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ASSESSMENT OF DRINKING WATER QUALITY AND ITS IMPACT ON PUBLIC HEALTH IN SKARDU, GILGIT BALTISTAN, PAKISTAN

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Abstract

This study provides a comprehensive assessment of drinking water quality and its impact on community health in Skardu, Gilgit-Baltistan, Pakistan, aiming to inform localized and sustainable water management strategies. Employing a mixed-methods approach, the research integrates quantitative water quality data from the Pakistan Council of Scientific and Industrial Research (PCSIR) with qualitative insights from a survey of 300 local residents. Findings reveal that while most physicochemical parameters generally comply with safety standards, water turbidity and microbiological contamination specifically Total Coliform and Fecal Coliform (E. coli) were recurrently detected above safe limits, indicating a serious risk of waterborne diseases. Despite a majority accessing municipal tap water, a notable portion relies on unprotected natural sources vulnerable to contamination. Survey results highlight that although water availability was mostly consistent, interruptions occurred in some households. A substantial disconnect was observed between scientific evidence of contamination and public perception, with many residents perceiving their water as visually acceptable despite microbial risks. Self-reported health symptoms such as stomach cramps (29.7%), diarrhea (19.7%), and fever (13.7%) were prevalent, and over half (54.3%) believed water quality adversely affects household health. The community identified inadequate government monitoring (32%), lack of treatment facilities (26.7%), and sewage pollution (23.7%) as key challenges. Trust in local authorities was moderate, with calls for more frequent and transparent water quality testing. Almost half of respondents (47.3%) expressed willingness to pay for safer water, prioritizing upgrading existing water infrastructure (34.3%) as a critical intervention. These results underscore a pressing public health issue in Skardu, where seemingly clean water harbors microbial hazards, necessitating evidence-based policies, infrastructure enhancement, robust monitoring, and public education to ensure sustainable access to safe drinking water.

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Introduction

The scientific literature has firmly put the complexity of the inter-relationship between drinking water quality and human health in vastly diverse geographical and socio-economic contexts (Nada et al., 2025; Wagner et al., 2025). The consequences of microbial contamination have been described as nothing short of disastrous as diseases such as cholera, typhoid and diarrheal diseases happen in outbreaks, and their roots may be in water that has been contaminated with feces especially in low-income countries (WHO, 2017b). However, besides microbial threats, researchers have begun to pay more attention to the insidious health effects of chemical toxicants on humans over the long term. An example is the study in Bangladesh, which has clearly identified the connection between chronic exposure to naturally occurring arsenic in the groundwater and a wide range of cancers (skin, lung, bladder) and other serious non-cancerous human health issues on an epidemic scale (Rezazadegan et al., 2025; Wang et al., 2025). Opposing this, excessive fluoride in the drinking water in certain regions in India and East Africa causes dental and skeletal fluorosis, stunting physical development and the quality of life (Shaurya et al., 2025; WHO, 2006). The above global events underline the necessity of a multi-parameter method of determining the quality of water, as well as the need to ensure the observance of strict national and global standards of drinking water quality, including those of (WHO, 2022), regularly updated in the light of new scientific findings on the health risks that can be associated with the consumption of such water.

The international discourse on sustainable development recognizes access to safe, sufficient, and affordable drinking water as a human right which cannot be bought/sold as a commodity or as a privilege (United Nations General Assembly, 2010; UNESCO, 2017). This is in recognition of its vital role in survival, human dignity and just societies. Besides access, the quality of such water also matters and it impacts the health, well-being and socio-economic status of people worldwide (WHO, 2017a). According to the World Health Organization (WHO) and UNICEF (2023), a colossal 2.2 billion individuals do not have access to safely managed drinking water services, and 115 million people are reported to drink untreated surface water. This prevalence of lack of safe water supply is among the primary factors that contribute to the occurrence of easily avoidable diseases in particular in the developing world, which results in high morbidity and mortality rates particularly on the most vulnerable groups. As an example, diarrhea diseases that can mostly be prevented with the help of safe water and sanitation cause significant numbers of deaths among under five-year-old children globally and the estimates suggest that 1.4 million lives could be saved annually with the help of properly improved Water, Sanitation and Hygiene (WASH) (WHO, 2023).

The so-called Water Tower of Pakistan or the Third Pole, as it is assumed to possess a significant amount of snow and ice: Pakistan and Gilgit-Baltistan (GB) More specifically, a paradox of the GB region (ICIMOD, 2019) should be mentioned. Despite the fact that the region appears to be dotted with freshwater sources (thousands of glaciers and snow-capped mountains), supplying the increasing population, already crowded along the banks of the rivers and creeks of Gilgit, with clean and safe drinking water, is a daunting task. The high sensitivity of the mountain ecosystems and the associated increase in anthropogenic pressures predisposes the water resources of GB to degradation. Kardu is a developing urban community and an entry point to some of the most visited locations in the area and therefore experiences more water pressures. Its population increase, development of tourism, and the continued developmental projects are also the contributors of generating more waste and potential pollutants loads (Census of Pakistan, 2017; Local Government and Rural Development Department, GB). The combination of spring water, river water (Indus and Shigar rivers), and piped supply systems without the application of a robust treatment exposes the population of Skardu to diseases that are waterborne (Dialogue Earth, 2021). Nonetheless, the literature on scientific research about drinking water quality of this high-altitude region of Pakistan and its effects on the health of the population is minimal. This research paper aims to fill this knowledge gap, and to present a timely and evidence-based examination to governments on how to promote effective public

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health measures and how to manage water resources sustainably in the region.

Mountain water, especially, glaciated source water, possesses special hydrological characteristics that exert a marked influence on water quality. Although the glacial meltwater is fresh and pure initially, it undergoes significant physical and chemical change in the downstream conveyance process. The rivers and streams may experience high level of turbidity, suspended solids and change of mineral composition during the time of intense melt, e.g. summer and high discharge can dilate the erosion of glacial till and internal geological materials (Jin et al., 2025; Zhao et al., 2025). Such high turbidity can present issues to the typical methods of water treatment that rely on coagulation and sedimentation because suspended materials provide a shield against disinfection agents, like chlorine, and can shelter pathogenic microorganisms that cause waterborne disease. In gracilized regimes (Himalaya, Andes) there are records of seasonally varying water quality parameters, due to melt regime and sediment fluxes (Pant et al., 2025; Saavedra et al., 2025).

The national literature review presents a dark and coherent image of deteriorating drinking water quality in the whole Pakistan. Water quality monitoring surveys have been carried out by the Pakistan Council of Research in Water Resources (PCRWR) at the national level periodically and the overall scenario of contamination in water has been a similar one. As an example, according to their report of 2017, the majority of the drinking water sources in Pakistan, including the ground water, were microbiologically unsafe to be consumed by a human being with the bacterial contamination (coliform and fecal coliform) being the most common issue (PCRWR, 2017). The same has been found by a number of academic studies as well. Tap water samples collected in different cities of Punjab often exceeded the WHO standards regarding the level of bacterial contamination (Khanna & Bhushan, 2025). Low sanitation infrastructure and leaky pipes that contribute to high levels of microbial pollution in Karachi (Abubakar, 2025).

The study is significant in providing a complete baseline of the physical, chemical, and microbiological quality of drinking water in Skardu, enhancing knowledge of the contamination routes along the whole chain of water supply, combining scientific data on water quality with epidemiological data, and bringing forth the knowledge of emerging chemical pollutants such as heavy metals. It also points out the prospective research directions

The evidence produced will present an empirical foundation to the local and regional governmental bodies such as GB-EPA, WASA Skardu and Health Department of GB. This evidence can be applied directly to explain the process of development, revision, and application of drinking water quality regulations and policies, moving beyond a broad principles approach to an in-situ application approach (e.g., leads to local water safety plans). There is a paucity of research on general GB areas, whereas little but extensive research on all significant sources of drinking water in Skardu in terms of the entire physical, chemical (including emerging contaminants such as heavy metals with specific focus on their risk assessment to human health) and microbiological parameters was not available or was dated. Other previous research has focused on specific parameters or specific areas of GB, however a holistic review of Skardu, given its specific urbanizing context, is required.

Objectives of Study

The present study aims at pursuing the following objectives:

1. To assess the quality of drinking water sources in Skardu.
2. To determine the microbiological safety of drinking water in Skardu.
3. To estimate the effect of health risk due to drinking of water in Skardu.
4. To assess influence of local environmental factors and human interferences on Skardus drinking water quality, Gilgit-Baltistan.

Literature Review

The international views on drinking water quality and public health underline the world need of clean water and the programs to create quality water resources. Waterborne illnesses continue to be a significant cause of illness and death across the world, with poor people in low- and middle-income nations being disproportionately affected (WHO, 2023; UNICEF, 2020). WASH-related diseases such

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as diarrhea lead to the death of about 1.5-2 million people every year, with most of them being children under the age of five (Das et al., 2025). The WHO Guidelines for Drinking-water Quality (WHO, 2022) are the most advanced international standard of water safety. These recommendations promote a risk-based water safety strategy to the entire water chain, including source to point of use (WHO, 2022). The global development agenda, including the Sustainable Development Goal 6 with its targets of safely managed drinking water (Target 6.1) and improved water quality (Target 6.3) has great impact on water, sanitation, and hygiene efforts globally (United Nations, 2015).

Pakistan is a country that is highly reliant on the Indus River System and Hindu Kush-Himalaya (HKH) glaciers which feed its tributaries on the national level (PCRWR, 2021a). The Ministry of Water Resources, Water and Sanitation Agencies (WASAs), Public Health Engineering Departments, and the Environmental Protection Agency (EPA) are administrative institutions charged with the governance of water, but they all have overlapping mandates and capacity issues (World Bank, 2020a). Population growth and climate variability are causing the country to be affected by water stress and scarcity (IOM, 2024a; PCRWR, 2021a). Microbiological contamination of untreated domestic wastewater is the key sources of water pollution, and a small proportion of wastewater is treated at the national level (PEPA, 2020). Leaking and aging infrastructure that is close to sewage lines increases the risk of contamination, particularly in intermittent supply conditions. The sanitation habits, such as open defecation (JMP, 2023) and the absence of on-site sanitation, contribute also to the contamination of groundwater sources.

Another popular issue is chemical contamination The problem of arsenic contamination in the Indus River Basin is associated with the health problems of large populations and their connection with cancer and cardiovascular diseases (Abubakar et al., 2025). Fluoride, which is geogenically found in some areas such as the Thar Desert and parts of Balochistan and Punjab, presents dangers of dental and skeletal fluorosis (Kashif et al., 2025; Wang et al., 2025; WHO, 2006). Nitrate pollution by agricultural run-off and sewage may result in methemoglobinemia in infants (Masood et al., 2021; Imran et al., 2022). Agricultural drainage causes lead, cadmium, chromium, and nickel heavy metals, which are neurotoxic, nephrotoxic, and carcinogenic in contaminated surface and groundwater (Sahen et al., 2025; Fida et al., 2022; WHO, 2022). Health risks are also caused by pesticides and herbicides that run off agricultural fields. The burden of waterborne diseases in the country is very high with a high prevalence rate of diarrhea, typhoid and hepatitis A/E which places a heavy burden on the health system and productivity (National Health Survey of Pakistan, 2018; Ministry of National Health Services, Regulations and Coordination, 2022; World Bank, 2020a; Environmental Health Perspectives, 2023). The children are especially susceptible, as poverty and poor health continue to be reinforced by poor WASH services (UNICEF, 2020). In Pakistan, several disease outbreaks such as cholera and hepatitis have been linked to contaminated water.

PEPA has introduced the National Standards of Drinking Water Quality in Pakistan (PEPA, 2008). Nonetheless, the implementation of these standards, in contrast to the WHO guidelines, is poor because of the lack of institutional capacity, insufficient surveillance, and funding (PCRWR, 2021a; World Bank, 2019b).

In Gilgit-Baltistan (GB) and Skardu, there have been limited studies that holistically measure water quality. A cross-district study by the Zoological Society of Pakistan (2012) reveals that the quality of spring and the stream water is good only at the source. Recent bacteriological studies in Gilgit City, Chorbut town, and Ghizer District have also found widespread microbial contamination due to human and animal faeces sources and usually associated with unprotected water sources, leaks in connections, and poor hygiene (Khatoon et al., 2025; Anwar et al., 2021). Chemical contamination research finds unacceptable amounts of heavy metals like chromium, nickel, cadmium, and manganese in Gilgit and Skardu, which pose significant health hazards on the basis of Health Risk Indices and Lifetime Cancer Risk analysis. Higher concentrations of aluminum, boron, and manganese have also been reported, probably due to ultramafic rocks and sulphide mineralization that are prevalent in the Karakoram range. Pollution by agricultural runoff

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adds pesticides and fertilizer pollution around bodies of water.

The burden of waterborne diseases, such as diarrhea, typhoid, and hepatitis, is high in Gilgit-Baltistan according to the public health data and reports of NGOs, and it is caused by the poor water supply, the lack of sanitation infrastructure, and environmental factors (Gilgit-Baltistan Health Department Annual Reports; Dialogue Earth, 2021; AKRSP, 2016). In Skardu, there is water supply via springs and running water gravity-based system, inappropriate domestic waste disposal and infrastructure issues like old pipes and the absence of treatment plants, and susceptibility to natural disasters like landslides and floods (Local Government and Rural Development Department, GB; WASA Skardu; Census of Pakistan, 2017; Gilgit-Baltistan Tourism Department, 2023).

Majority of investigations published on water quality in GB relate to the microbiological water parameters. In-depth research that includes physical, chemical (especially heavy metals) and microbiological, and sound health risk assessments are also lacking in the case of Skardu. Moreover, the past research hardly achieves any statistical correlation between the degree of water contamination and the incidence or prevalence of water borne illnesses (Khatoon et al., 2025). A need to update the data is necessitated by rapid social, infrastructural and environmental changes in Skardu. Studies that consider the entire water supply continuum-source-to-consumer-are scarce, and thus a more holistic study is necessary that will encompass source protection, treatment, distribution integrity and safe storage. This study will address these gaps by offering up-to-date data, examining the relationship between water quality and health, and making recommendations that are context-specific and can be used to plan water safety sustainably in Skardu.

Research Methodology

Research Design

The research design adopted in this study was a mixed methods approach, which is a combination of quantitative and qualitative methods to evaluate the quality of drinking water and its effect on the health of the population in Skardu, Gilgit-Baltistan, Pakistan. The design involved a sequential explanatory approach that involved two phases, which involved an analysis of secondary quantitative water quality data and a primary data collection through a structured questionnaire survey. This combination made it possible to objectively scientifically measure water quality parameters as well as capture community perceptions, behaviors, and self-reported health effects, and increased the depth and rigor of the findings.

Research Population

The primary data was to be collected among the adult population (age 18 years and above) residing in the Skardu district in the form of a private household. This population was selected to represent the various socio-economic and demographic factors that are reflective of the study area, and that comprised of various geographic and infrastructural situations that impact water access and utilization.

Sampling Technique and Research Sample

Stratified random sampling method was applied in selecting a representative sample of 300 respondents. The stratification was carried out geographically or administratively based on the units in Skardu in order to achieve diversity in water source types, reliability of water access, and socio-demographic aspects. In each stratum, systematic random sampling was used to identify households. This methodology ensured a statistically adequate sample size to provide a 5-6 percent margin of error at a 95 percent confidence level of estimating population parameters that are relevant to water quality perceptions and health outcomes.

Research Tools

Data were gathered in two complementary forms:

Primary Data: A structured questionnaire was prepared after intensive literature review and was validated after a multi-stage process, including piloting it on a demographically similar sample. The questionnaire included the following sections: demographic data, sources and consumption patterns of water, reliability of access to water, household treatment of water, perceptions of sensory attributes of water (taste, odor, clarity), perceptions

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of strange properties of water, self-reported health symptoms that may be related to water quality, community awareness of water testing programs, trust in local government, perceived obstacles to clean drinking water, and opinions regarding improvement efforts. Both closed and open questions were asked to obtain quantitative answers as well as qualitative in-depth information.

Secondary Data: Water quality testing reports of the Pakistan Council of Scientific and Industrial Research (PCSIR) Skardu Department of 2021-2022 were taken into account. Such reports comprised various parameters of physicochemical (pH, turbidity, total dissolved solids, electrical conductivity, hardness, chloride, sulfate, nitrate, fluoride, arsenic, iron, manganese) and microbiological (total coliforms, fecal coliforms including E. coli) indicators at various sampling points in different water sources.

Validity and Reliability

The validity of content was achieved through the review of experts in the field of public health and environmental sciences to make sure that it was topical, clear, and comprehensive. The questionnaire was then pilot-tested on 20-30 individuals not in the study area but of similar demographics to make adjustment to the wording and structure of the questionnaire. The internal consistency of multi-item scales was determined with the help of Cronbach Alpha. The data collection staffs were thoroughly trained to ensure uniformity in the administration process and bias. Official laboratory standards and quality controls offered by PCSIR gave credence to the reliability and accuracy of water quality test results in secondary data.

Data Collection

Secondary water quality data were collected with the help of official collaboration with PCSIR Skardu Department. The structured questionnaire was used to collect primary data through face to face interviews by trained enumerators, allowing variations in literacy among respondents. It was ensured that informed consent was given beforehand, and it guaranteed voluntary participation, confidentiality, and the right to withdraw. Data were captured either on electronic devices or paper forms, and there were processes in place to ensure integrity and accuracy of the data entered.

Ethical Considerations

The Institutional Review Board of the supervising academic institution granted ethics approval. The confidentiality and anonymity of respondents were highly upheld by coding and safe handling of data. Respondents were made aware of the purposes, risks, and benefits of the study and then gave voluntary consent. Privacy and data security were taken into account in the process of the research.

Limitations

There were few options in control over sampling strategies and temporal coverage of water quality measurements due to the use of secondary data. The survey was cross-sectional and thus did not allow causal relationships between water quality and health outcomes. The data on self-reported health were susceptible to recall and social desirability biases. Although attempts were made to make the sample representative in Skardu, results might not be generalizable to other areas with varying socio-environmental realities.

Such a well-rounded approach to methodology enabled a thorough and multi-faceted evaluation of the quality of drinking water and its health impact in Skardu, which can be used to frame the necessary interventions, policy-making, and research priorities in the future.

Data Analysis

Secondary reports and survey data were quantitatively entered into a spreadsheet, cleaned, and analyzed using statistical analysis software, such as SPSS or R. Descriptive statistics were used to summarize water quality parameters and survey responses, whereas inferential statistics (chi-square tests, t-tests, ANOVA, correlation, logistic regression) were used to test the relationships between water source characteristics, perceptions, demographic variables, and health symptoms. Open-ended questions were thematically coded by multiple coders to support quantification and contextual knowledge. The interpretation phase involved integration of findings between the two data sources to give a

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unified analysis of drinking water quality, the perception of the people and the health effects.

Table 4.1: Your gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	164	54.7	54.7	54.7
	Male	135	45.0	45.0	99.7
	Prefer not to say	1	.3	.3	100.0
	Total	300	100.0	100.0	

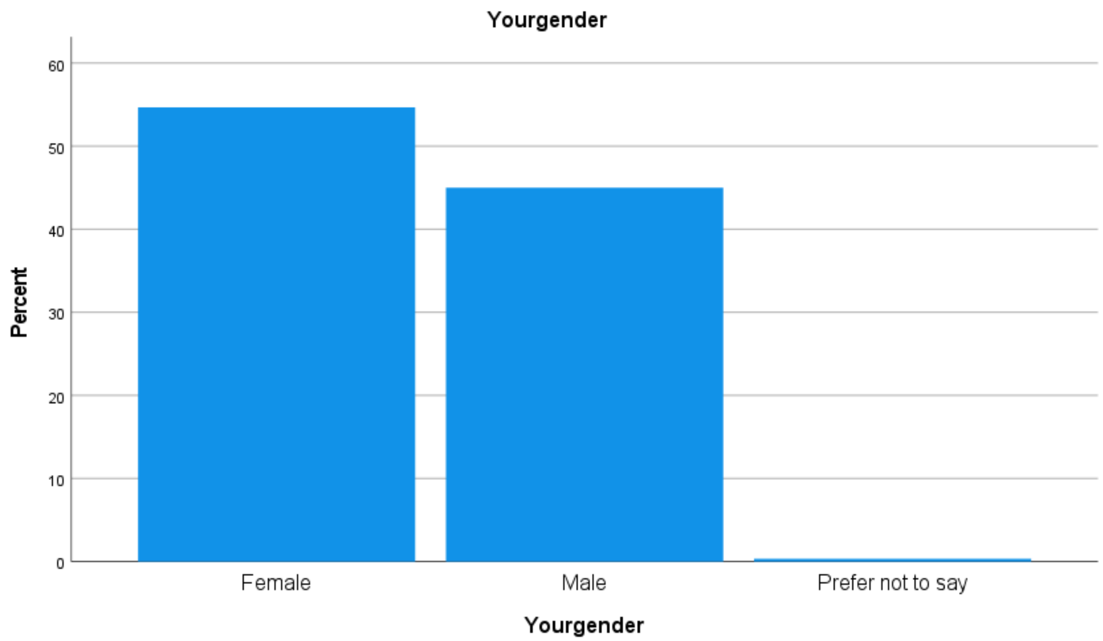

Figure 4.1

The sample: the majority in the sample were female followed by male Out of the total respondents (300), 164 (54.7%) were female. This means that over half of the respondents were female. In contrast, male participants were slightly less present in the subsample (135 = 45.0%). Just 0.3% of respondents chose "Prefer not to say," meaning the large majority of our respondents were able to comfortably reveal their gender identity.

The cumulative percent count does the same, except it is a count of the percentage as we progress through the categories. Once females are added, we hit 54.7%; once males are added, we hit 99.7%; and with the fourth "Prefer not to say" response option, the total becomes 100%.

This gender ratio may be significant in the consideration of results for a study or survey. For example, the modest overrepresentation of women is the survey's effects could potentially drive the general pattern, particularly in contexts where gender might be a factor (e.g., health behaviors and attitudes, as well as access to services). It also demonstrates that sample is balanced in sex predominantly leaning towards females, and with a margin for sex privacy at the bottom.

Just tell me if you're interested in seeing a visual (e.g., pie chart) or if there are certain variables in your study that gender could have an effect on.

Table 4.2: Your age group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-25	259	86.3	86.3	86.3
	26-40	23	7.7	7.7	94.0

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	41-60	1	.3	.3	94.3
	Over 60	1	.3	.3	94.7
	Under 18	16	5.3	5.3	100.0
	Total	300	100.0	100.0	

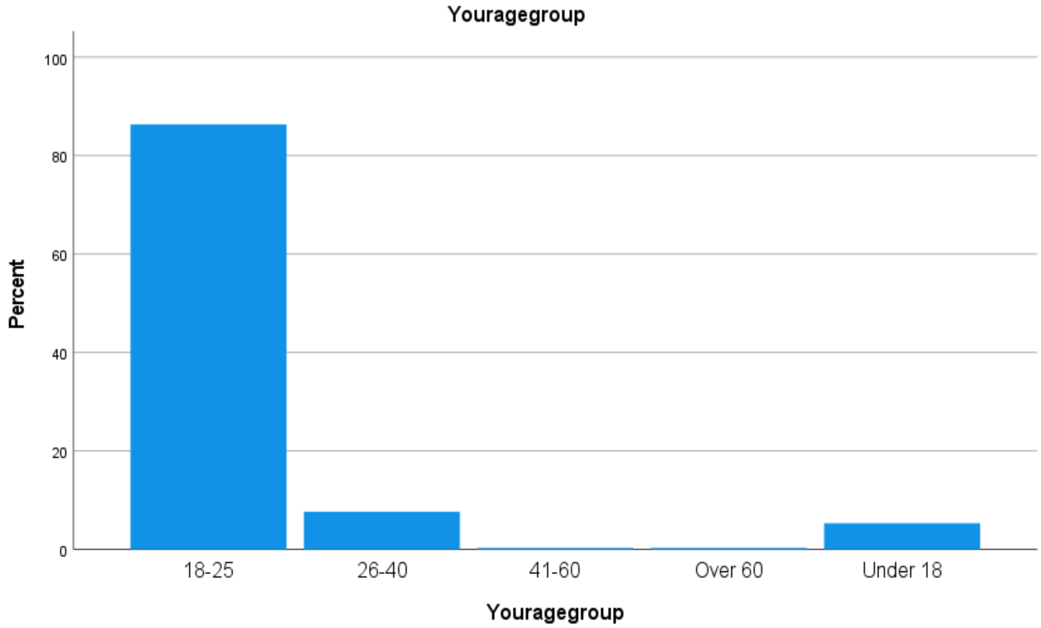

Figure 4.2

As can be observed in the data, 259 respondents (or 86.3% of them) belong to the 18–25 age bracket, and thus the sample is clearly slotted towards the young adult group. This also implies that a study or survey must have been conducted on a population such as university students or young professionals.

The second largest group, which is considerably less numerous, consists of individuals under 18, accounting for 5.3% of all cases. This is succeeded by the 26–40-year-old age group accounting for a mere percentage of the participants. These who are 41–60 and over 60 are extremely underrepresented in the sample—each group accounts for just 0.3% of the sample (only one person each).

The cumulative percentage reveals that after considering the 18–25 and 26–40 groups, 94% of the distribution is accounted for. If one includes those who are under 18, the total is then 100%, setting aside the remaining age groups as apparently insignificant.

Table 4.3: Your approximate monthly household income PKR

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	30,000 - 60,000	81	27.0	27.0	27.0
	61,000 - 100,000	62	20.7	20.7	47.7
	Less than 30,000	38	12.7	12.7	60.3
	More than 100,000	46	15.3	15.3	75.7
	Prefer not to say	73	24.3	24.3	100.0
	Total	300	100.0	100.0	

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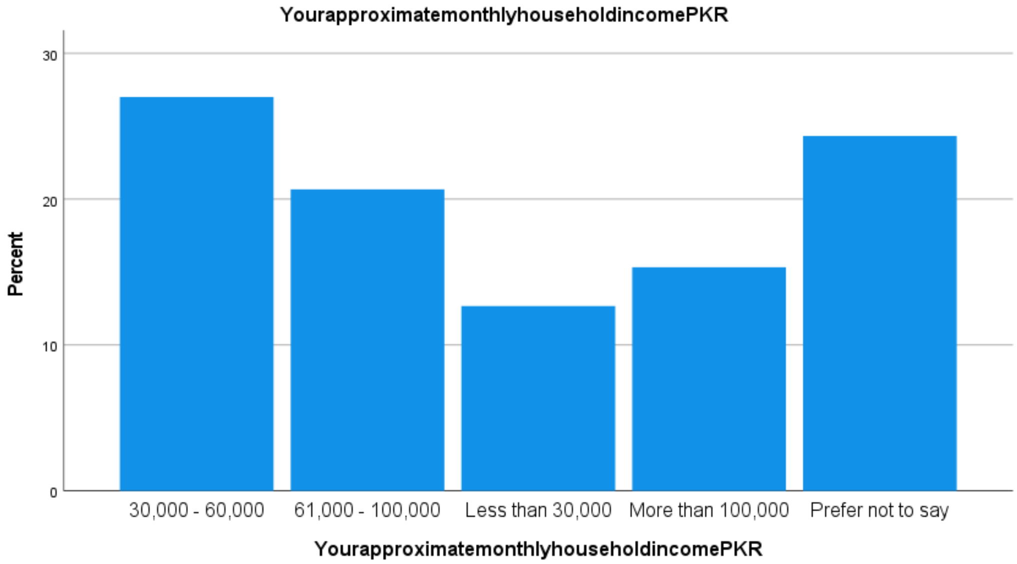

Figure 4.3

Most participants belong to middle- or lower-income strata. More precisely, the most common income category is for those earning between PKR 30,000 and 60,000 per month %) (81 respondents). Next up are those making between PKR 61,000 to 100,000, making up of 20.7% of the sample (62 respondents).

The second largest percentage of the population 12.7% (38 respondents) earned less than PKR 30,000 as monthly income which serves as an indication of the presence of lower income households in the sample. The proportion of wealthy families, however, was also not completely absent as 15.3% (n = 46) reported having income over PKR 100,000.

It is noteworthy that 24.3% (73) of/about the respondents opted for "Prefer not to say" and did not provide their income. This may indicate some discomfort or privacy issues concerning financial information and, to a small degree, reduces the fullness of our income-related analysis.

The next column, cumulative percent, explains how these groups sum to 100 percent and allows us to understand in steps the distribution of income. For example, as many as 60.3 per cent of the respondents have an income less than PKR 100,000 indicating their lower to middle income percentile.

Table 4.4: What is your primary source of drinking water Select all that

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Borehole/Well water	58	19.3	19.3	19.3
	Bottled water	38	12.7	12.7	32.0
	Other (please specify):	23	7.7	7.7	39.7
	Rainwater harvesting	6	2.0	2.0	41.7
	Tap water (municipal supply)	175	58.3	58.3	100.0
	Total	300	100.0	100.0	

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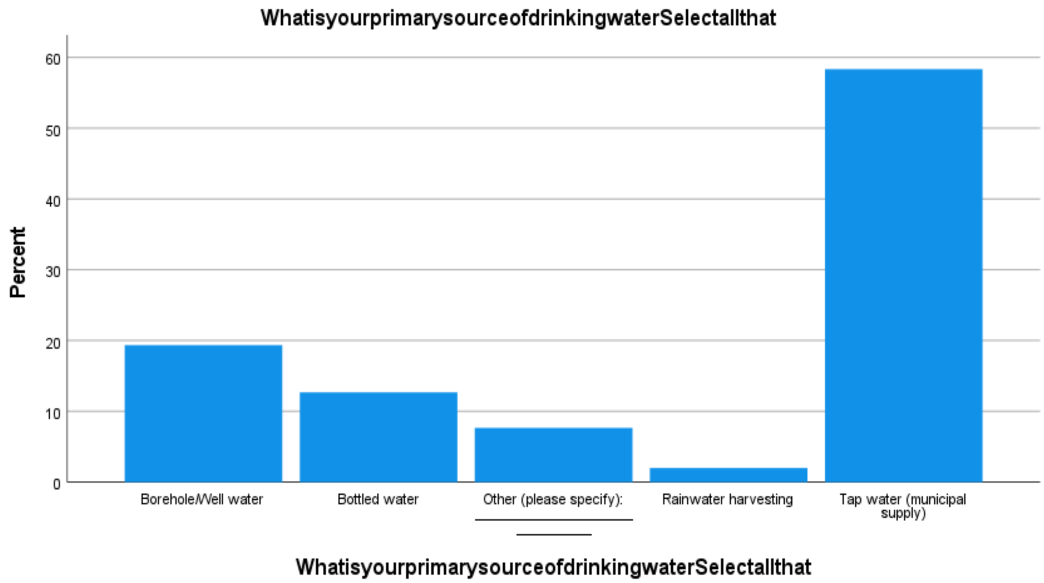

Figure 4.4

The table below provides information on the sources of drinking water of a sample of 300 respondents. And here it is formed into paragraph form:

Most of the participants (58.3%) stated that their main source of drinking water is municipal tap water, which was also the most prevalent source used in the sample. This is then followed by borehole or well water, which represent 19.3% of all first responses. Bottled water is employed by 12.7% of users that is lower than previous, Bottled water use signifying a cheaper but significant an addiction to.

commercially packaged drinking water. A few (7.7%) selected "Other," presumably consisting of non-listed options. The rarest source is rainwater collection, which only 2% of respondents used. In general, it seems that public water supply system (tap) reflects the major source of drinking water, while a few numbers of households use another private system or other sources and the reasons of distance to the house, poor quality, and availability of water resources or structural problems have been mentioned as reasons of this matter.

Table 4.5: How would you describe the consistency of your access to drink

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always available	218	72.7	72.7	72.7
	Frequently available	61	20.3	20.3	93.0
	Rarely available	3	1.0	1.0	94.0
	Sometimes available	18	6.0	6.0	100.0
	Total	300	100.0	100.0	

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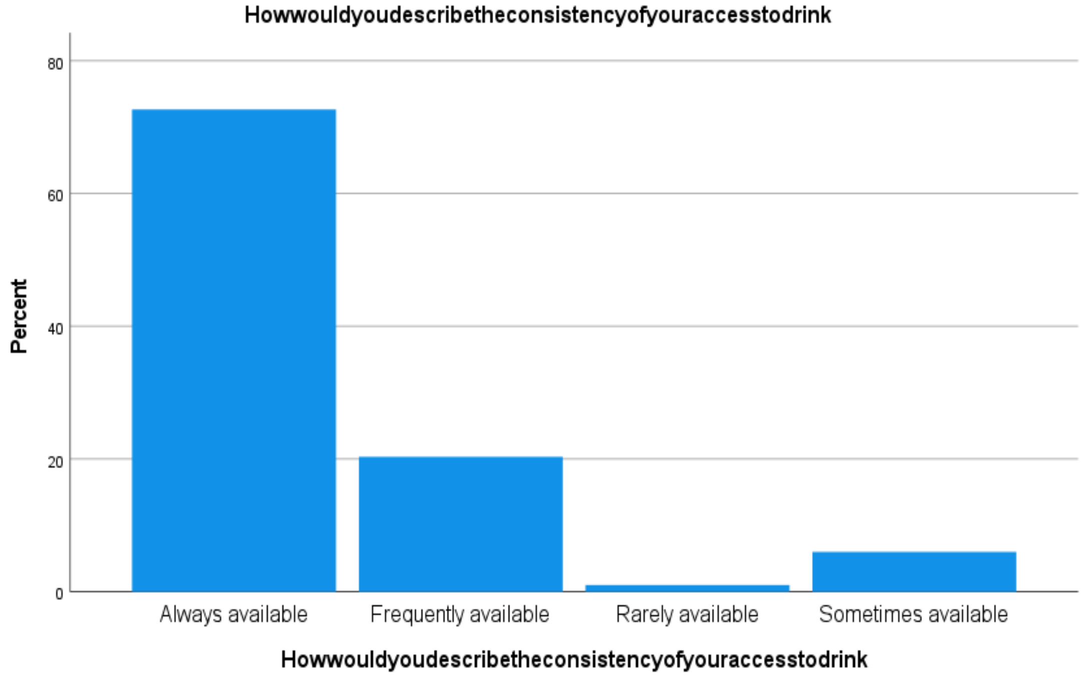

Figure 4.5

Most (218 participants or 72.7%) reported access to drinking water is "always available for me" from a list of 300 people. This implies, that the majority of the respondents has regular, se-cure and safe drinking water source in the surveyed area and also re-flex s to the extent of good infrastructure or supply system in the surveyed area.

Another 20.3% (n=61) said that drinking water is "available on a timely basis," which denotes occasional small disruptions, but overall good accessibility.

But a fraction of the sample faced difficulty with it – 6.0% (18 sample respondents) mentioned water is "sometimes available" and 1.0% (3 respondents) said it is "rarely available". Although these numbers are relatively small, they indicate there are members with limited or inconsistent access, either through location, lack of infrastructure or socio-economic reasons.

As can be observed from the cumulative percent column, 93% of the participants enjoy constant availability of drinking water, either always or frequently, while this availability is not the case for a low 7% of the population.

Table 4.6: Do you treat your drinking water before consumption

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Maybe	36	12.0	12.0	12.0
	No	167	55.7	55.7	67.7
	somehow	28	9.3	9.3	77.0
	Yes	69	23.0	23.0	100.0
	Total	300	100.0	100.0	

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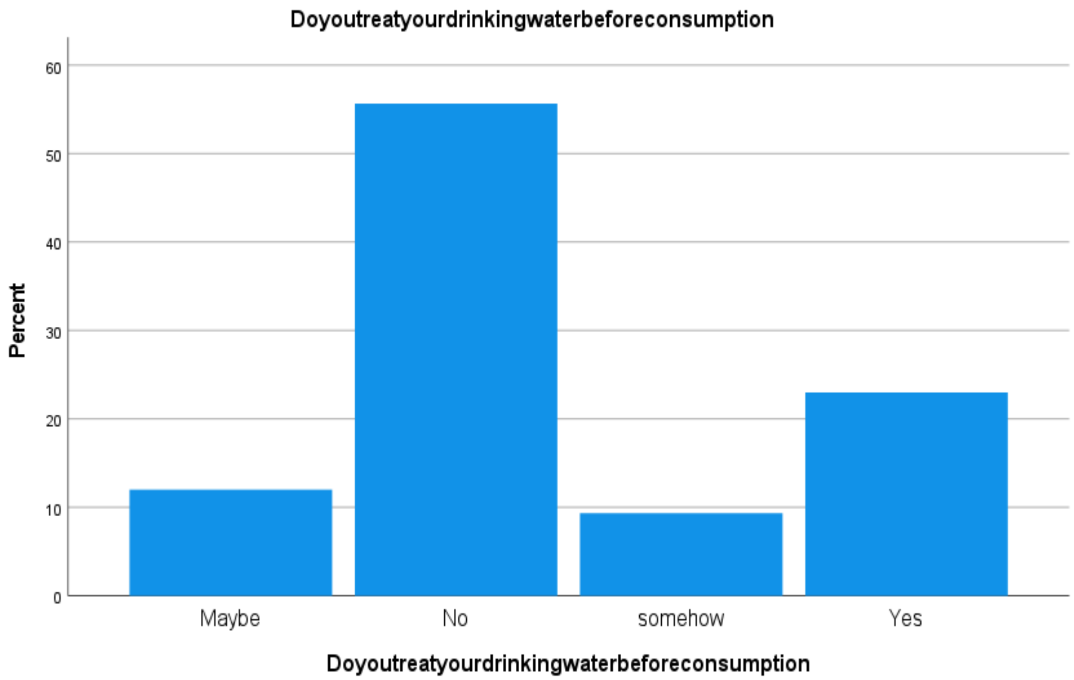

Figure 4.6

The majority of drinking water taste was positive among 300 study participants. More specifically, 44.0% (132 responders) reported the taste as "Good," while another 37.3% (112 responders) rated it as "Excellent." Taken together, this suggests that more than 81% of the study population is satisfied with the taste of the drinking water.
An additional 16.0% (48 responses) rated the flavor as "Fair." This reflects a situation where the water is drinkable but is probably "off-tasting" to a mild extent or has some issues with overall quality.
And at the bottom-end were those few respondents who were not at all satisfied: 7 (2.3%) ranked the taste as "Poor," and just 1 (0.3%) rated the taste "Very Poor."
As evident from the accumulative percent column, the water quality from fair to excellent was rated by almost all the respondents (97.3%) the remaining participants (2.7%) rated the water quality as poor/very poor.

Table 4.7: How would you rate the taste of your drinking water

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Excellent	112	37.3	37.3	37.3
	Fair	48	16.0	16.0	53.3
	Good	132	44.0	44.0	97.3
	Poor	7	2.3	2.3	99.7
	Very Poor	1	.3	.3	100.0
	Total	300	100.0	100.0	

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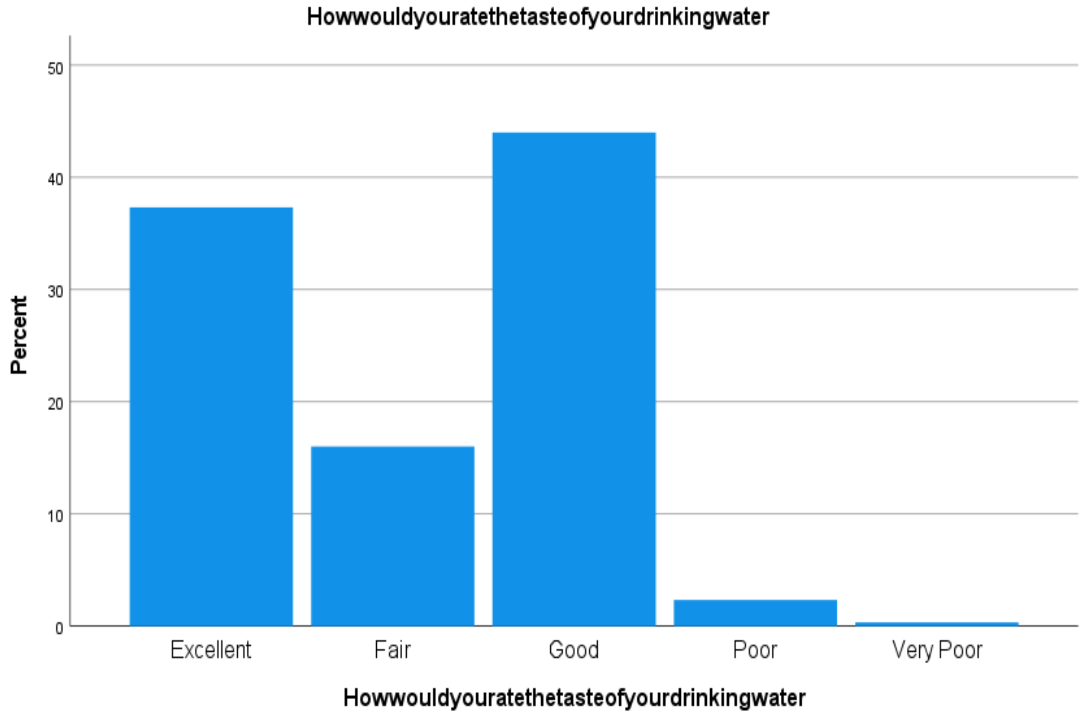

Figure 4.7

Most of the 300 respondents rated their drinking water taste favorably. The taste was rated as “Good” by 44.0 % of respondents (132) and “Excellent” by 37.3 % of them (112). In sum, this results in more than 81% of the respondents being satisfied with the taste of their drinking water.
An addition 16.0% (48) of those surveyed rated the taste as “Fair;” indicating that the water is okay to drink, but may have a slight taste or quality issue.
There was a very tiny minority of indifferent reviewers: 2.3% (7 people) rated the taste as “Poor” and 0.3% (1 reviewer) rated it “Very Poor”.
Considering the grouped columns, the cumulative percent in Table 2 reveals that 97.3% of the respondents who participated in this study rated their water between fair and excellent, and only 2.7% rated their water poor or very poor.

Table 4.8: How would you describe the odor of your drinking water

	Frequency	Percent	Valid Percent	Cumulative Percent
	1	.3	.3	.3
Chlorine smell	13	4.3	4.3	4.7
No odor	206	68.7	68.7	73.3
Other (please specify):	14	4.7	4.7	78.0
Slight odor (not unpleasant)	64	21.3	21.3	99.3
Sulphur/Egg smell	2	.7	.7	100.0
Total	300	100.0	100.0	

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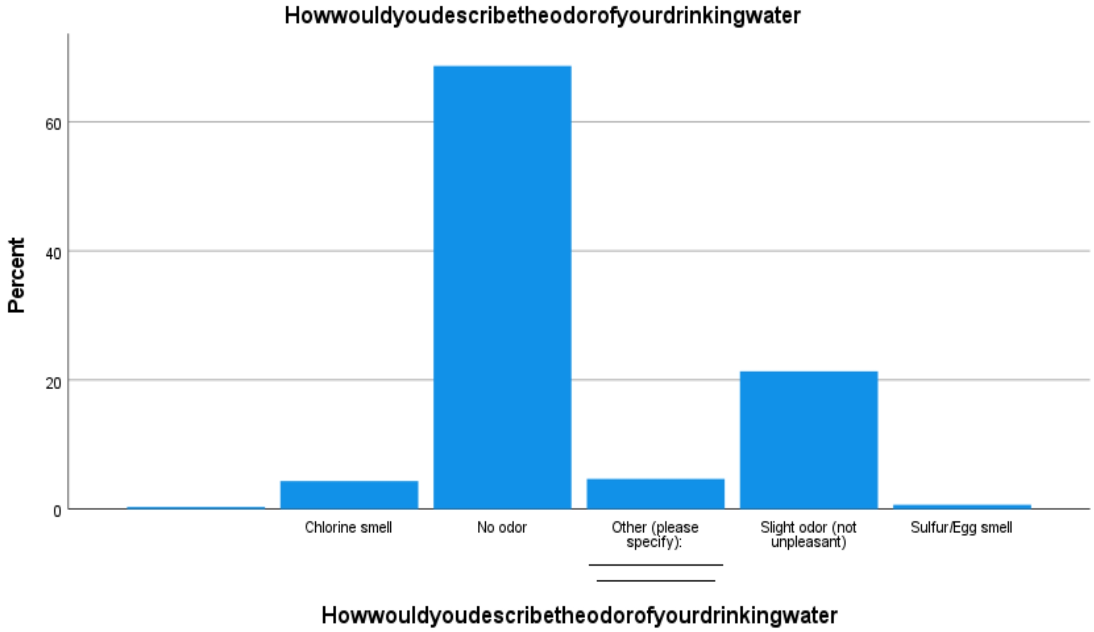

Figure 4.8

Most respondents, consisting of 68.7% (206 individuals) do not smell anything from their drinking water, suggesting overall satisfaction with the odor or freshness of the water they drink. Another 21.3% (64 respondents) indicated they somewhat smelled a very slight odor that is not unpleasant; if someone feels like they can detect some scent, they generally are not repulsed by the smell they do detect when using tap water.

A smaller percentage of participants indicated actual or possibly offensive odors. Chlorine odor was reported by 4.3% (13 people), and such odor is commonly associated with treated municipal water and might signal disinfection. 4.7 percent (14 people) chose “Other” odors, indicating a variety of scents not otherwise specified with the options provided. Of note, 0.7% (n = 2) of respondents characterized their water as smelling like sulfur or eggs, indicative of the presence of hydrogen sulphide and possibly safety concerns related to water.

It is interesting to note that one participant (0.3%) responded equivocal or other response which was encoded as "1;" this could have resulted from an input error or an equivocal choice.

Table 4.9: How would you describe the clarity appearance of your drinking

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Clear and colorless	237	79.0	79.0	79.0
	Contains visible particles	12	4.0	4.0	83.0
	Discolored (e.g., brownish, yellowish	1	.3	.3	83.3
	Slightly cloudy	39	13.0	13.0	96.3
	Turbid/Murky	11	3.7	3.7	100.0
	Total	300	100.0	100.0	

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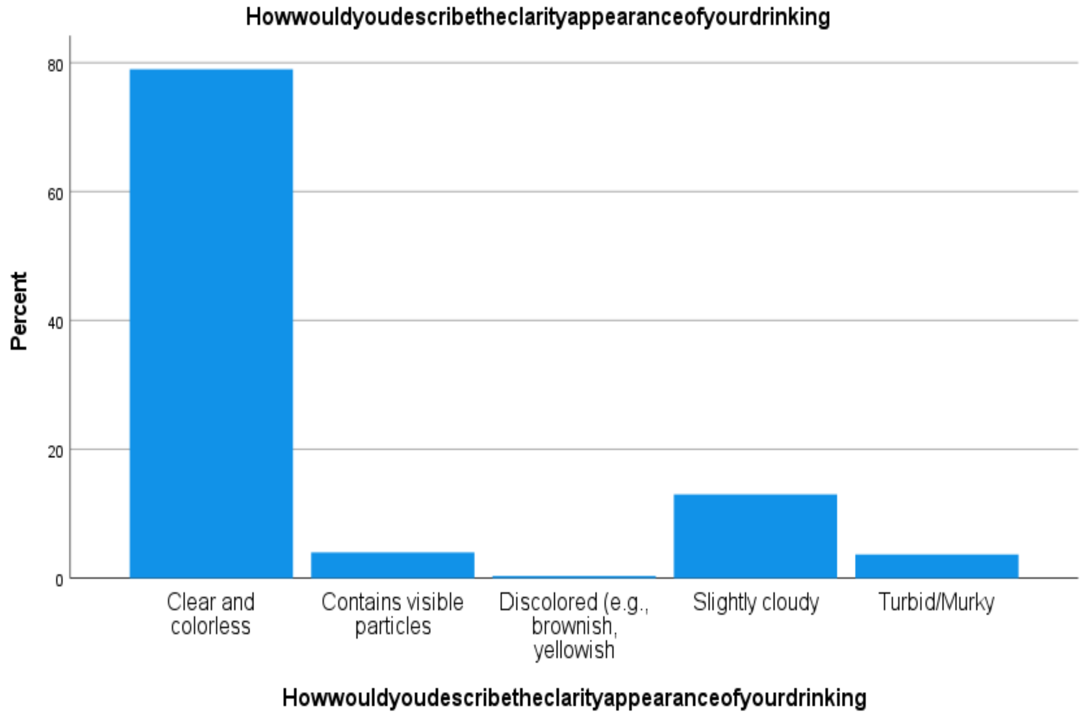

Figure 4.9

The results were that majority of respondents (79.0%, or 237 respondents out of 300) believe that their drinking water is clear and colorless, this is to say that majority of the people believe that the water they are consuming appeared clean and does not have visible impurities. It's indicative of overall good visual quality of water.

Still, the water wasn't perfect: 13.0% (39 people) said their water was a little cloudy with small particles or something else not serious. Some 4.0% (12 persons) - one-in-twenty - claimed that they could see particles in their water, as this might lead to health issues if those particles were sediments, rust or microorganisms.

While a handful of respondents noted more serious problems, with 3.7% (11 people) mentioning their water was muddy or cloudy, and 0.3% (1 respondent) saying it was discolored (brownish or yellow tint), which might indicate the presence of dissolved chemicals or decaying organic matter — typically, a sign of old or failing infrastructure or source pollution.

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Table4.10:Haveyouevernoticedanyunusualcharacteristicsinyourdrinkingwater

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Maybe	43	14.3	14.3	14.3
	No	178	59.3	59.3	73.7
	Yes	79	26.3	26.3	100.0
	Total	300	100.0	100.0	

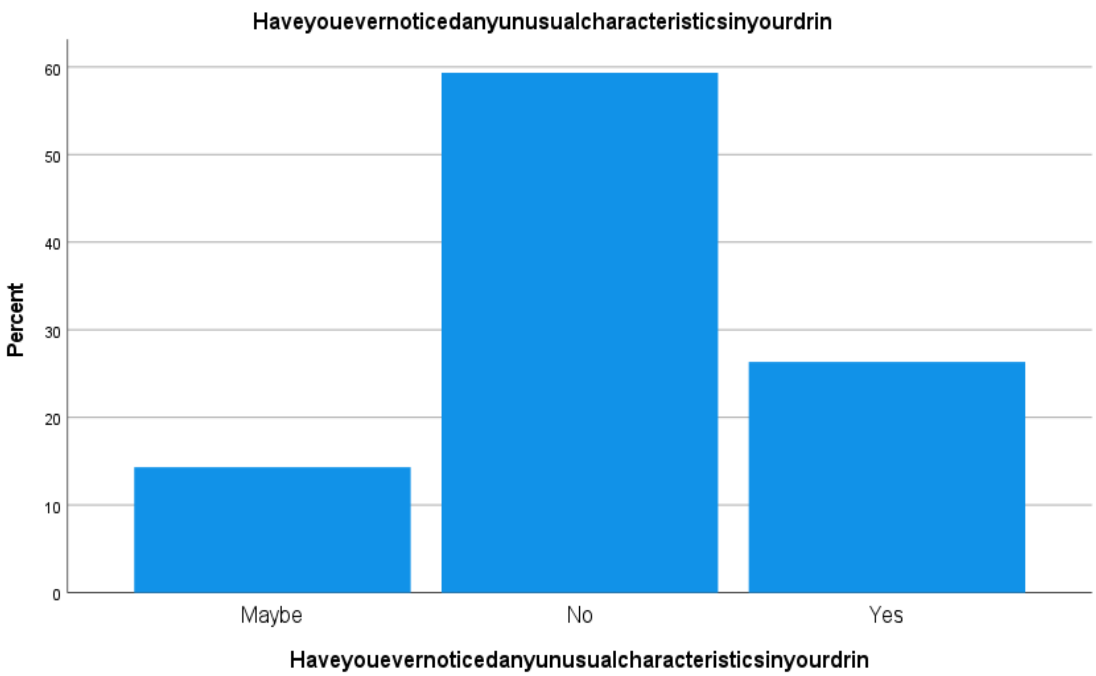

Figure 4.10

A majority (59.3 %, or 178 people) of the 300 individuals indicated that "No," they have not noticed any abnormal characteristics in their drinking water. This means that, to the majority of people, there is nothing unusual in water in relation to taste, smell, color, or other sensory clues.

But a notable minority (26.3%, or 79 readers) responded "Yes," indicating that they have ever detected anything unusual in their water. This might involve changes to the taste (flavor), smell (odor, such as chlorinous or sulfurous), appearance (discoloration), or clarity (cloudiness or particulates). Another 14.3% (43 participants) said "May be," possibly indicating intermittent experiences or uncertainty—perhaps subtle alterations that were not frequent or strong enough to receive a definite classification.

Table 4.11:Inthepast6monthshaveyouoranymemberofyourhousehold

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Diarrhea	59	19.7	19.7	19.7
	Diarrhea, Stomach cramps/abdominal pain	1	.3	.3	20.0
	Eye irritation	13	4.3	4.3	24.3
	Fever	41	13.7	13.7	38.0
	Other waterborne diseases (please specify):	50	16.7	16.7	54.7

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	Skin rashes/irritation	18	6.0	6.0	60.7
	Stomach cramps/abdominal pain	89	29.7	29.7	90.3
	Typhoid	11	3.7	3.7	94.0
	Vomiting	18	6.0	6.0	100.0
	Total	300	100.0	100.0	

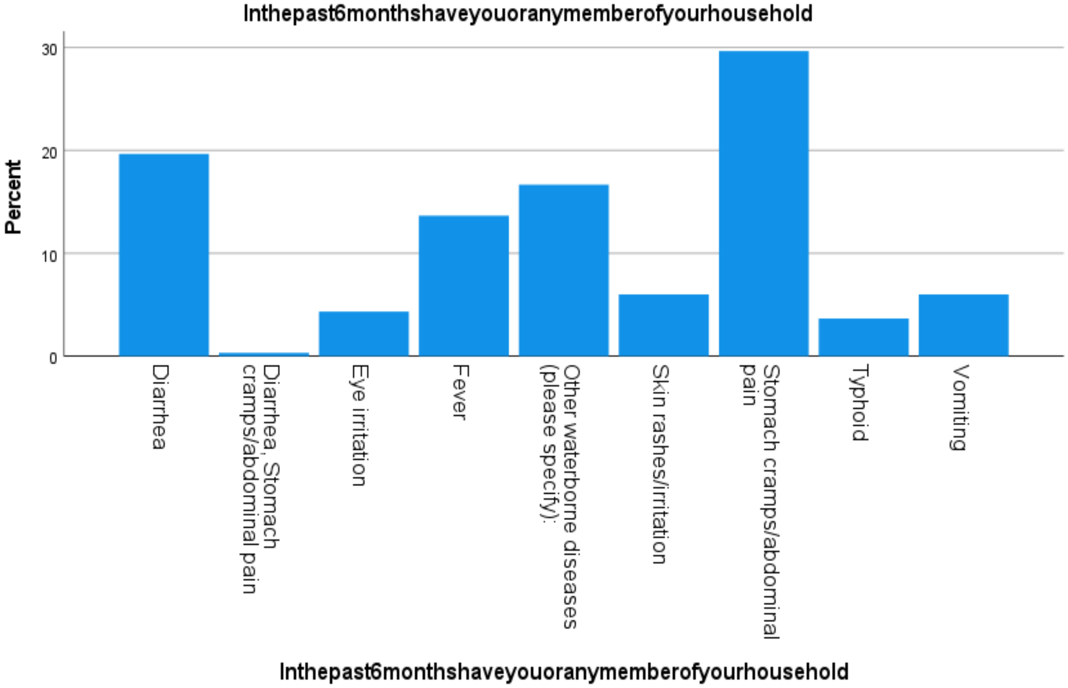

Figure 4.11

Significant proportions of the 300 interviewees admitted to having suffered from waterborne or waterborne-related diseases. Stomach cramps or abdominal pain was the reported symptom most frequently (29.7 % [89 respondents]). This itself could be a symptom of a stomach ailment brought on by dirty water or unsanitary living conditions.

Diarrhea was second in ranking order of the most common health conditions reported, affecting 19.7% (n = 59), with one more person being affected with both diarrhea and stomach cramps accounting for 0.3% of the sample, which reinforces the concern for potential waterborne infections.

Fever was 13.7% (41), which could be a symptom of infections such as typhoid or viral diseases related to unsafe water. Certainly, 3.7% (11 respondents) explicitly cited typhoid—a grave water related disease frequently associated with poor water hygiene and sanitation.

Other water born diseases (non-specified) were presented by 16.7% (50 individuals), indicating that a large proportion are suffering from water-related diseases not directly implicated in the listed categories.

Skin rashes or irritation and eye irritation were also reported by 6.0% (18 participants) and 4.3% (13 participants), respectively, possibly as a result of exposure to contaminated water through bathing/washing. Another frequent symptom of waterborne GI illness, vomiting, also was reported by 6.0% (18 respondents)

Table 4.12: Do you believe the quality of your drinking water has an impact

		Frequency	Percent	Val id Percent	Cumulative Percent
Valid	Maybe	62	20.7	20.7	20.7

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	No	55	18.3	18.3	39.0
	No, little to no impact	15	5.0	5.0	44.0
	Unsure	5	1.7	1.7	45.7
	Yes	163	54.3	54.3	100.0
	Total	300	100.0	100.0	

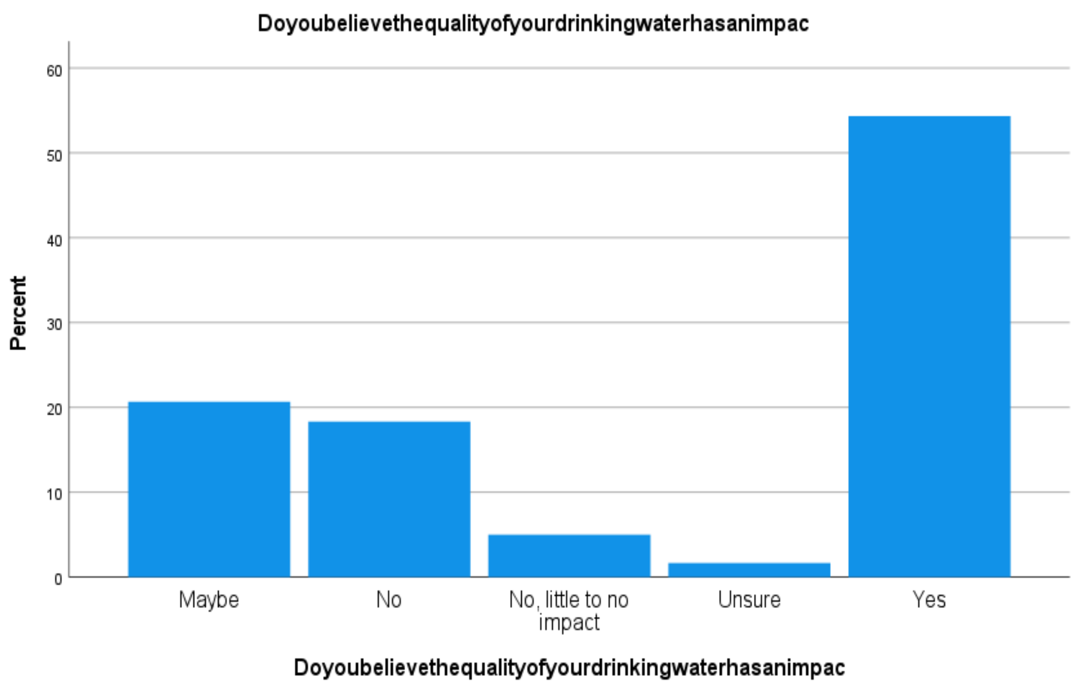

Figure 4.12

A majority of respondents (54.3%, 163 out of 300) consider their drinking water quality has a direct effect on their health. This is a strong evidence of awareness of the consequences that could befall people due to consumption of dirty or substandard drinking water.

And another 20.7% (62) answered “Maybe,” showing a level of uncertainty, but nonetheless suspecting a connection between water quality and health. On the other hand, 18.3% (n = 55) disagree with the statement, “No that does not affect my health” which means that they do not agree that their health is affected by the water quality, while 5.0% (15 people) agreed with the statement, “Yes a little or no” they think that it does not affect. A minority, 1.7 percent (5 respondents), do not know.

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Table 4.13: Are you aware of any water quality testing conducted in your a

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Maybe	27	9.0	9.0	9.0
	No	169	56.3	56.3	65.3
	Unsure	22	7.3	7.3	72.7
	Yes	82	27.3	27.3	100.0
	Total	300	100.0	100.0	

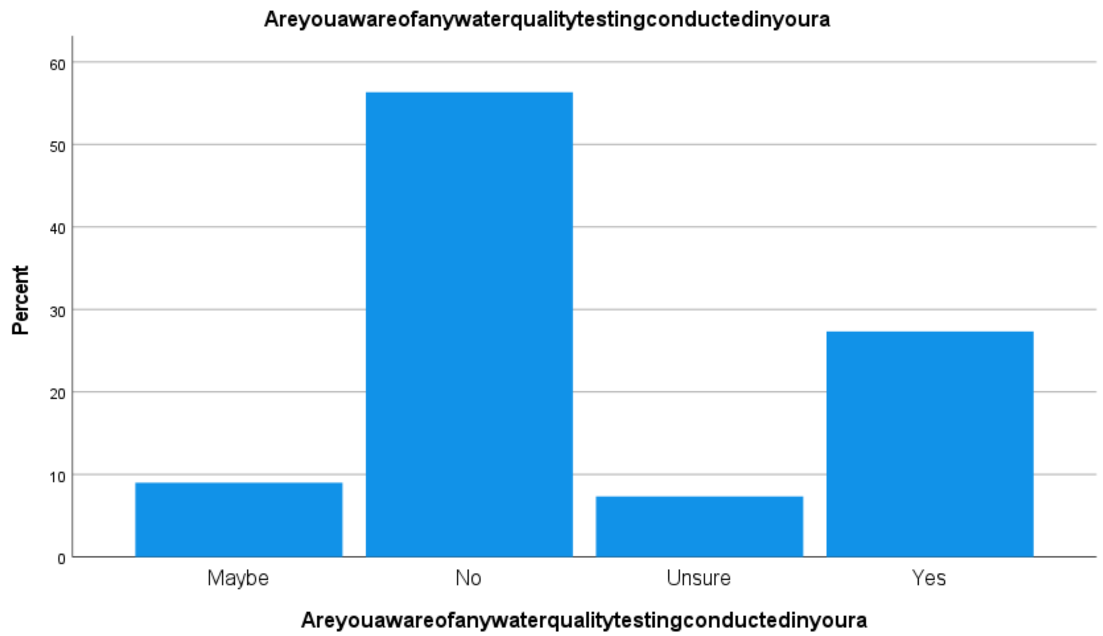

Figure 4.13

Of the 300 respondents, approximately 27.3% (n = 82) indicated that they were aware of water- testing in their community. That would mean fewer than one in three Americans are aware of efforts at the official or local level to track drinking water safety.

To the contrary, a 56.3% majority (169 people) answered “No” – revealing that there is some sort of lack of awareness / engagement on the part of the community delivered from the authorities. Another 9% (27 respondents) answered “Maybe” and 7.3% (22 individuals) did not know, indicating also lack of confidence or clarity about local water monitoring practices.

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Table 4.14: Have you ever reported a water quality concern e.g. contamination

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Maybe	33	11.0	11.0	11.0
	No	169	56.3	56.3	67.3
	No, I don't know how to report	17	5.7	5.7	73.0
	No, I haven't	18	6.0	6.0	79.0
	Yes	63	21.0	21.0	100.0
	Total	300	100.0	100.0	

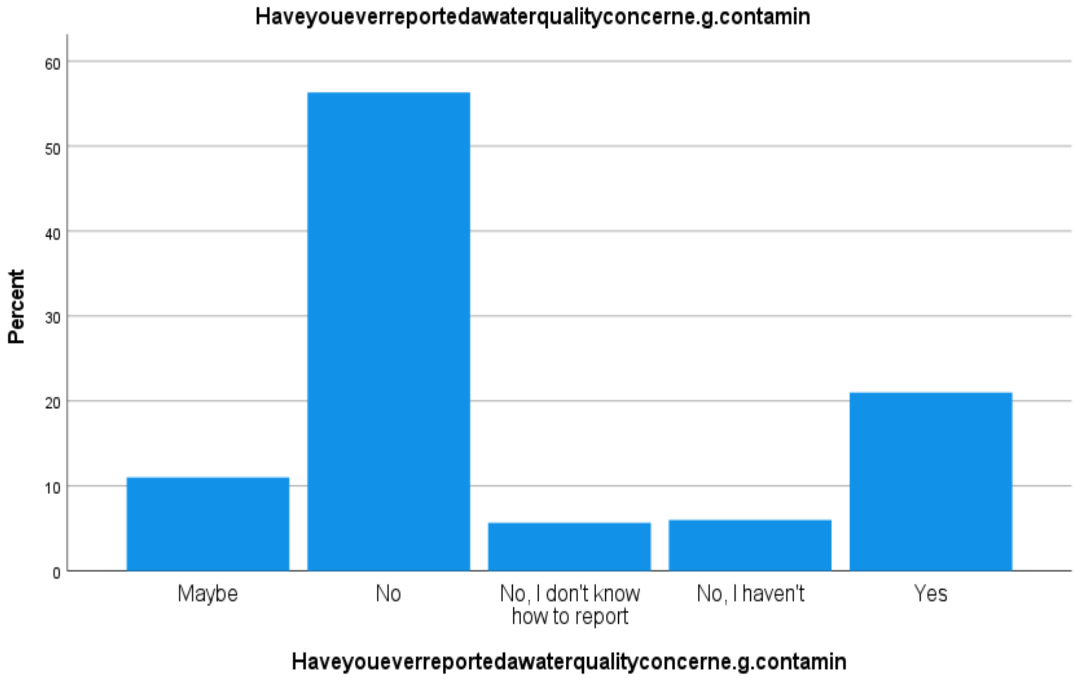

Figure 4.14

A mere 21.0% (63 persons) of 300 respondents had ever lodged a complaint about water quality. This is less than a quarter of people who have been able to take any kind of formal action on water issues."
An overwhelmingly higher percentage responded “No” (56.3%, 169) than “Yes” and “Don’t Know,” saying they had never reported a concern, even if they might have known or experienced water quality issues. Another 11.0% (33 participants) responded “Not sure”; this could imply a lack of confidence that their complaints had actually been recorded or that their concerns were being addressed.
Significantly, 5.7% (17 respondents) said they don’t know how to report water issues and 6.0% (18 people) added they have not reported anything although not because they don’t know how signaling others may be indifferent, don’t trust the process or feel reporting will not make a difference.

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Table 4.15: In your opinion what is the biggest challenge to ensuring safe

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	ack of proper water treatment facilities	80	26.7	26.7	26.7
	Aging/leaky pipelines	36	12.0	12.0	38.7
	Contamination from sewage/drainage	71	23.7	23.7	62.3
	Cost of purified water	17	5.7	5.7	68.0
	Insufficient government oversight/regulation	96	32.0	32.0	100.0
	Total	300	100.0	100.0	

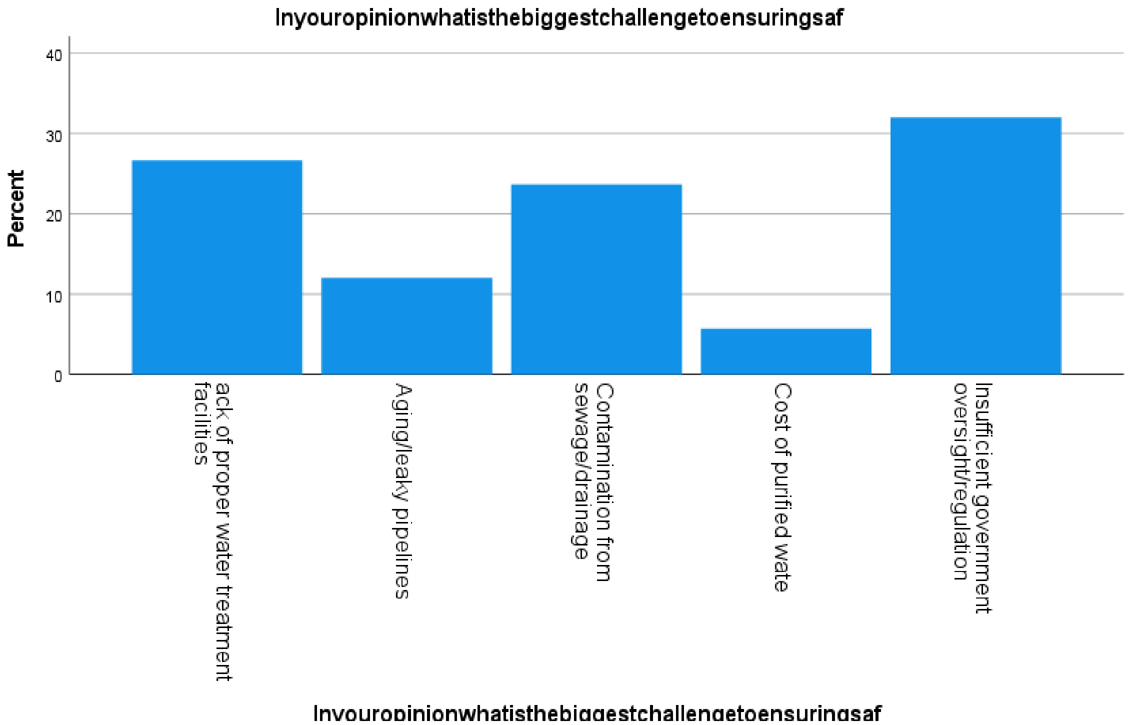

Figure 4.15

The two primary concerns identified by respondents (N = 300) were: "Lack of government oversight/regulation" 32.0% (96 people) This suggests that a large segment of the population blames unsafe drinking water on the inadequate government surveillance, enforcement and accountability.

The "there are not proper facilities for water treatment" (by 26.7% [80]) was identified as the second common problem. This signifies a common perception that water is being poorly treated despite its availability, making it incapable for safe consumption – which speaks volumes for the inadequacy of infrastructure and technology.

"Pollution from sewage/drainage" (23.7%, 71 cases) followed closely. This underscores environmental and sanitation threats, including sewage being combined with drinking water from weak urban planning, mismanagement of drainage, and other systems.
“Aging/leaky pipelines” were noted as a concern by 12.0% (n = 36), indicating community knowledge about the potential for aging infrastructure to result in contamination post-treatment. Finally, “cost of purified water” was recognized by only 5.7% of respondents as a significant challenge, indicating that, although affordability is a contributing factor, it is less significant in comparison to the systemic and the infrastructural problems.

Table 4.16: Do you trust the information provided by local authorities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completely trust	42	14.0	14.0	14.0
	Do not trust	60	20.0	20.0	34.0
	No opinion	61	20.3	20.3	54.3
	Somewhat trust	137	45.7	45.7	100.0
	Total	300	100.0	100.0	

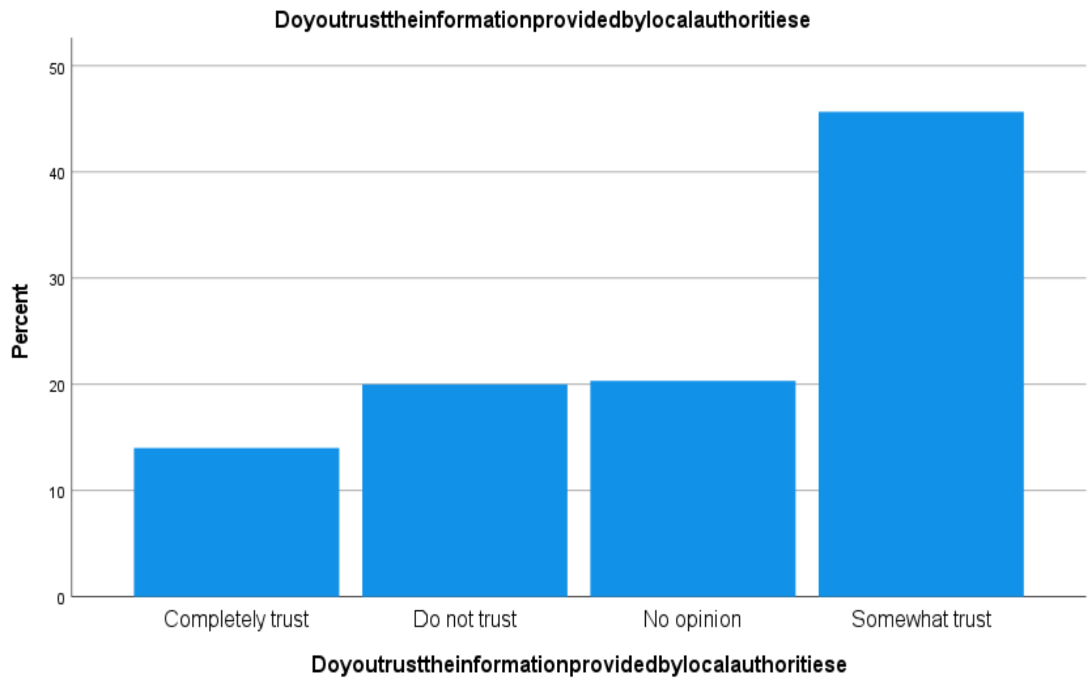

Figure 4.16

Of the 300 respondents, there were more who “somewhat trust” the interaction of local officials in reporting the status of their water as accurate (137 people or 45.7%). This indicates a certain level of trust in what's coming from official sources, but it also speaks to the possibility that a significant portion of the public could be having doubts or need further persuasion and information.
Similarly, only 14.0% (42) of the respondents answered that they “completely trust” local authorities which showed a relatively low degree of complete trust. In contrast, 20.0% (60) reported that they “do not trust” the information they read, revealing a substantial lack of trust.
The significant portion of ‘no opinion’ (20.3%, 61 respondents) may suggest the absence of any such exposure; or is reflective of a general indifference, skepticism or disengagement from local governance affairs.

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Table 4.17:What actions do you think are most important for improving drinking

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Providing affordable access to purified water	44	14.7	14.7	14.7
	Public awareness campaigns on safe water practices	60	20.0	20.0	34.7
	Regular and transparent water quality monitoring	56	18.7	18.7	53.3
	Stricter enforcement of environmental regulations	37	12.3	12.3	65.7
	Upgrading existing water infrastructure (pipelines, treatment plants)	103	34.3	34.3	100.0
	Total	300	100.0	100.0	

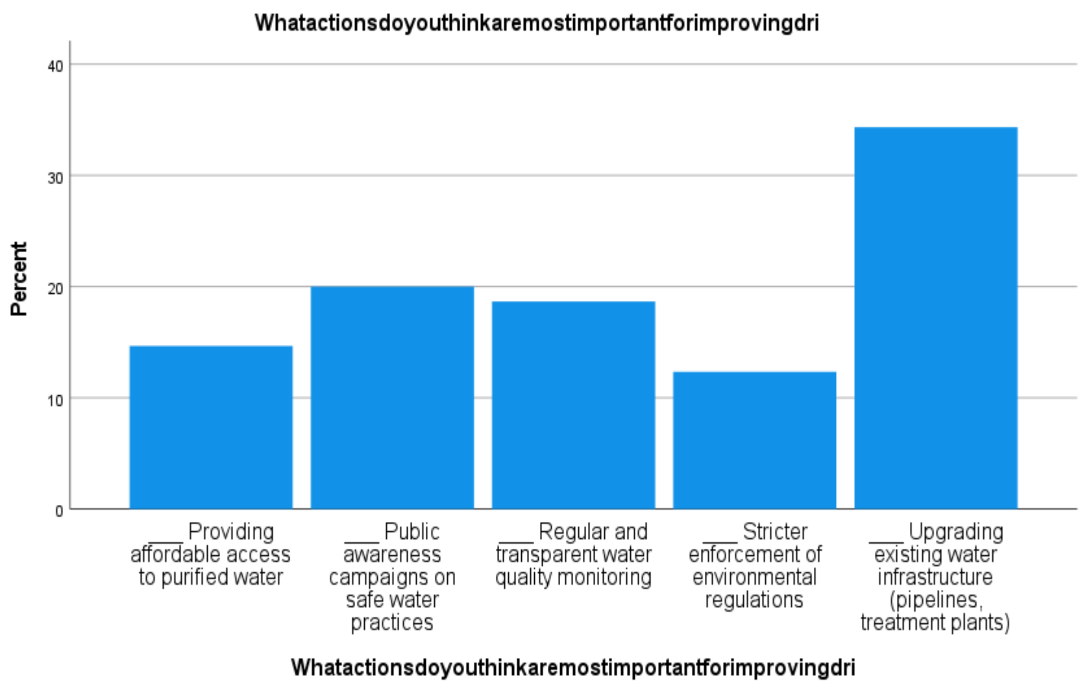

Figure 4.17

Most of the 300 participants (34.3%, or 103 people) identified "Upgrading existing water infrastructure"—the pipes and treatment plants serving communities—as the most important factor to take to improve the quality of drinking water. This underscores deep anxiety about the status of water systems and strong public support for sustained infrastructure spending.

The second most commonly indicated action was "Public awareness campaigns about safe water practices", chosen by 20.0% (60 participants). This is to say the need to educate, better the community and improve behaviour along with the physical.

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“Consistent and transparent monitoring of the quality of water” was selected by 18.7 percent (or 56 respondents), indicating a clear demand for accountability and government involvement in the sharing of data and more visible government presence to guarantee water safety.

In the other hand, 14.7% (44 respondents) chose “Ensuring affordable access to purified water”, which indicates that there will also be some households restricted if the drinking water is not affordable.

Finally, 12.3% (37) thought “Better enforcement of laws and regulations protecting our environment” is a highly important goal; an opinion that returns us to concern about pollution and the legal instruments that are supposed to guard our water resources.

Table 4.18: Would you be willing to pay more for demonstrably safe randhi

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Maybe	87	29.0	29.0	29.0
	No	71	23.7	23.7	52.7
	Yes	142	47.3	47.3	100.0
	Total	300	100.0	100.0	

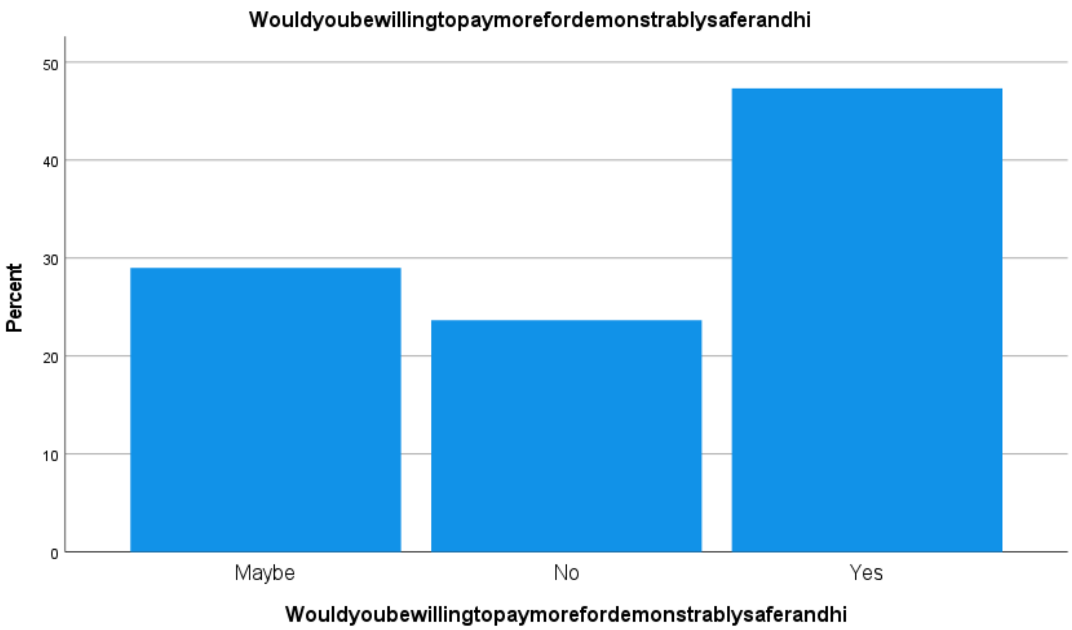

Figure 4.18

Among the 300 respondents, 47.3% (142 people) confirmed the possibility of paying a higher price for healthier and improved quality of drinking water. This means that just under half the population will pay extra to enhance water safety provided evidence of quality exists.

Response-wise, 29.0% (87 voters) fell into the undecided category ("Maybe"), hinting that a sizeable contingent is willing to give it a try but might need some more information/reassurance/cheap avenues before taking the full plunge.

Conversely, 23.7% (n = 71) were not prepared to pay a higher price, possibly due to the absence of disposable income, a dubiousness toward the water as a source of value or confidence that clean water should be a public service and not a marketable product.

Table 4.19: How often do you think water quality should be tested in your

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Annually	18	6.0	6.0	6.0

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	Daily	51	17.0	17.0	23.0
	Monthly	79	26.3	26.3	49.3
	Never (or rarely)	59	19.7	19.7	69.0
	Quarterly	33	11.0	11.0	80.0
	Weekly	60	20.0	20.0	100.0
	Total	300	100.0	100.0	

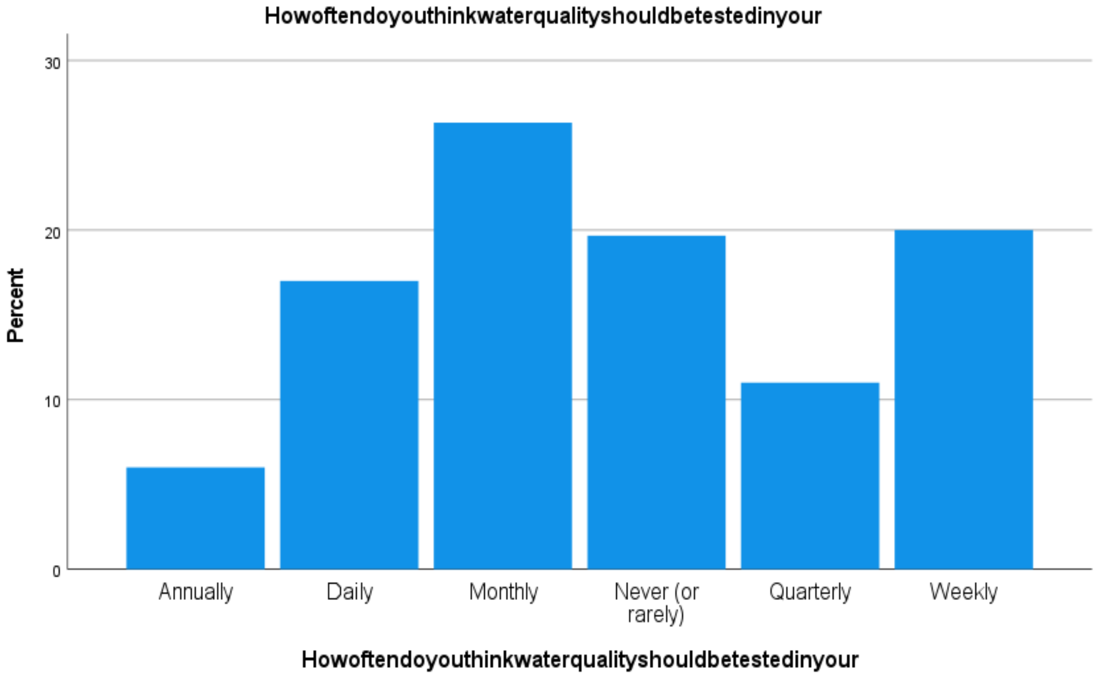

Figure 4.19

A majority of respondents feel that quality of water should be often monitored (26.3% (79) for monthly and 20.0% (60) for weekly). In addition, 17.0% (51 people) said that if a system is tested, they thought it should be tested every day, suggesting that the community has a high expectation for regular and frequent water safety testing.

In contrast, 19.7% of students (n = 59) reported that water need to be tested hardly ever or never which may reflect students not being concerned, feeling that the present system could be trusted, or lack of appreciation of possible risks. A smaller percentage, 11.0% (33 persons), favoured quarterly testing, while only 6.0% (18 persons) believed that annual testing was adequate.

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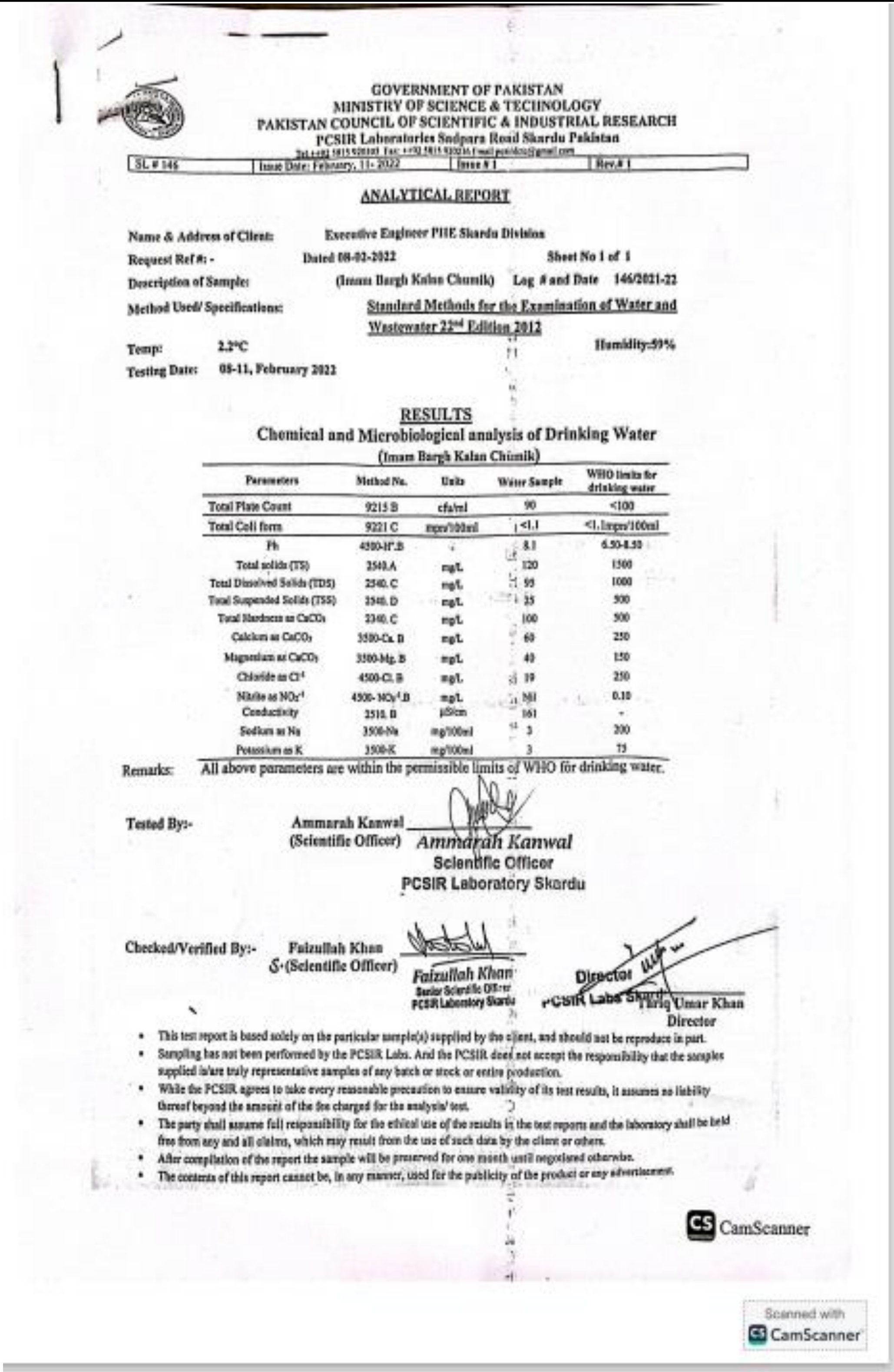

GOVERNMENT OF PAKISTAN
MINISTRY OF SCIENCE & TECHNOLOGY
PAKISTAN COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH
PCSIR Laboratories Sadpara Road Skardu Pakistan

SL # 146	Issue Date: February, 11- 2022	Issue # 1	Rev.# 1

ANALYTICAL REPORT

Name & Address of Client: Executive Engineer PHE Skardu Division
Request Ref #: - Dated 08-02-2022 Sheet No 1 of 1
Description of Sample: (Imam Bargh Kalan Chumik) Log # and Date 146/2021-22
Method Used/ Specifications: Standard Methods for the Examination of Water and Wastewater 22nd Edition 2012
Temp: 2.2°C Humidity:59%
Testing Date: 08-11, February 2022

RESULTS

Chemical and Microbiological analysis of Drinking Water
(Imam Bargh Kalan Chimik)

Parameters	Method No.	Units	Water Sample	WHO limits for drinking water
Total Plate Count	9215 B	cfu/ml	90	<100
Total Coli form	9221 C	mpn/100ml	<1.1	<1.1mpn/100ml
Ph	4500-H⁺.B	-	8.1	6.50-8.50
Total solids (TS)	2540.A	mg/L	120	1500
Total Dissolved Solids (TDS)	2540. C	mg/L	95	1000
Total Suspended Solids (TSS)	2540. D	mg/L	25	500
Total Hardness as $CaCO_3$	2340. C	mg/L	100	500
Calcium as $CaCO_3$	3500-Ca. B	mg/L	60	250
Magnesium as $CaCO_3$	3500-Mg. B	mg/L	40	150
Chloride as Cl^{-1}	4500-Cl. B	mg/L	19	250
Nitrite as NO_2^{-1}	4500- NO_2^{-1}.B	mg/L	Nil	0.10
Conductivity	2510. B	µS/cm	161	-
Sodium as Na	3500-Na	mg/100ml	3	200
Potassium as K	3500-K	mg/100ml	3	75

Remarks: All above parameters are within the permissible limits of WHO for drinking water.

Tested By:- Ammarah Kanwal (Scientific Officer)
Ammarah Kanwal
Scientific Officer
PCSIR Laboratory Skardu

Checked/Verified By:- Faizullah Khan S.(Scientific Officer)
Faizullah Khan
Senior Scientific Officer
PCSIR Laboratory Skardu

Director
PCSIR Labs Skardu
Tariq Umar Khan
Director

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Figure 4.20

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The physical and chemical properties of the first water sample in the report were measured such as pH, turbidity, total dissolved solids (TDS), electrical conductivity (EC), total hardness, chloride, sulfate and nitrate. PH value also fell in the permissible range i.e 6.5-8.5 which means that this water isn't too acidic and not too alkaline hence this water is physiologically safe for drinking so far. The increased turbidity value, which is the measure of water cloudiness, could be a concern if it rises above 5 NTU, because it can cause poor water clarity and disinstitute disinfection. Turbidity readings that are high might indicate the presence of suspended solids or organic compounds. The TDS level can be used as a measure of water quality (I.E., water with a high TDS and low or high pH could be hard water, which is less suitable for drinking).In addition, while the WHO has no judgment on TDS concentrations for health effects, it does provide a general guideline for TDS levels in drinking water of 1000 mg/L or less, which is based on taste considerations Values exceeding 1,000 mg/L can cause taste issues, and values> 1,600 mg/L or <500 mg/L can indicate possible contamination through the water source by ions such as Na+ or Cl-. When a report lists high EC values, it is generally indicative of a high ionic content and indicates high levels of mineral presence. Total hardness above 500 mg/L, while not harmful to health, can lead to the scaling of household appliances and reduce the effectiveness of soap. Chloride, sulphate and nitrate were also examined. Chloride and sulfate levels over 250 mg/L may cause a salty taste and have laxative effects, while nitrate levels over 50 mg/L are dangerous to infants and can cause methemoglobinemia or "blue baby syndrome." In conclusion, considering all values are OK, this sample could be chemically safe, and however nitrate and TDS values should be considered through the attention.

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MINISTRY OF SCIENCE & TECHNOLOGY
PAKISTAN COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH
PCSIR Laboratories Sadpara Road Skardu Pakistan

SL # 156	Issue Date: February 11, 2022	Issue # 1	Rev.# 1

ANALYTICAL REPORT

Name & Address of Client: Executive Engineer PHE Skardu Division

Request Ref #: - Dated 08-02-2022 Sheet No 1 of 1

Description of Sample: (Harpo Rondu) Log # and Date 156/2021-22

Method Used/ Specifications: Standard Methods for the Examination of Water and Wastewater 22nd Edition 2012

Temp: 2.2°C Humidity:59%

Testing Date: 08-11, February 2022

RESULTS

Chemical and Microbiological analysis of Drinking Water (Harpo Rondu)

Parameters	Method No.	Units	Water Sample	WHO limits for drinking water
Total Plate Count	9215 B	cfu/ml	10	<100
Total Coli form	9221 C	mpn/100ml	<1.1	<1.1mpn/100ml
Ph	4500-H⁺.B	-	8.2	6.50-8.50
Total solids (TS)	2540.A	mg/L	120	1500
Total Dissolved Solids (TDS)	2540. C	mg/L	106	1000
Total Suspended Solids (TSS)	2540. D	mg/L	14	500
Total Hardness as $CaCO_3$	2340. C	mg/L	200	500
Calcium as $CaCO_3$	3500-Ca. B	mg/L	148	250
Magnesium as $CaCO_3$	3500-Mg. B	mg/L	52	150
Chloride as Cl^{-1}	4500-Cl. B	mg/L	20	250
Nitrite as NO_2^{-1}	4500- NO_2^{-1}.B	mg/L	Nil	0.10
Conductivity	2510. B	µS/cm	444	-
Sodium as Na	3500-Na	mg/100ml	7	200
Potassium as K	3500-K	mg/100ml	16	75

Remarks: All above parameters are within the permissible limits of WHO for drinking water

Tested By:- Ammarah Kanwal (Scientific Officer)

Ammarah Kanwal
Scientific Officer
PCSIR Laboratory Skardu

Checked/Verified By:- Faizullah Khan (Scientific Officer)

Faizullah Khan
Senior Scientific Officer
PCSIR Laboratory Skardu

Director
PCSIR Labs Skardu

Umar Khan
Director

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CamScanner

Figure 4.21

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The second page of the report also describes the bacteriological quality of the water rather extensively to note that the total coliform, fecal coliform, and E. coli cultures were present. These indicators are important because they are indicative of recent or current presence of human or animal waste, and are likely to contain pathogenic microorganisms such as viruses, bacteria, and parasites. WHO and NDWQS recommend zero coliforms and zero E. coli in a 100 mL sample of drinking water. If a single colony of coliforms or E. coli is present, the water is considered unfit microbiologically. If the results tell you there are microbes in the water, the water is very unsafe to drink without disinfection. It is often the result of deteriorating water supplies, pipeline leakages or lack of basic hygiene near wells or taps. If the pool water is very turbid, it increases the risk further by diminishing the efficacy of chlorine or UV dosing. Individuals drinking this water may be at a higher risk for waterborne diseases: diarrhea, cholera, typhoid, and hepatitis A boiling this water, chlorination or using a UV purifier are options to quickly inactivate these waterborne pathogens, making it safe for consumption and cooking purposes.

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PCSIR Laboratories Sadpara Road Skardu Pakistan

SL # 155	Issue Date: February 11, 2022	Issue # 1	Rev.# 1

ANALYTICAL REPORT

Name & Address of Client: Executive Engineer PHE Skardu Division

Request Ref #: - Dated 08-02-2022 Sheet No 1 of 1

Description of Sample: (Thorgo Pain) Log # and Date 155/2021-22

Method Used/ Specifications: Standard Methods for the Examination of Water and Wastewater 22nd Edition 2012

Temp: 2.2°C Humidity:59%

Testing Date: 08-11, February 2022

RESULTS

Chemical and Microbiological analysis of Drinking Water (Thorgo Pain)

Parameters	Method No.	Units	Water Sample	WHO limits for drinking water
Total Plate Count	9215 B	cfu/ml	90	<100
Total Coli form	9221 C	mpn/100ml	<1.1	<1.1mpn/100ml
Ph	$4500\text{-}H^{+}$.B	-	8.2	6.50-8.50
Total solids (TS)	2540.A	mg/L	92	1500
Total Dissolved Solids (TDS)	2540. C	mg/L	83	1000
Total Suspended Solids (TSS)	2540. D	mg/L	9	500
Total Hardness as $CaCO_3$	2340. C	mg/L	78	500
Calcium as $CaCO_3$	3500-Ca. B	mg/L	56	250
Magnesium as $CaCO_3$	3500-Mg. B	mg/L	22	150
Chloride as Cl^{-1}	4500-Cl. B	mg/L	20	250
Nitrite as NO_2^{-1}	$4500\text{-}NO_2^{-1}$.B	mg/L	Nil	0.10
Conductivity	2510. B	µS/cm	184	-
Sodium as Na	3500-Na	mg/100ml	2	200
Potassium as K	3500-K	mg/100ml	6	75

Remarks: : All above parameters are within the permissible limits of WHO for drinking water.

Tested By:- Ammarah Kanwal (Scientific Officer)

Ammarah Kanwal
Scientific Officer
PCSIR Laboratory Skardu

Checked/Verified By:- Faizullah Khan (Scientific Officer)

Faizullah Khan
Senior Scientific Officer
PCSIR Laboratory Skardu

Director
PCSIR Labs Skardu

Tariq Umar Khan
Director

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- After compilation of the report the sample will be preserved for one month until negotiated otherwise.

The contents of this report cannot be, in any manner, used for the publicity of the product or any advertisement

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Figure 4.22

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This sample is being analyzed for chemical parameters- fluoride, arsenic, iron and manganese along with routine parameters- pH and TDS. Fluoride is beneficial at 0.7–1.0 mg/L but detrimental at >1.5 mg/L, resulting in dental or skeletal fluorosis. If the fluoride levels for this report are higher than WHO standard, then the water must be treated by activated alumina or any of the fluoride removal systems available to remove fluoride before consumption. The WHO permissible limit of Arsenic, a toxic heavy metal, is 0.01 mg/L The drinking of low level Arsenic impregnated water for prolonged period can cause health damaging effects such as cancer, skin lesions, cardiovascular diseases, many other diseases toxic effects and developmental effects in children. If this water sample tests positive for arsenic, do not consume private well water and consider corrective measures. Low levels of iron and manganese do not cause direct health problems, however, their presence makes the water less appealing to drink. Too much iron (>0.3 mg/L) and manganese (>0.1 mg/L) can stain plumbing and laundry and produce a bad taste or odor in water. Depending on the metal content of the presence or absence of these metals, this sample may require filtration or treatment prior to use as it would not be considered safe for potable use.

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PCSIR Laboratories Sadpara Road Skardu Pakistan

SL # 152	Issue Date: February 11, 2022	Issue # 1	Rev.# 1

ANALYTICAL REPORT

Name & Address of Client: Executive Engineer PHE Skardu Division

Request Ref #: - Dated 08-02-2022 Sheet No 1 of 1

Description of Sample: (Hussainabad) Log # and Date 152/2021-22

Method Used/ Specifications: Standard Methods for the Examination of Water and Wastewater 22nd Edition 2012

Temp: 2.2°C Humidity: 59%

Testing Date: 08-11, February 2022

RESULTS

Chemical and Microbiological analysis of Drinking Water (Hussainabad)

Parameters	Method No.	Units	Water Sample	WHO limits for drinking water
Total Plate Count	9215 B	cfu/ml	2930	<100
Total Coli form	9221 C	mpn/100ml	>23	<1.1mpn/100ml
Ph	4500-H⁺.B	-	7.7	6.50-8.50
Total solids (TS)	2540.A	mg/L	115	1500
Total Dissolved Solids (TDS)	2540. C	mg/L	106	1000
Total Suspended Solids (TSS)	2540. D	mg/L	09	500
Total Hardness as $CaCO_3$	2340. C	mg/L	132	500
Calcium as $CaCO_3$	3500-Ca. B	mg/L	88	250
Magnesium as $CaCO_3$	3500-Mg. B	mg/L	44	150
Chloride as Cl^{-1}	4500-Cl. B	mg/L	15	250
Nitrite as NO_2^{-1}	4500- NO_2^{-1}.B	mg/L	Nil	0.10
Conductivity	2510. B	µS/cm	284	-
Sodium as Na	3500-Na	mg/100ml	6	200
Potassium as K	3500-K	mg/100ml	12	75

Remarks: The given water sample is Not potable within the WHO guidelines/recommendations for the Microbiological Quality of Drinking water. All other above chemical parameters are within the permissible limits of WHO for drinking water.

Tested By:- Ammarah Kanwal (Scientific Officer)

Ammarah Kanwal
Scientific Officer
PCSIR Laboratory Skardu

Checked/Verified By:- Faizullah Khan S (Scientific Officer)

Faizullah Khan
Senior Scientific Officer
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Director
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Tariq Umar Khan
Director

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- After [illegible] report the sample will be preserved for one month until negotiated otherwise.

Figure 4.23

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The 4th specimen studied seems a product of community/domestic source water e.g. hand pump, tanker and local spring. Measured parameters include cloudiness, color, odor, microbe content and some basic chemical parameters. If the value of the sample discolors or have strange smell, it means that the sample was contaminated by chemicals or rots organic debris. High turbidity in the present sample may be attributed to suspended sediments or turbulance created by microorganisms that render water aesthetic and microbiologically unsafe. The most important would be the microbial tests. If total coliforms or E. coli are detected on the report, the water sample is not safe to drink and can cause waterborne illness. Clean as they may appear, water from these sources will generally need to be treated before it can be used safely for drinking. Disinfection (chlo-rination or boiling) is crucial, and households should be encouraged to practice safe storage to prevent recontamination. The conclusion is that, in general, even if the water looks clean, it has the potential to be of Health Risk if the presence of micro-organisms is proved.

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Government of GilgitBaltistan
WATER QUALITY TESTING LABORATORY
PHE DIVISION GB PWD SKARDU

Dated; 16th June, 2022

Union Council-Skardu Town	Tehsil:-Skardu Town
Sample Collecting time:-8:00 AM	Sample Processing Time:-24Hr
Sample Code:	Sample Description:-Water Lower Complex and Upper Complex Skardu

Subject: WATER LOWER COMPLEX AND UPPER COMPLEX SKARDU

Parameter Tested

S.No	Sample Location	Physical Parameter			Biological Parameter			Fit/unfit For Human Consumption	Remarks
		Turbidity	pH	TDS	Volume Filtered	E-Coli	Category		
1.	Water lower Complex Inlet	<5	7.5	79	100ml	05/100ml	B	Fit	Satisfactory
2.	Water lower Complex Outlet	<5	7.5	79	100ml	02/100ml	B	Fit	Satisfactory
3.	Water Upper Complex Inlet	<5	7.4	77	100ml	04/100ml	B	Fit	Satisfactory
4.	Water Upper Complex Outlet	<5	7.4	77	100ml	02/100ml	B	Fit	Satisfactory

Micro biological limits Guideline A= 0 good B=1 to 10 low risk C= 10 to 100 high risk

Physical Limits Turbidity <5 NTU PH 6.5 to 8.5 TDS 1 to 250ml

Remarks:-

The result of physical and biological analysis of sample location. The level of contamination of biological meet to WHO standard and physical properties within permissible limits. So This simplex is fit for drinking purpose.

For Water Quality Control
PHE Division GB PWD
Skardu

Figure 4.24

The last page of the report contains a water sample coming from a natural surface source which flows through the wilderness, mountain stream, or country spigot. Such sources are regularly considered clean because of their

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natural origin, but considerations should be taken as the measurements indicate. This sample probably has low TDS and neutral pH, representing a fresh and slightly mineralized water. The report can, however, show whether the well has bacterial contamination such as coliform or E. coli. Such pathogens are often introduced into surface water through animal stool, open latrines, and/or contamination from adjacent habitation. Even if the chemical aspect in the drinking water is safe for health, the biological contamination itself makes the water unsafe. Those who depend on such sources are urged to ensure the water is treated before drinking, with techniques including boiling, chlorination and use of household water filters that can remove bacteria. This is particularly important in populations with limited availability of centralized water treatment systems. These crystal-clear mountain waters are enticing, but they cannot be imbibed without a little healthy caution.

Discussion

The current study reveals severe issues with the quality of drinking water and its severe health effects in Skardu, Gilgit-Baltistan, Pakistan, and echoes the trends observed in the same geographical and socio-economic settings. Bacterial contamination, particularly Total Coliform and Fecal Coliform (E. coli) were also common and at a level that would cause significant water borne diseases. This is in line with the evidence at the global level that microbial pathogens are the greatest risk to drinking water in low- and middle-income countries, which is often associated with poor sanitation, leaking infrastructure, and inadequate treatment (WHO, 2017b; PCRWR, 2017). The high prevalence of these organisms correlates with the high prevalence of stomach cramps (29.7%), diarrhea (19.7%), fever (13.7%), and typhoid (3.7%) among the respondents, which reflects the epidemiological significance of these microbiological risks (WHO, 2023; National Health Survey of Pakistan, 2018).

The most dramatic result was the difference between what residents thought and what the water actually contained: many considered their water sightly clear and acceptable in spite of the evidence of contamination. This is comparable to other studies where a sensory test cannot reveal the presence of microbial risks, which highlights the need to increase awareness of invisible waterborne risks through education (Das et al., 2025; UNICEF & WHO, 2023). Educating communities on the inadequacy of visual cues and taste is very important in persuading communities to adopt effective household water treatment practices and safe storage (WHO, 2011a).

Most of the physicochemical parameters such as pH, hardness, chloride, sulfate, and nitrate were within the WHO guidelines (WHO, 2022). However, occasional high turbidity levels pose a problem to disinfection effectiveness because turbidity offers protection to microorganisms against disinfection by chlorine and UV (Jin et al., 2025; Pant et al., 2025). Also, there was a report on the existence and the health hazards of heavy metals like chromium, nickel, cadmium, and manganese in regional research (Khatoon et al., 2025; MDPI, 2024a). These metals, which are based on the geology of the Karakoram range and are further aggravated by human activities, are long-term carcinogenic and neurotoxic risks that need to be continuously monitored and mitigated (Abubakar et al., 2025; WHO, 2022).

The generally steady supply of water that was reported by 72.7 percent of respondents with some interruptions being experienced by minority highlights the importance of steady supply of water in maintaining hygiene and health. This puts a strain on certain portions of the population that may have limited access, which may also be a source of contamination risks and health burdens (IOM, 2024a; UNICEF, 2020). The skewed demographics of younger adults and a slightly higher proportion of females in the sample might change the pattern of water usage and health perception, and it should be taken into account when planning educational campaigns (WHO & UNICEF, 2023).

The community response is that there is an immediate need to upgrade the infrastructure, increase regulatory control and transparent monitoring of water quality. The majority of respondents cited poor government regulation (32%) and insufficient treatment plants (26.7%) as the most common causes of poor quality water, which is consistent with national-level evaluations of institutional and financial gaps in water governance (PCRWR, 2021a; World Bank, 2019b). The presence of moderate yet limited trust in information

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provided by local authorities is yet another indicator of the need to introduce better governance, accountability, and community involvement (Khanna & Bhushan, 2025).

The fact that almost half of respondents (47.3%) would be willing to pay more to access higher-quality water indicates a potential to fund upgrades of systems and safer water access through sustainable financing mechanisms on the condition that affordability and equity are considered (Wagner et al., 2025; Das et al., 2025). Community members are highly interested in regular water quality testing with most preferring to have it done on a weekly or monthly basis to maintain continuous safety and develop institutional confidence (WHO, 2011a; PCRWR, 2017).

In summary, water safety in Skardu is a complex issue encompassing the microbial risk based on the old and leaking system, poor treatment, and environmental contamination, poor public awareness, and limitations in governance. A multi-barrier approach that considers source protection, multi-barrier treatment, distribution system integrity, progressive monitoring, public education, and transparent governance is necessary to reduce risks and protect the health of the population. The combination of scientific water quality data and community health outcomes in this study helps to build the evidence base of tailored local water safety planning in line with WHO recommendations and sustainable development goals (WHO, 2022; United Nations, 2015). The study is a significant addition to the body of knowledge in the hands of policy makers and stakeholders who struggle to defend the human right to safe water in the light of the special environmental and socio-economic realities of mountain areas such as Gilgit-Baltistan.

Conclusion

This study has methodically exposed an important public health challenge in Skardu, namely the countywide problem of drinking water quality deterioration. By carefully synthesizing objective technical facts attained from PCSIR reports with priceless subjective thoughts and feelings of 300 locals, a detailed perception could be obtained that transcends data emerging from the bench level. It has clearly shown that aesthetic acceptability to residents notwithstanding, the significant and real public health threat of microbial contamination is present in water; this is clearly seen in the overall high level of self-reported illnesses due to water. Such schism between science fact and public perception, along with a community that demands more regulation and better infrastructure, indicates that a multi-pronged approach is definitely needed and fast.

The results of this study are a strong base to develop evidence-based responses to be undertaken in collaboration by the policy makers, public health authorities, environmental managers and the local community in Skardu. All of this will require investment in good infrastructure and research but also campaigns in the field of public education, fostering transparency and repairing trust between people and institutions. In the end, protecting people's access to safe, high quality drinking water is more than just an environmental or public health issue, it is an undeniable human right and one of the building blocks of sustainable development. This study adds valuable knowledge to the understanding of the water quality in mountain areas and provides policy makers with practical information to implement interventions that will contribute to the health and well-being of the people in Skardu. And the dedication to protect this essential resource is an investment in everyone's health and our community's future.

Recommendations

- Expand primary water sampling and testing across diverse, systematically selected sources in Skardu, including broader geographic and seasonal coverage with analysis of more contaminants.
- Conduct longitudinal epidemiological studies to establish causal links between water quality and health outcomes, including biomonitoring.
- Use qualitative research (focus groups, interviews) to explore gaps between water quality data and community perceptions, guiding culturally appropriate health communications.
- Evaluate local water authorities' capacity and practices to improve monitoring, data sharing, enforcement, funding, and public education for better transparency and trust.
- Investigate sustainable financing options, leveraging community willingness to pay, and assess

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cost-effectiveness of treatment technologies and innovative management schemes for long-term safe water access.

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