

Contaminated Water Effects on Human Health: A Case of Pakistan

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Abstract

It is vital to have clean water for a healthy lifestyle. Drinking polluted and dirty water causes millions of people to perish. This study's goal was to investigate the effects of tainted water on Rahim Yar Khan's population's health. Rahim Yar Khan's water management and monitoring are subpar, and the city's subsurface water is unfit for drinking because high concentrations of calcium, magnesium, chloride, hardness, and heavy metal are present. The data's empirical component was gathered from hundred repliers in Rahim Yar Khan. The interview schedule was the tool utilized in this study's with the help of purposive sampling for data collection. Descriptive and inferential statistical methods were applied to the data analysis. This study examined public perceptions of the negative health effects after consuming contaminated water and the results shows that high level of diseases are increasing in that selected area just because of drinking contaminated water, some people seemed concerned because of poor hygiene measures for drinking water. The results of this study shows high level of health risk in that selected area for human health.

Keywords: Water, Contamination, Livelihoods, Health, Industrialization

Introduction

In developing nations, problems with water quality come first, then air pollution, solid waste, and waste water disposal. Due to urbanization, industrialization, global warming, population growth, and changes in residential uses, water volume is becoming insufficient with time, and its quality is declining (Gundry et al, 2004). The main issue in developing nations is poorer water

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quality, which is made worse by improper management, a lack of qualified personnel, and financial constraints (Muryani, 2021). Access to clean water is a basic right for all living creatures. Biggest issues facing all nations, particularly the developing ones, is the lack of clean water in the Globe. At least 25% of people on the planet do not currently have access to clean drinking water and as the global population grows, this issue will only become worse.

According to the UN report, a number of countries in Africa, the Middle East, and South Asia may experience a shortage in the next 20 years due to the growing global population and decreasing freshwater availability (Adelodun et al, 2021). In developing nations, the most common problems are with water quality, which is followed by air pollution, solid waste, and waste water disposal (Adelodun et al, 2021). Over time, the amount of water available is decreasing and its quality is getting worse because of factors like population growth, industry, urbanization, global warming, and shifting household needs. In underdeveloped nations, access to high-quality drinking water is sometimes hampered by inadequate management, a shortage of professionals, and financial constraints (Lin et al, 2022).

One of the main challenges is water contamination, which has been a problem for several centuries. It is among the majority of other types of environmental contamination that have arisen as a result of the development and expansion of industrial-urban areas during the last 60 to 70 years, especially the last 20 years. One naturally replenish able resource is water. It comes to us from the sky as rain, snow, fog, and compression, and it goes back by transpiring and evaporating (Fida et al, 2023). There are various types of water on Earth, including lakes, rivers, streams, and oceans. Growing plants are supposed to absorb it, incorporate it into the groundwater where it is stored, and eventually release it into streams, lakes or the oceans.

A basic necessity for every individual is access to an adequate amount of clean drinking water and fresh water. A healthy lifestyle absolutely requires access to clean water. However, millions of people around the world are deprived of this fundamental human right. For all of the nations in the globe, the decline in the availability of fresh water is a serious and worrying issue (Ighalo & Adeniyi, 2020). According scientific research chemical contamination and water-borne diseases have been sharply rising. Many people in this world are lack of

their basic needs especially the most wanted basic need clean drinking water is still out of their reach. However, these limited water supplies are under risk due to pollution, which is mostly brought on human activity. The mining, industrial, agricultural and power generation sectors are just a few of the numerous factors that lead to the pollution of water bodies. People as a whole will eventually be impacted by this pollution (Hasan, 2019).

Numerous microorganisms, including bacteria, viruses, and protozoa, can cause diarrhea. A person with diarrhea loses electrolytes and fluids, which can result in dehydration and, in extreme circumstances, death. Approximately 4 billion instances of diarrhea annually result in 1.8 million deaths, with children under five accounting for approximately 90% of these cases (1.6 million deaths). Children who experience diarrheal illness on a regular basis are more susceptible to malnourishment and other illnesses. The most significant issue with public health that is directly linked to water and sanitation is diarrhea. Hand washing with soap and water can reduce diarrheal illness by thirty percent. According to experts, the second most important factor in preventing waterborne illnesses is having proper sanitation facilities.

Any chemical, physical, or biological agent that alters the water's quality and has a hazardous impact on any living thing that uses it is considered a source of water pollution (Habib et al, 2023). Human health may be seriously impacted when they consume water that has been contaminated. Water contamination can also make it unfit for the intended usage (Singh, 2020). A small amount of negligence on the part of municipal organizations may cause a number of diseases to spread. There are 160 million people living in Pakistan, a country in Southeast Asia that borders the Arabian Sea. Its total size is 796096 sq. km. The nation is endowed with sufficient supplies of surface and ground water. However, the quality and quantity of water are severely stressed as a result of the high rate of population expansion, urbanization, industrial and agricultural development, overexploitation of groundwater resources, and unsustainable water consumption patterns. Water resources are lost as a result of this. It is the duty of the government, science, and society to address the rapidly worsening conditions regarding the nation's water supply and quality. In much of Pakistan, groundwater use in both urban and rural areas is at its peak, which causes the water table to continuously decline.

A recent statistic states that the amount of water available per person is only 1100 cm³. The quality of groundwater varies depending on the region; in general, it ranges from fresh near large rivers with Total Dissolved Solids (TDS) less than 1000 ppm to severely saline with salinity reaching 3000 ppm. Recent investigations have revealed elevated levels of arsenic, fluoride, and nitrates in a number of groundwater samples from the provinces of Sindh and Punjab. Surface water frequently has pesticide residues found in it as a result of agricultural runoff.

As 37% of Pakistani families get their primary drinking water from piped water. The proportion in urban regions (62%) is greater than that in rural areas (21%). The districts within provinces with the lowest percentage of households using piped water as their primary source of drinking water in Pakistan. In Pakistan's rural areas, hand pumps are the primary source of clean drinking water. The primary cause of death for children under five, worldwide is contaminated water and sanitary conditions. People are caught in a vicious cycle of illness and poverty without access to potable water or sanitary facilities. Millions of women waste their valuable time collecting contaminated water throughout the poor countries, and children are dying from treatable diarrheal infections (Leal Filho et al, 2022). In Pakistan, there is an inverse relationship between population increase and water supply per person. With 33.7 million people, there was 5650 each person's available cubic meter of water in 1951. Now, the population had nearly doubled, yet there was only 2800 water capacity in cubic meter per person available. Pakistan started to experience a water deficit (Zeshan, 2018). According to a report, around 62% of Pakistan's urban residents and 84% of its rural residents do not consume treated water, which results in 100 million diarrheal illness cases being reported about 40% of fatalities being related to taking contaminated water (Fida et al, 2023). Rapid population growth exacerbates the issue by leading to inadequate management of water quality. The nation lacks programs for monitoring and supervision of the quality of drinking water. The situation has gotten worse due to inadequate institutional setup, a dearth of well-equipped laboratories, and a lack of a legislative framework addressing problems with drinking water quality. As a result, many ailments can arise from drinking water, counting as hepatitis, typhoid and intestinal worms (Zeshan, 2018).

In Pakistan, water-borne illnesses are thought to be the cause of 250,000 infant deaths annually. There is talk about the effects of arsenic and mercury from industrial effluents on drinking water by (Ahmed et al, 2020). Both anthropogenic activities and natural sources of toxins support the environment. Every person's health is seriously endangered by the presence of harmful substances in the environment (Kalid et al, 2020). Mercury is a recognized carcinogen that can cause a wide range of symptoms, such as headaches, dizziness, exhaustion, altered personality, nausea, vomiting, abdominal pain, respiratory distress, lung impairment, renal failure, glycosuria, narrowed visual fields, seizures, ataxia, coordination issues and metallic mouth tastes (Fida et al, 2023).

According to the scientific research, groundwater contamination with arsenic has developed as significant public health issue in numerous portions of Pakistan. According to (Amin et al, 2019), the massive population growth and challenges brought on by the individuals moving from rural to urban areas are the main causes of ground water contamination. Increases in the number of algae in the water have caused a drastic decline in oxygen levels, which is one of the main causes of water pollution. The majority of river systems have been contaminated by forestry, urbanization, and agricultural growth. Although some come from natural sources, humans are the main cause of water pollution. The amount of dissolved oxygen in surface water is influenced by chemicals, fertilizer used in agriculture, and industrial wastewater. Drinking contaminated water can have a negative impact on a person's heart and kidneys, as well as lead to poor blood flow, skin rashes, nausea, and nervous system impairment. Waste management, water contamination, and air pollution from industrial emissions are few of them. The main issue posing a risk to the public's health is drainage and sewerage (Masood et al, 2021).

Method

The topic of the current study was "Contaminated Water Effects on Human Health: A Case Study of Pakistan". Quantitative approach of research was used in this study since it effectively performs numerical analysis. The researcher was able to describe the link of cause and effect between dependent, independent variables with use of this method, which also helped to test the hypothesis. Rahim Yar Khan was used to get the data. Keeping in mind the maturity and awareness

of the results of the contaminated water's impact on health target audience was restricted to those between the ages of 18 and 40 and above.

Sample

Primary data sources were used in the study. Rahim Yar Khan (Punjab), Pakistan, served as the study's focal point. The socioeconomic circumstances and a comprehensive questionnaire was developed to examine the effect of tainted water on people's health. In the current study, the researcher employed a basic purposive sampling strategy. A sample of 100 respondents was chosen and interviewed using the purposive sampling technique, which involves the researcher selecting the respondents based on a specific aim in mind. Investigator did not act unlawfully towards his subjects when he travelled to the cosmos to gather data. The researcher purposefully concealed his respondents' identities when discussing research confidentiality. Thus, all of the answers he had gathered were completely objective.

Study Tools

A special questionnaire was built for the study that contains two types of questions: the first is multiple-choice questions, and the second is a tripartite scale (To great extent, to some extent, not at all).

The independent variable was Contaminated Water, whereas dependent variable was poor hygiene. The main Indicators in this study Industrialization, Ground water, Population growth and Health.

To validate the reliability and legitimacy of our research instrument, we administered the survey to a panel of professionals in the realms of social sciences and humanities. This panel included an authority adept at professionally assessing and appraising the tool, along with an expert specializing in meticulous proofreading. Adjustments were implemented based on the feedback and insights provided by these seasoned specialists before the tool's dissemination to the participants commenced. In order to ascertain the robustness of the data instrument, we meticulously scrutinized the Cronbach alpha correlation coefficient for each principal dimension independently, as well as for the tool as a whole, yielding a coefficient of 90. Consequently, this coefficient was utilized to validate the initial data collected from the sample members as pertinent for the study's application. The details are presented in Table 1.

Table 1
Cronbach's Alpha for Questionnaire Reliability

Domain	Cronbach's alpha
Contaminated Water	0.91
Population growth	0.93
Health	0.88
Total	0.90

Data Analysis

Both methods were used to analyse the study's data. Inferential and descriptive statistical techniques. The percentages and frequencies were analyzed using the descriptive statistical method, and the chi square and hypothesis testing were conducted using the inferential statistical technique in Statistical Package for Social Sciences (SPSS).

A technique called pre-testing allows researchers to test their instruments before gathering their final results. Prior to data collection, the researcher used statistical analysis to examine the hypothesis's relationship to the interview schedule. The statistical tool of the simple percentage was employed to characterize the fundamental features of the sample, with a particular emphasis. Percentages are calculated using the formula below.

$F = \text{Frequency}$ and $P = \frac{F}{N} \times 100$

N is the total number of frequencies.

Results and Discussions

Millions of people lost their lives as a consequence of taking tainted, impure, and dirty water. Drinking contaminated water is an increasing issue, and the current administration and its stakeholders have recently been concerned about its severe impacts on health. Drinking water, rivers, lakes, and oceans are all impacted by water pollution, which is bad for human health as well as the environment. According to (Sarker et al, 2021) urbanization while other man-made issues are mostly the result of population growth, and our bodies have been contaminated as a result of industrial growth. Serious issues with human health are caused by bad hygiene and contaminated water for drinking that are results of human activities and natural events. Eating certain foods and drinking certain types of water can expose humans to arsenic. The majority of negative effects are

observed after drinking water exposure, despite the fact that food is typically the primary source of exposure for humans. This is due to two main factors: first, the majority of arsenicals found in food are organic and hence have little to no toxicity; second, exposure to drinking water sources often exposes people to the more harmful inorganic form of arsenicals at relatively high levels. Table 1

Table 1

Distribution of Usage of Ground water for Drinking Purpose

Category	Frequency
To great extent	23
To some extent	66
Not at all	11
Total	100

Source: *Field Survey, 2023.*

This chart shows that the majority of respondents (46%) thought there was some connection between water contamination and health problems. The greatest threat to public health and quality of life worldwide is posed by contaminated water. Rain and snowmelt water that runs off rooftops picks up debris, hazardous chemicals, and rubbish along the way. Additionally, many of our water resources are not adequately protected, leaving them vulnerable to industrial plant pollution. As (Qamar et al, 2022) expressed the opinion that this might contaminate the water supply. Sewage and other waste, industrial effluents, agricultural runoff, and industrial waste from the chemical industry, fossil fuel plants, and nuclear power plants are the main causes of water pollution (Fida et al, 2023). The most fundamental source of pollution is industrialization. Industrialization, between other belongings, brought in the extensive usage of fossil fuels, including coal, gas, and oil that are currently main cause of pollution.

Table 2

Distribution of Social Problems Faced due to Contaminated Water

Category	Frequency
Health issue	46
Educational problem	12
Financial problem	21
All of above	21
Total	100

Source: *Field Survey, 2023.*

The below table shows that there is a relationship between human health and contaminated water impact on human health. Majority of the respondents were agree on this point that the contaminated water used by themselves is creating a lot of health problems for their lives. It is affecting them badly and this is a big threat to the world as future generation will face it in a severe form. Analysis from the Environment Protection Agency, chemicals are a major source of contaminated water. Chemical toxic dosages can have short-term or long-term negative impacts on health. A high chemical dosage typically results in an acute reaction that happens nearly instantly. Nonetheless, the majority of chemical concentrations in drinking water are frequently insufficient to result in serious health issues. They are more likely to result in long-term health issues that persist even after brief chemical exposure. Chronic health consequences encompass a variety of conditions, such as cancer, birth deformities, organ damage, and nervous system issues. Table 3

Table 3

Distribution of Relation between Human Health Problems and Water Contamination

Category	Frequency
To great extent	31
To some extent	53
Not at all	16
Total	100

Source: *Field Survey, 2023.*

The below table reveals the degree to which respondents agreed—59% agreed to a large extent, 32% agreed to some extent, and 9% disagreed completely about how much contaminated water effects children in a severe form. This table shows that a significant portion of respondents agreed about contaminated water effect on children. Drinking water needs to be devoid of substances that could be harmful to people's health. These elements consist of organic materials, minerals, and microbes that cause illness. A significant proportion of the populace in developing nation's experiences health issues linked to either inadequate access to potable water or water contaminated by microorganisms. In underdeveloped nations, low water quality is thought to be the cause of death for 5 million children. Table 4

Table 4*Distribution that Children were more effected from Contaminated Water*

Category	Frequency
To great extent	59
To some extent	32
Not at all	9
Total	100

Source: *Field Survey, 2023*

The health of human is greatly endangered by the presence of harmful material in the environment. Numerous illnesses brought on by this polluted water as well. The below table explain that industrialized water effecting human health in many ways especially it a big cause in major Human diseases. Due to lack of available economic resources or lack of proper education, poor people are unaware of the end results of polluted water. So, these people are using contaminated water that could take their lives (Ahmed, et al, 2020). According to (Noreen et al, 2019), activities associated with industrialization and technological advancement have caused in introduction of hazardous substances into the atmosphere (land, air, and water). Due to them, harmful compounds like environmental contaminants have become more prevalent. Table 5

Table 5*Distribution that Chemical Water Causes different health Disease*

Category	Frequency
To great extent	37
To some extent	46
Not at all	17
Total	100

Source: *Field Survey, 2023.*

An acute bacterial infection of the digestive system is cholera. It produces severe episodes of diarrhea that can swiftly cause acute dehydration and even death if left untreated. Cholera is a global issue, particularly in emergency scenarios. Access to clean drinking water, proper sanitation practices, and hygienic eating habits can all help avoid it. Groundwater naturally contains high quantities of fluoride, which can induce fluorosis, a dangerous bone condition. There are at least 25 countries in the world where fluorosis is endemic. A parasite that is carried by specific mosquito species is the cause of the deadly disease malaria. When mosquitoes bite humans, they carry the infection. Approximately

one million children die from malaria each year, and there are 300 million to 500 million cases worldwide. Reducing the number of mosquitoes in homes and communities by getting rid of standing water (which is brought on by unprotected water tanks and poor drainage) will help lower the number of malaria cases. Consuming tainted food or water can lead to the bacterial infection known as typhoid fever. The symptoms include nausea, headaches, and appetite loss. Each year, over 12 million people contract typhoid. Humans can contract intestinal parasite worms, called helminthes, by eating contaminated food or coming into contact with soil tainted with the faces of sick individuals. In the underdeveloped world, intestinal worms affect approximately 10% of the population. The severity of the illness might cause stunted growth, anemia, or malnourishment (Masood et al, 2021). Children usually have the highest amount of worms and are especially vulnerable. Roughly 400 million school-age children have hookworm, whipworm, or roundworm infections. The primary way that trachoma, an infection of the eyes, spreads is through inadequate hygiene brought on by unsanitary environmental circumstances and insufficient water sources. Because to trachoma, almost 6 million people are blind today. Women are impacted by it two to three times more than men are. Youngsters are particularly vulnerable. According to studies, supplying enough water could result in a 25% decrease in illness rates.

This is the most important table shows that how much contaminated water is effecting human lives and threatening them to severe health problem that leads to death as well in some cases. In selected area as per our results respondents were saying that contained water is causing different health diseases like 73% said about Diarrhea, 61% were saying that it is causing Hepatitis, same majority of the respondent 79% were agree on that contaminated water is causing Malaria in the area, while 68% papulation said it is causing Small pox disease as well. In the same time 83% Papulation was agree on this point that except all these disease it is also causing many other health related issues. So, after viewing this we can say contaminated water is a big threat these day in Rahim Yar Khan, Pakistan.

Table 6

Distribution of Diseases Caused by Contaminated Water to Human Health

Category	Frequency	
	Yes	No
Q		

Diarrhea	73	27
Hepatitis	61	39
Malaria	79	21
Small Pox	68	32
Other Human Health Issues	83	17

Source: *Field Survey, 2023*

Inferential Analysis

Inferential statistical analysis is employed in this study to evaluate the relationship between dependent and independent variable through Chi-Square and cross Tabulation. It is a simple statistical method used to make the assumption of cause and effect and access the extent to which a sample's results can be applied to a wider population.

Statement No availability of pure drinking water effects on the Human Health

Table 7

Cross tabulation: To what an extent the available ground water is unable for drinking purpose?

** To what an extent that Human Well-being is more effected from polluted water?*

		To what an extent that Human-Wellbeing is effected by polluted Water?			
		To great Extent	To some Extent	Not at all	Total
To what an extent the available ground water is not able for drinking purpose?	To great Extent	45	21	2	68
	To some Extent	23	7	0	30
	Not at all	1	0	1	2

Total		69	28	3	100
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Source: *Field Survey, 2023*

Table 8

Chi-Square Test

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.170a	3	.538
Likelihood Ratio	2.106	3	.550
Linear-by-Linear Association	1.151	1	.283
N of Valid Cases	100		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is .77.

The table above displays that the relationship between “To what an extent that Human Health is effected from contaminated Water? The results in this table show that contaminated water is effecting badly to human health. The association between the lack of clean drinking water and the health effects by contaminated water is displayed in the above table. A significant portion stated that ground water is inappropriate for ingestion by humans. Additionally, majority respondents stated that contaminated water has a significant negative impact on human health, with this a large amount of people said that the water is somewhat unsafe to drink, and even this unsafe and unhealthy water is effecting children lives as well.

Conclusion and Recommendations

The primary problem in Rahim Yar Khan was the lack of clean water. In Pakistan, urbanization, industry, and population growth are the main causes of the declining water supply and poor water quality as time goes on. About 30–45% of illnesses in Pakistan are attributed to dirty water quality. This study examined how individuals perceive contaminated water and its negative impacts. The government should review its proposal, start a thorough investigation of the water supply before installing water purifying facilities, and take other options into consideration. While local governments should make sure that water purification facilities are constructed in local areas, the government should raise awareness about dirty water and its harmful effects to human well-being. In this

way Individuals will have access to fresh drinking water. To assure the excellence of drinking water, regular analyses should be conducted.

Because of our modern lifestyles, people are responsible for a huge number of chemicals in the environment. Many contaminants in drinking water are thought to have negative health consequences. There is convincing proof that a select few naturally occurring substances, including fluoride and arsenic, are responsible for certain negative impacts on human health. Pure water is Pakistan's most pressing problem; as time goes on, there is less of it available, and its quality is declining as a result of industrialization, urbanization, and population growth. About 30–45% of sicknesses in Pakistan are connected to low water quality. Every year, almost 10,000 individuals in Karachi die just because of contaminated water. A survey of related literature revealed that tainted water is a global problem that affects both developed and developing nations, not just Pakistan. The government should rethink its approach, start a thorough investigation of the water before installing water purifying facilities, and take other options into account. Increase public awareness of contaminated water and put pressure on the local government to guarantee that all plants are operating in accordance with WHO regulations. Physical, chemical, and microbiological analyses should be performed on all residential and public water sources. Garbage and industrial waste disposal should be outlawed completely from communities' environs.

In their previous research argument on water contamination, researcher state that while chemicals from natural resources are present in all water, human activity is also responsible for the presence of chemicals in many other waters. These may result from industrial facility discharges during agricultural operations or from the widespread use of a variety of chemicals in industry. Because of our modern lifestyles, people are responsible for a huge number of chemicals in the environment. Many contaminants in drinking water are thought to have negative health consequences. There is convincing proof that a select few naturally occurring substances, including fluoride and arsenic, are responsible for certain negative impacts on human health. The effects of arsenic and mercury from industrial effluents in drinking water are discussed in many researches. Both manmade and natural sources release toxic substances into the environment. The health of humans is greatly endangered by the presence of harmful materials in the environment.

Irritability, exhaustion, sleeplessness, changes in personality, headache, narrowed visual fields, seizures, ataxia, lack of coordination, metallic taste in the mouth, nausea, vomiting, diarrhea, abdominal pain, pneumonitis, respiratory distress, lung impairment, renal failure, glycosuria, severe brain damage, and a host of other conditions are among the many illnesses brought on by mercury exposure. The processes of industrialization and technological advancement have resulted in the release of hazardous substances into the environment, including the air, water, and land. Due to these, there are now more and more hazardous chemicals present in the environment, including heavy metal pollutants, pesticides, agrochemicals, sewage wastes, food additives, and other related toxins that are providing a health risk to humans and animals.

References

- Adelodun, B., Ajibade, F. O., Ighalo, J. O., Odey, G., Ibrahim, R. G., Kareem, K. Y., ... & Choi, K. S. (2021). Assessment of socioeconomic inequality based on virus-contaminated water usage in developing countries: a review. *Environmental Research*, 192, 110309.
- Ahmed, T., Zounemat-Kermani, M., & Scholz, M. (2020). Climate change, water quality and water-related challenges: a review with focus on Pakistan. *International Journal of Environmental Research and Public Health*, 17(22), 8518.
- Amin, R., Zaidi, M. B., Bashir, S., Khanani, R., Nawaz, R., Ali, S., & Khan, S. (2019). Microbial contamination levels in the drinking water and associated health risks in Karachi, Pakistan. *Journal of Water, Sanitation and Hygiene for Development*, 9(2), 319-328.
- Fida, M., Li, P., Wang, Y., Alam, S. K., & Nsabimana, A. (2023). Water contamination and human health risks in Pakistan: a review. *Exposure and Health*, 15(3), 619-639.
- Gundry, S., Wright, J., & Conroy, R. (2004). A systematic review of the health outcomes related to household water quality in developing countries. *Journal of water and health*, 2(1), 1-13.
- Habib, N., Rankin, P., Alauddin, M., & Cramb, R. (2023). Determinants of livelihood diversification in rural rain-fed region of Pakistan: evidence from fractional multinomial logit (FMLOGIT) estimation. *Environmental Science and Pollution Research*, 30(5), 13185-13196.
- Hasan, M. K., Shahriar, A., & Jim, K. U. (2019). Water pollution in Bangladesh and its impact on public health. *Heliyon*, 5(8).
- Ighalo, J. O., & Adeniyi, A. G. (2020). A comprehensive review of water quality monitoring and assessment in Nigeria. *Chemosphere*, 260, 127569.
- Khalid, S., Shahid, M., Natasha, Shah, A. H., Saeed, F., Ali, M., ... & Dumat, C. (2020). Heavy metal contamination and exposure risk assessment via drinking

- groundwater in Vehari, Pakistan. *Environmental Science and Pollution Research*, 27, 39852-39864.
- Leal Filho, W., Azul, A. M., Brandli, L., Lange Salvia, A., & Wall, T. (Eds.). (2022). *Clean water and sanitation*. Cham: Springer International Publishing.
- Lin, L., Yang, H., & Xu, X. (2022). Effects of water pollution on human health and disease heterogeneity: a review. *Frontiers in environmental science*, 10, 880246.
- Masood, N., Batool, S., & Farooqi, A. (2021). Groundwater pollution in Pakistan. In *Global groundwater* (pp. 309-322). Elsevier.
- Muhammad Zeshan Ali, (2018) <https://www.ijser.org/researchpaper/Exploring-the-Implication-of-Contaminated-water-on-the-Health-of-the-Residents-in-Dera-Ghazi-Khan-City.pdf>
- Muryani, E. (2021, November). Literature review: Water quality and public health problems in developing countries. In *AIP Conference Proceedings* (Vol. 2363, No. 1). AIP Publishing.
- Noreen, U., Ahmed, Z., Khalid, A., Di Serafino, A., Habiba, U., Ali, F., & Hussain, M. (2019). Water pollution and occupational health hazards caused by the marble industries in district Mardan, Pakistan. *Environmental Technology & Innovation*, 16, 100470.
- Qamar, K., Nchasi, G., Mirha, H. T., Siddiqui, J. A., Jahangir, K., Shaeen, S. K., ... & Essar, M. Y. (2022). Water sanitation problem in Pakistan: A review on disease prevalence, strategies for treatment and prevention. *Annals of Medicine and Surgery*, 104709.
- Sarker, B., Keya, K. N., Mahir, F. I., Nahiun, K. M., Shahida, S., & Khan, R. A. (2021). Surface and ground water pollution: Causes and effects of urbanization and industrialization in South Asia. *Scientific Review*, 7(3), 32-41.
- Singh, J., Yadav, P., Pal, A. K., & Mishra, V. (2020). Water pollutants: Origin and status. *Sensors in water pollutants monitoring: Role of material*, 5-20.

