Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/x6zet275

COMPARATIVE STUDY OF PUBLIC AWARENESS AND HEALTH RISK CONCERNS OF DRINKING WATER QUALITY: QUESTIONNAIRE BASED SURVEY AND HOUSEHOLD RESPONSES FROM MULTAN AND BAHAWALPUR, PAKISTAN

Mahlab Ijaz[1*], Dr. Suriyakla Perumal Chandran[2], Muhammad Ali[3].

[1*]. Mahlab Ijaz Phd Scholar (Phd In Health Sciences Specialized In Public Health) Faculty Of Medicine, Lincoln University College Malaysia Mahlabijaz15@Gmail.Com
[2]. Dr. Suriyakla Perumal Chandran Associate Professor Biochemistry And Genetics Unit Deputy Dean Md-Pre Clinical, Faculty Of Medicine, Lincoln University College Malaysia Suriyakaka@Lincoln.Edu.My
[3]. Dr. Muhammad Ali Assistant Professor Department Of Envoirmental Sciences, Faculty Of Agriculture, Islamia University Of Bahawalpur. Muhammadali@Iub.Edu.Pk

***Corresponding Authoor:** Mahlab Ijaz
*Phd Scholar (Phd In Health Sciences Specialized In Public Health) Faculty Of Medicine, Lincoln University College Malaysia Mahlabijaz15@Gmail.Com

Abstract
Fresh water resources are depleting globally and Pakistan is not an exemption to worldwide concern regarding water pollution. This research is design with an aim to evaluate public awareness of water quality, associated obligations and impact on human health in urban areas of Multan and Bahawalpur. For this a questionnaire survey was conducted to investigate socio-demography, general information of water quality, related water quality assessment as well as behavioral factor which affect public perception. Impact of these variables and there effect on human health was assessed by using linear regression and disruptive statistics. Finding revels that 34% respondents in Multan and 20% in Bahawalpur pay special attention to their drinking water quality while 33% and up to 40% are fairly concerned with their water quality. Among them major portion were also concerned of their health and effect on body after consuming poor quality of water. Furthermore, education level also helps differentiating in trust level between three groups. Gender also put a significant role in differentiating groups where male were relatively confident due to social networking then female. Majority of respondents also acknowledge a strong link between poor drinking water quality and health issues. Additionally, a good number of respondents also know typhoid and diarrhea is the major source of waterborne disease. This is quite interesting for public health officials and policymakers who could carry out initiatives to prevent public from water contamination. These findings are generally relevant and have national ramifications in low to medium income countries.

Keywords: Water quality, Respondents, Health, Water pollution, Concerned

Introduction

Water pollution is major environmental problem in twenty first century. Drinking safe water over a long period of time does not exhibit any health related concerns towards human body. According to recent reports an alarming situation arose as estimated 2.1 billion populations is lacking in access to fresh water quality for drinking purpose. According to World Health Organization (WHO) that worldwide only one in every three person is lacking access to clean water for drinking purpose (Wolf et al., 2023). Recently, fresh water quality and quantity is only challenged by intensive use of water. Increasing water demand with poor water quality adversely affect different countries including India, Pakistan, Yemen, Bangladesh, Lebanon and various countries of Africa (Jabeen et al., 2015). Consuming poor quality of water will subsequently leads to transmission of infectious diseases including typhoid, cholera, dysentery and hepatitis A which also increases mortality rate. Issue gained international attention due to climatic and socio-economic factor which aided in contaminating fresh water bodies worldwide. Population growth and unplanned urbanization put pressure on fresh water quality and demand which also drastically affect public health (Bhatt et al., 2024). Therefore an effective management system must be established to maintain supply of good quality drinking water essential for public health. It is of great importance to consider public views towards drinking water safety, quality, demand, and management to prevent it from contamination (Wang et al., 2018).

Public awareness towards environmental issues is based on sufficient public environment participation. Public awareness towards water quality standards needs a complicated interaction of various elements i.e., physiochemical properties, socio-demographic parameters, economic impact and water treatment. Other factors in public awareness include water system management, water source availability and safety (Benameur et al., 2022). Public awareness regarding water pollution and health has been evaluated by various researchers as in Ankara, Turkey a contingent valuation method was adopted to validate public perception for improvement of water quality (Calicioglu et al., 2011). Similarly, Mahler et al. (2015) summarize water quality issues and related concerns of public and found that local community was satisfied by quality of water. These studies exhibit a close relationship between water quality and people's livelihood as well as health.

Pakistan contains large quantity of fresh water reservoirs which faces significant challenges in terms of quality and quantity due to climate change and anthropogenic activities. Water demand increases by the pressure exerted by population growth, agricultural and domestic activities leads to water scarcity. These factors together ranked Pakistan at 14 globally with baseline water stress (Ishaque et al., 2023). Furthermore, quality of ground water in various major cities also exacerbates the situation which poses serious risk to health. High level of contaminants especially arsenic directly affects almost 60 million populations that are why water borne diseases are ranked at the top and their outbreak is highly infectious (Ilyas et al., 2019). According to Pakistan Social and Living Standard Measurement (PSLM) 6% urban and 22% rural population lack access to fresh water for drinking purpose while 23% urban and 40% rural population also lacks standard sanitation.

Recent studies were completely focused on quality of bottled water consumption, recycled municipal waste water while a handful studies were available to find relationship between public awareness, health and water quality. Therefore, current study is designed to find the relationship between public awareness of drinking water safety, water related health concerns and attitude towards drinking water in urban areas of Multan and Bahawalpur through questionnaire survey. Current study highlights loopholes in water quality system, public perspective and health related issues.

Materials and Methods

Study Area

Study was conducted in two major cities Multan & Bahawalpur situated in Southern Punjab, Pakistan. Both cities were situated alongside river Chenab and Satluj. Population of both cities was altogether 3.1 million with climatic condition arid to semi-arid. Mean annual rainfall in Multan is 175 mm while in Bahawalpur it is 143 mm which is insufficient to fulfill basic requirements.

Temperature in both cities ranges between 40°C and 5°C. 85-90% population of both cities relies on ground water for domestic and drinking purpose.

Procedure

To investigate public awareness towards water quality and knowledge about related health hazards, a questionnaire survey was conducted in in both cities. Questionnaire deals with the responses of question about drinking water safety, quality and contamination of drinking water in households, demographic information, degree of trust towards water quality, problems related to water and its solution to prevent it from any health hazard. Current study consists of random sampling technique to ensure unbiasedness while representing the data from Multan and Bahawalpur. Random sampling was done to increase validation and generalizability of data to proof that each factor has chance of selection (Etikan et al., 2016). 18 years or older household was interviewed as they possess greater knowledge for water quality and related health issues. Water quality data was collected from 129 respondents from Multan and 105 from Bahawalpur. In total, 234 sample data was obtained from both cities which is sufficiently enough for statistical analysis (Memon et al. 2020).

Study Instruments

To assess the response with variables the questionnaire was structured into four different sections including geographic, socio-demographic, general information and health issues. First section describes the geospatial and hydrological characteristics of study area where each response is geo-tagged using Global Positioning System (GPS) also included with sea level elevation and ground water depth. Data from multiple Union Councils were collected based on water source and consumption pattern which varyingly depends upon elevation and aquifer access. Second sections include gander, age, education and income which describe respondent's demographic detail. General information section of questionnaire reveled that residents of both cities relies on ground water with a varying degree towards centralized or local water supply, its timely maintenance as well as water quality of filtration plant. A large number of respondents reported demerits of non-functional local water treatment plant where tap water gives coloration, odor and less flow rate. Health issues section includes daily consumption of water, water quality, impact of drinking water on body, skin disorders, precautionary measures taken to prevent from water borne diseases as well as what local government can do when water borne diseases spread in the area. Statistical analysis was performed by using SPPS 24.0 software package IBM SPSS Statistics (IBM Corp., Armonk, NY, USA).

Results

Socio-demographic information of study area

Socio-demographic information of respondent in Multan and Bahawalpur was reveled in table 1. Among gender, respondent male in Multan city is 55.81% while in Bahawalpur percentage was 37.14%. Female in Multan is 44.19% while in Bahawalpur it was 62.86%. Age distribution of respondents was between 18 to 50 and above and was categorized in three distinct types. In Multan, 29.46% respondents were in age group 18 and 34 while in Bahawalpur city similar age group exhibit 44.76%. Age group between 35 to 50 gives responses 47.29% and 29.52% in both Multan and Bahawalpur, respectively while above 50 the response percentage is only 23.26% and 25.71%. Data also revealed that 12.4% were illiterate in Multan while 23.81% were in Bahawalpur. Other respondents have varying education level i.e., 36.43% for high school in Multan, 48.57% high school respondent from Bahawalpur. Graduated participants in Multan were 28.68% while in Bahawalpur they were only 6.67%. Among employment status, employed participated in survey were 43.41% and 41.9% followed by self-employed which were 18.6% and 16.19% in Multan and Bahawalpur City. Retired respondents were least in both cities with 5.43% in Multan and 13.33% in Bahawalpur. Regarding monthly income highest participants were 42.64% in Multan with salary 25000 to 50000 while in Bahawalpur 42.86% participants have less than 25000 incomes. Permanent

resident in survey area with more than one year of Multan were 83.72% while in Bahawalpur 84.76% were fall in similar category.

Table 1. Socio-demographic profile of respondent from both cities

Characteristics	Multan		Bahawalpur	
	Frequency	Percentage	Frequency	Percentage
Gender	Male: 72 Female: 57	55.81 % 44.19 %	Male: 39 Female: 66	37.14 % 62.86 %
Age	18-34: 38 35-50: 61 >50: 30	29.46 % 47.29 % 23.26 %	18-34: 47 35-50: 31 >50: 27	44.76 % 29.52 % 25.71 %
Education	Illiterate: 16 High School: 47 Higher Secondary: 29 Graduated: 37	12.40 % 36.43 % 22.48 % 28.68 %	Illiterate: 25 High School: 51 Higher Secondary: 22 Graduated: 7	23.81 % 48.57 % 20.95 % 6.67 %
Employment Status	Employed: 56 Self-employed: 24 Unemployed: 29 Retired: 7 Student: 13	43.41 % 18.60 % 22.48 % 5.43 % 10.08 %	Employed: 44 Self-employed: 17 Unemployed: 12 Retired: 14 Student: 18	41.90 % 16.19 % 11.43 % 13.33 % 17.14 %
Monthly Income	< 25000: 33 25000-50000: 55 50000-75000: 15 75000-100000: 20 >100000: 6	25.58 % 42.64 % 11.63 % 15.50 % 4.65 %	< 25000: 45 25000-50000: 27 50000-75000: 32 75000-100000: 0 >100000: 1	42.86 % 25.71 % 30.48 % 0.00 % 0.95 %
Permanent resident of area (> 1 year)	Yes: 108 No: 21	83.72 % 16.28 %	Yes: 89 No: 16	84.76 % 15.24 %

General information regarding water quality and filtration system

Building type, average daily water usage, source/type of drinking water system, status/ satisfaction of drinking water, water pollution events and drinking water quality was recorded in table 2. Single family living in home was 43.41% and 27.62% in Multan and Bahawalpur city, respectively while combined family in both cities exhibit significantly increased number. Average daily water uptake was also varied between 10.85% to 56.59% where highest consumed water range is 6-8 liters a day. Ground water source for drinking water is highest in both cities as most surface water fresh water source are contaminated or near to contamination. Ground water consumption in both cities was above 90%. Nearly half of the water system in Multan is central while half are local and driven well. Similarly only 20% water system is Bahawalpur is central while 42% and 37% are local and driven well. Questionnaire survey also revealed that few water systems are non-functional while all other are functional. Water quality satisfaction reported by residents of both cities were more than 50% while residents not satisfied with water quality are 24% and 21% respectively for Multan and Bahawalpur. Almost 44% and 35% water samples were reported as colored by residents, fewer respondents reported odor and algae in their water samples while others doesn't reported any water pollution event. Respondent's response to water quality analysis were also 3% for Multan and 1.9% for Bahawalpur.

Table 2. Public awareness and perception about drinking water quality

Characteristics	Multan		Bahawalpur	
	Frequency	Percentage	Frequency	Percentage
Building type	Single family: 56 Combined family: 72 Apartment: 1	43.41 % 55.81 % 0.78 %	Single family: 29 Combined family: 76 Apartment: 0	27.62 % 72.38 % 0.00 %
Average daily water usage	2-4 liters: 14 4-6 liters: 28 6-8 liters: 73 8-10 liters: 14	10.85 % 21.71 % 56.59 % 10.85 %	2-4 liters: 10 4-6 liters: 22 6-8 liters: 57 8-10 liters: 16	9.52 % 20.95 % 54.29 % 15.24 %
Source of drinking water	Ground water: 117 Surface water: 12	90.70 % 9.30 %	Ground water: 101 Surface water: 4	96.19 % 3.81 %
Type of water system	Central: 62 Local: 33 Driven Well: 34	48.06 % 25.58 % 26.36 %	Central: 21 Local: 45 Driven Well: 39	20.0 % 42.86 % 37.14 %
Current status of water system	Functional: 126 Non-functional: 3	97.67 % 2.33 %	Functional: 85 Non-functional: 20	80.95 % 19.05 %
Satisfaction with current water quality status	Yes: 88 No: 31 May be: 10	68.22 % 24.03 % 7.75 %	Yes: 65 No: 22 May be: 18	61.90 % 20.95 % 17.14 %
Water pollution events	Colored: 57 Odor: 6 Algae: 9 None: 57	44.19 % 4.65 % 6.98 % 44.29 %	Colored: 37 Odor: 29 Algae: 5 None: 34	35.24 % 27.62 % 4.76 % 32.38 %
Drinking water quality ever analyzed	Yes: 4 No: 125	3.10 % 96.90 %	Yes: 2 No: 103	1.90 % 98.10 %

Health issues regarding drinking poor water quality

Drinking water storage containers

Figure 1 describes lack of precautionary measures in terms of drinking water storage in containers. 54.5% and 49.3% respondents reported plastic bottles for storage container, 37.8% and 41.5% adhere to store drinking water in stainless steel containers and 7.7% and 9.2% employed earthen ware to keep drinking water in both Multan and Bahawalpur. While conducting survey, a blatant disregard was observed to prevent from any haphazard. Further when asked for washing of storage containers prior to use only 20% did weekly or biweekly cleaning. Respondent also narrate that daily or weekly cleansing of container is not necessary as fresh water is already stored in it.

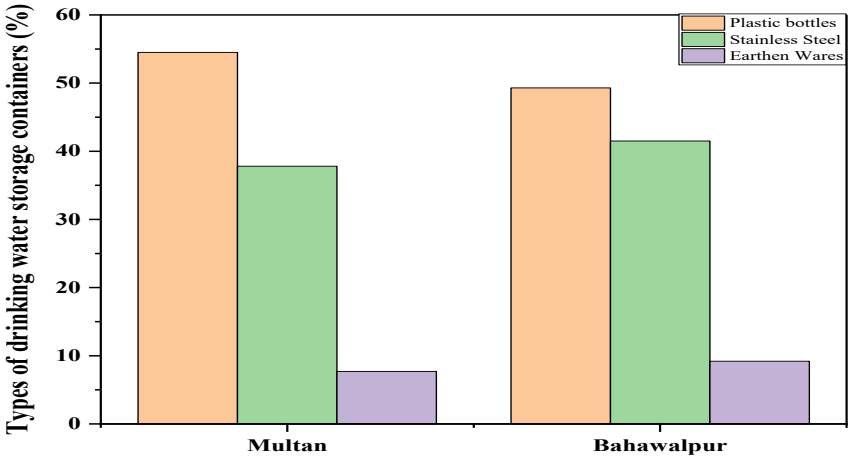

Figure 1: Types of drinking water storage container

Water borne diseases by consuming poor quality water

Questionnaire survey regarding water quality and related health also documents severity of potential waterborne diseases as illustrated in figure 2. Among respondents, 40% in Multan and 44% in Bahawalpur identified diarrhea as the most notorious waterborne disease which impacted largely to children and person with week immunity. Cholera and typhoid are considered as second most harmful waterborne disease caused by drinking contaminated water especially by sewage intrusion into fresh drinking water system. 16% in Multan and 11% households in Bahawalpur also link hepatitis A with water pollution having significant health hazards. Skin disorders are least among all where it only affects 7% respondents in Multan and 5% in Bahawalpur.

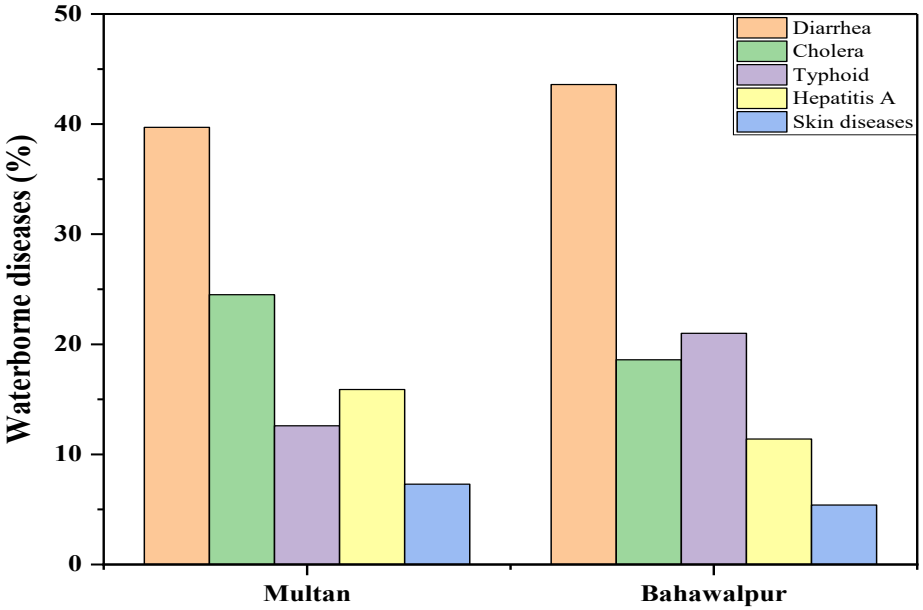

Figure 2: Waterborne diseases due to poor drinking water quality

Sources of water pollution

Figure 3 exhibit distribution of drinking water pollution source among respondents from both cities. Intrusion of sewage water is the major source of fresh water contamination with 59% and 55% for both cities. According to respondents, mixing of industrial effluents into fresh water is reported by 27% and 19% in both cities. Agricultural runoff form agricultural lands are 5.5% in Multan while 20.8% it is reported in Bahawalpur. Urbanization accounted for only 8.8% and 5.1% in both Multan and Bahawalpur.

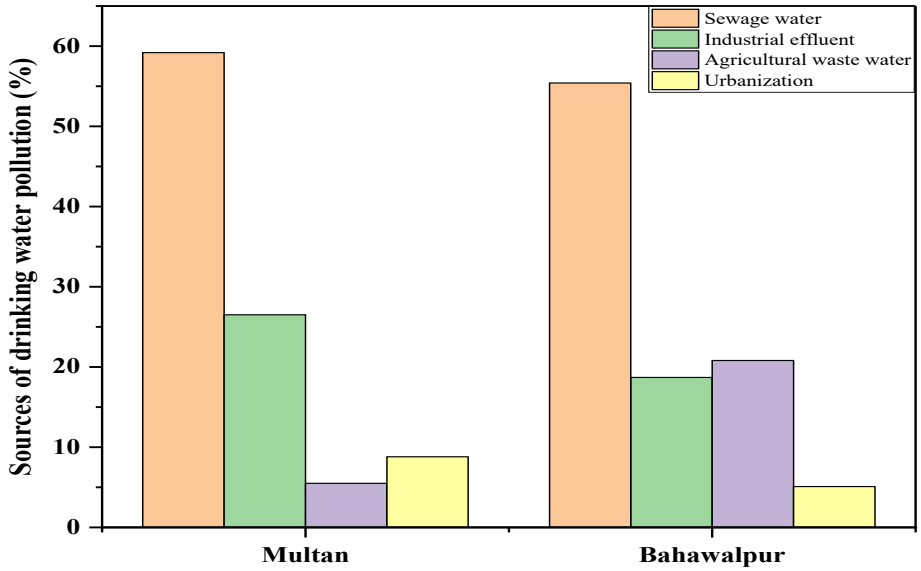

Figure 3: Sources of drinking water pollution

Factors influencing risk perception of water quality

Relationship between drinking water quality and public awareness are influenced by various factors which were analyzed by multinomial regression model as given in table 3 a) Multan & b) Bahawalpur. Table 3 shows gender including male and female, urban population as well as education type and level which had statistically significant role between awareness level and groups. Table 3 concluded that respondent with higher education are well aware about water quality. Among gender males respondent are also aware of water quality they are consuming. Urban population gives potentially mixed responses to water quality questionnaire survey. Based on the above mentioned model public concern to drinking water quality is given in figure 4. Public response is divided into three different categories i.e., extremely concerned, fairly concerned & less concerned. Mixed concerning responses are given by public residing in Multan with 34% extreme and 33% were fairly and less concerned. In case of resident of Bahawalpur, 20% respondents were extremely concerned of their drinking water quality, 36% are fairly concerned while 44% are least concerned.

Table 3. Factors influencing risk perception of water quality in Multan and Bahawalpur

Public trust in safety of drinking water in Multan		B	Standard error	Wald	Degree of Freedom	Sig	Exp (B)	95% confidence interval for Exp (B)	
								Lower Bound	Upper Bound
Intercept		-1.125	0.535	-2.100	0	2.25			
Gender	Male	0.390	0.444	0.879	0	0.781	1.478	0.618	3.533
	Female	0.000			0				
Urban		-0.232	0.449	-0.517	1	0.465	0.792	0.328	1.193
Graduated		0.181	0.617	0.293	1	0.362	1.198	0.357	4.019
Primary Education		0.835	0.634	1.317	0	1.67	2.305	0.665	7.987
Secondary Education		0.013	0.626	0.021	1	0.027	1.013	0.297	3.457

Public trust in safety of drinking water in Bahawalpur		B	Standard error	Wald	Degree of Freedom	Sig	Exp (B)	95% confidence interval for Exp (B)	
								Lower Bound	Upper Bound
Intercept		-0.640	0.509	-1.258	0	1.281			
Gender	Male	0.217	0.425	-0.512	1	0.435	0.804	0.349	1.849
	Female	0.000			0				
Urban		-0.109	0.503	-0.217	1	0.218	0.896	0.334	2.405
Graduated		0.181	0.595	0.304	1	0.362	1.198	0.373	3.853
Primary Education		0.764	0.634	1.205	0	1.529	2.148	0.619	7.451
Secondary Education		-0.002	0.629	-0.003	1	0.004	0.997	0.29	3.425

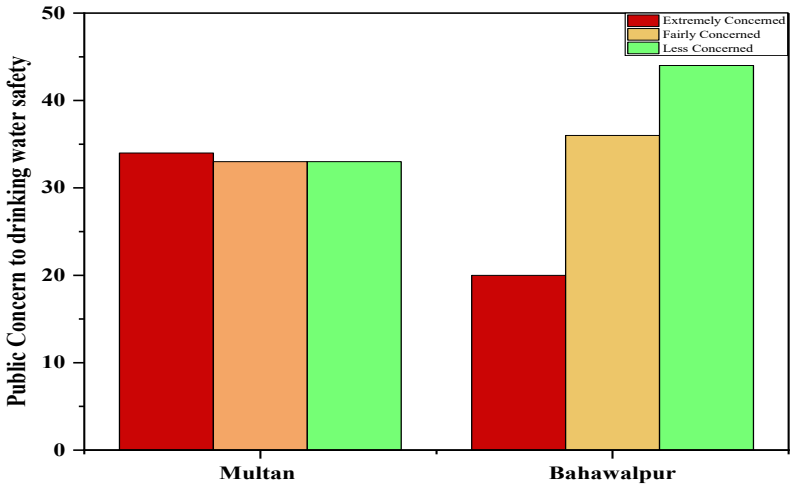

Figure 4: Public concern to drinking water safety in Multan and Bahawalpur

Discussion

Public response to drinking water quality is pivotal to water usage, water management, consumer services, water reuse and risk acceptability. Violations in drinking water quality are largely attributed to health based disorders with significant risk to life in infants and children (Marcus, 2022). According to World Health Organization (WHO) tap water is considered to be the safest source of water which is also be used for drinking purpose (WHO, 2004). Current work is largely based on public perception towards drinking water quality in urban areas i.e., Multan and Bahawalpur City. Findings from the current work reveled that rapid increase in population and urbanization has put fresh water resources to the brink of disaster coupled with poor municipal waste management surface runoff of agricultural waste along with industrial contribution. These altogether in combination significantly affect health of the resident. According to a report by Pakistan Council of Research on Water Resources (PCRWR) ground water of both cities were deteriorated by addition of industrial effluents, seepage of sewage water and agricultural runoff. Findings from current work build a strong correlation between awareness and public attitude to water pollution, influenced by sources of information (Benameur et al., 2022).

Public perception regarding water quality is usually ignored due to lack of knowledge, less use of mainstream or social media, ignorance or arrogant behavior of respondents. Results for the survey suggest that people between age group 45 and 60 years are less aware of water quality due to poor understanding, less social activities and less engagement. Similarly, income between 50000 and 75000 pkr also have less involvement due to its economic condition. Only educated personal with age between 20 and 35 years has highest involvement in community engagement and is well aware of current social issues. Families living in combination also have less involvement in such activities and possibly have less concern to these issues. Campaign in such areas highlight water related issues and change demography. Educating community with less income also helps in promotion of water management practices provides risk management associated with water quality (Anderson et al., 2007).

Use of tape water for drinking purpose is an easiest task as it is the primary source of water at place. For this building type and water transportation is efficient and effective with satisfaction of water quality. Moreover water taken up from selected sites is ground water which is immune to external environment therefore diseases might be introduced into water through intrusion of municipal sewage water and industrial effluents. Water pollution events are also uncommon in such types where color water might indicate presence of excess salt or ions of hazards metal. Level of satisfaction as responded by residents in current study from both cities is also compared to the study by Mahler et al. (2015). Unregulated ground water consumption without any proper management indicates potential hazard to human being as reported by Ford et al. (2019) where different

communities in Canada consume well water which are risk to human health. Type and usage of water containers also had significant effect on health and water quality. Public seminars and education in school is necessary to raise awareness (Tarannum et al., 2018).

Regular information regarding water quality is essential to protect public health (Mahler et al., 2015). Diarrhea and typhoid with most common diseases related to poor water quality found in study area. Water contamination which took place in the vicinity is easily understood by local's o media and give special attention to the events. Among several water contamination events such as water contaminated by microbial activity, heavy metal pollution and discharge of industrial effluents, our work is in consistence with pervious publications regarding water pollution events and public health (Boulabeiz et al., 2019). Our results also suggest that despite knowledge of health risk towards water contamination or unsafe use of water by using outdated water containers they neglected the safeguard which helps improve water quality and limit the risk assessment arose by waterborne diseases. Findings from the current work also suggest respondents don't get a full scale awareness regarding microbial and chemical contamination which might have major concern for human health due to potential toxins present in water (Dean et al., 2016).

Public concerns towards drinking water safety and purity in both cities also suggest that regardless of age and income most people were aware on the basis of education where Multan as a big city has minimum difference between each level. Bahawalpur on the other hand gives only 20% extremely concerned where various factors involve in the public perception towards water quality. A most important factor is sex where men are highly concerned over women with water quality due to increased social networking where women taken occasional interest over such topics. Different studies related to environmental science exhibit that education on the other hand play important role in respondent's perception and behavior. Survey respondents with his gher education level have greater awareness then respondents with lower education (Swaim et al., 2014; Wang et al., 2016).

Conclusion

Current study provides significant insightful for public perception towards drinking water quality and public health in urban environment of Multan and Bahawalpur city where fresh water resources are already depleting quickly. Results describes that respondents with high level of knowledge regarding water quality are confident towards their water resources and support system. Questionnaire survey also revealed that up to 80% of respondents are vigilant to their drinking water resources quality, safety and health risk associated to waterborne diseases. Active drinking water monitoring is often linked to education were source of contamination is easy to identified which also helps improve public awareness however lack of access to relevant information also exacerbate water related disorders. Pathogens present in drinking water often cause various diseases which negatively affect human health. Educating public to aware against water quality is helpful in changing behavior and become top priority among people. This will promote positive attitude in society to safeguard the community from hazards related to public health and also grab attention for policy makers and health authorities. Findings from current study provide national consequences which is relevant to low and middle income nations.

References

1. Anderson, B. A., Romani, J. H., Phillips, H., Wentzel, M., & Tlabela, K. (2007). Exploring environmental perceptions, behaviors and awareness: water and water pollution in South Africa. *Population and Environment*, *28*(3), 133-161.
2. Benameur, T., Benameur, N., Saidi, N., Tartag, S., Sayad, H., & Agouni, A. (2022). Predicting factors of public awareness and perception about the quality, safety of drinking water, and pollution incidents. *Environmental Monitoring and Assessment*, *194*(1), 22.
3. Bhatt, S., Mishra, A. P., Chandra, N., Sahu, H., Chaurasia, S. K., Pande, C. B., ... & Hunt, J. (2024). Characterizing seasonal, environmental and human-induced factors influencing the

dynamics of Rispana River's water quality: Implications for sustainable river management. *Results in engineering*, *22*, 102007.

4. Boulabeiz, M., Klebingat, S., & Agaguenia, S. (2019). A GIS-based GOD model and hazard index analysis: The quaternary Coastal Collo Aquifer (NE-Algeria). *Groundwater*, *57*(1), 166-176.

5. Calicioglu, O., Hepgunes, E., Firat, M., & Alp, E. (2011, September). Public perception and willingness to pay analysis for the improved water quality in Ankara, Turkey. In *Proceedings of the 12th International Conference on Environmental Science and Technology, Rhodes, Greece* (pp. 8-10).
6. Dean, A. J., Fielding, K. S., & Newton, F. J. (2016). Community knowledge about water: who has better knowledge and is this associated with water-related behaviors and support for water-related policies?. *PloS one*, *11*(7), e0159063.
7. Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American journal of theoretical and applied statistics*, *5*(1), 1-4.
8. Ford, L., Waldner, C., Sanchez, J., & Bharadwaj, L. (2019). Risk perception and human health risk in rural communities consuming unregulated well water in Saskatchewan, Canada. *Risk Analysis*, *39*(11), 2559-2575.
9. Ilyas, M., Ahmad, W., Khan, H., Yousaf, S., Yasir, M., & Khan, A. (2019). Environmental and health impacts of industrial wastewater effluents in Pakistan: a review. *Reviews on environmental health*, *34*(2), 171-186.
10. Ishaque, W., Mukhtar, M., & Tanvir, R. (2023). Pakistan's water resource management: Ensuring water security for sustainable development. *Frontiers in environmental science*, *11*, 1096747.
11. Mahler, R. L., Barber, M. E., & Shafii, B. (2015). Urban public satisfaction with drinking water since 2002 in the Pacific Northwest, USA. *International Journal of Sustainable Development and Planning*, *10*(5), 620-634.
12. Marcus, M. (2022). Testing the water: Drinking water quality, public notification, and child outcomes. *Review of Economics and Statistics*, *104*(6), 1289-1303.
13. Memon, M. A., Ting, H., Cheah, J. H., Thurasamy, R., Chuah, F., & Cham, T. H. (2020). Sample size for survey research: Review and recommendations. *Journal of applied structural equation modeling*, *4*(2), i-xx.
14. Jabeen, A., Huang, X., & Aamir, M. (2015). The challenges of water pollution, threat to public health, flaws of water laws and policies in Pakistan. *Journal of Water Resource and Protection*, *7*(17), 1516-1526.
15. Swaim, J. A., Maloni, M. J., Napshin, S. A., & Henley, A. B. (2014). Influences on student intention and behavior toward environmental sustainability. *Journal of Business Ethics*, *124*(3), 465-484.
16. Tarannum, F., Kansal, A., & Sharma, P. (2018). Understanding public perception, knowledge and behaviour for water quality management of the river Yamuna in India. *Water Policy*, *20*(2), 266-281.
17. Wang, Y., Sun, M., Yang, X., & Yuan, X. (2016). Public awareness and willingness to pay for tackling smog pollution in China: a case study. *Journal of Cleaner Production*, *112*, 1627-1634.
18. Wang, L., Zhang, L., Lv, J., Zhang, Y., & Ye, B. (2018). Public awareness of drinking water safety and contamination accidents: A case study in Hainan Province, China. *Water*, *10*(4), 446.
19. Wolf, J., Johnston, R. B., Ambelu, A., Arnold, B. F., Bain, R., Brauer, M., ... & Cumming, O. (2023). Burden of disease attributable to unsafe drinking water, sanitation, and hygiene in domestic settings: a global analysis for selected adverse health outcomes. *The Lancet*, *401*(10393), 2060-2071.
20. World Health Organization. (2004). *Guidelines for drinking-water quality* (Vol. 1). World health organization.