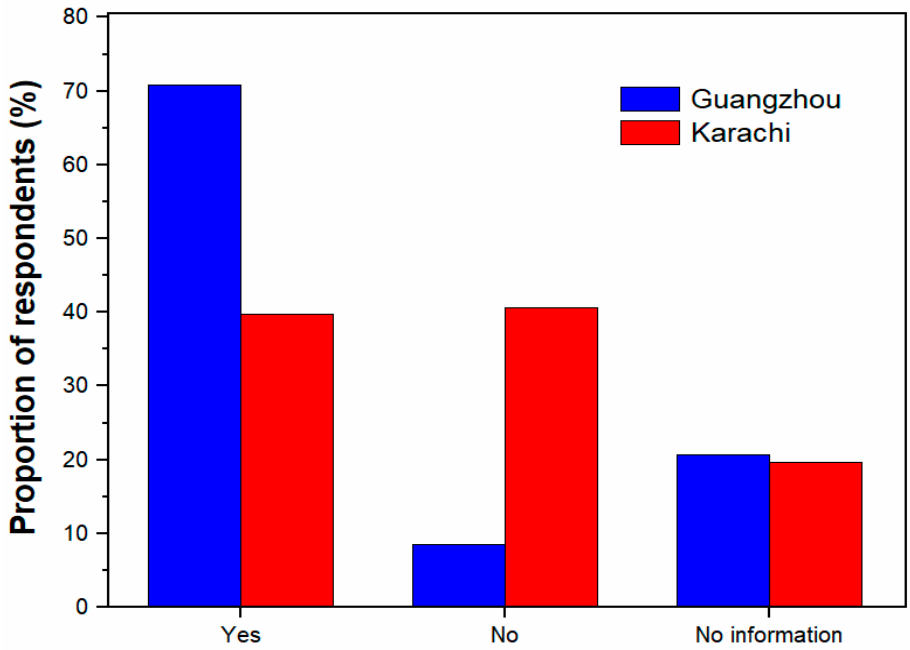

Figure 6. The percentage trust of respondents in the protection provided by the EPA/Ministry of Environment in terms of information on and solutions to water pollution accidents.

4. Conclusions

The present study was based on a comparative assessment of the public awareness levels about drinking water quality and the likely occurrence of water pollution accidents in two southern metropolitan cities (Guangzhou and Karachi) of neighboring Asian countries (i.e., China and Pakistan). The data were collected through questionnaires/interviews, which were analyzed using the scoring method system and multinomial regression analysis. It was observed that the public in Guangzhou (China) was relatively more aware of their individual responsibilities in society; hence, the number of nonrespondents was lower in Guangzhou. The respondents in Guangzhou were generally more educated (with a higher literacy rate) than those in Karachi. The number of young respondents (18.0–29.0 years of age) was high in both cities compared with the number of middle-aged and old respondents. The number of small-sized households, as well as the income/month, was lower in Karachi, which might be a reason for the lower awareness of most respondents in Karachi. The main source of drinking water in both cities was tap water, while most respondents in Guangzhou were relatively more aware of drinking water quality, existing contaminants, drinking water sources, awareness events, and EPA functions. Furthermore, the respondents in Guangzhou had more trust in government-provided information about the likely occurrence of water pollution accidents. However, the level of awareness and the positive attitude in both cities still need to be improved.

Therefore, enhanced public awareness campaigns should be undertaken in educational institutes and community centers. NGOs may also play a role through seminars and environmental awareness activities to improve the education and motivation of ordinary people, aiming at an environmentally literate society. This study also advocates for more public involvement in framing and implementing environmental policies to achieve the best possible water quality framework. This study recommends behavior on the basis of questionnaire responses to develop good policies related to drinking water quality in similar cities.

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