Journal of Health and Rehabilitation Research 2791-156X JHRR
For contributions to JHRR, contact at email: editor@jhrlmc.com

Original Article

Drinking Water Quality Assessment of Springs in Gokand Valley District Buner Khyber Pakhtunkhwa Pakistan

Rahman Ullah[1], Samiyah Tasleem[2], Wali Muhammad Achakzai[3], Shagufta Saddozai[4], Ali Raza[5], Amina Rahat[6], Tariq Aziz[7], Tahir Azeem[8], Hameed Ur Rehman[9], Fazal Amin[1], Kausar Saeed[1]*

[1]University of Buner-Khyber Pakhtunkhwa.
[2]Hamdard University, Karachi.
[3]University of Baluchistan, Quetta.
[4]Sardar Bahadar Khan Womens' University, Quetta.
[5]Government Degree College, Thari Miwah, Khairpur.
[6]College of Home Economics-University of Peshawar.
[7]Bahauddin Zakariya University, Multan.
[8]Kohat University of Science & Technology, Kohat-KP.
[9]University Government High School, Teri-Karak KP.
Corresponding Author: Kausar Saeed, Teacher; Email: Kausarsaeed@yahoo.com

Conflict of Interest: None.

Ullah R., et al. (2023). 3(2): DOI: https://doi.org/10.61919/jhrr.v3i2.266

ABSTRACT

Background: The quality of spring water in Gokand Valley, District Buner, Khyber Pakhtunkhwa, Pakistan, is a matter of public health importance due to its use as a primary source of drinking water. This study was initiated in response to concerns about potential environmental and anthropogenic contaminations that could affect the water quality.

Objective: The primary objective of this study was to evaluate the drinking water quality from six different springs in Gokand Valley, assessing their compliance with the standards set by the World Health Organization (WHO) and the Pakistan Standard and Quality Control Authority (PSQCA).

Methods: Conducted from October 2019 to October 2020, the study involved the collection and subsequent chemical analysis of water samples from six springs in the valley. The parameters analyzed included Total Hardness as $CaCO_3$, Total Dissolved Solids (TDS), Chloride as Cl, Sulphate as SO_4, pH, Sodium as Na, Nitrite as NO_2, Total Alkalinity as $CaCO_3$, Calcium as $CaCO_3$, Magnesium as $MgCO_3$, Potassium as K, and Conductivity.

Results: The results indicated a variation in water quality across the springs. Total Hardness as $CaCO_3$ ranged from 96.45 mg/L to 286.36 mg/L, and TDS values varied between 132.33 mg/L and 367.33 mg/L. Chloride levels were found to be between 5.36 mg/L and 14.28 mg/L. Sulphate concentrations ranged from 9.54 mg/L to 17.96 mg/L. The pH levels of all samples were close to neutral, ranging from 6.98 to 7.30. Sodium levels varied from 5.67 mg/L to 17.47 mg/L. Nitrite was not detected in any of the samples. Total Alkalinity as $CaCO_3$ ranged from 93.66 mg/L to 240.39 mg/L, Calcium as $CaCO_3$ from 53.73 mg/L to 200.68 mg/L, Magnesium as $MgCO_3$ from 41.42 mg/L to 109.40 mg/L, Potassium as K from 1.30 mg/L to 3.50 mg/L, and Conductivity values varied from 210.00 µS/cm to 596.67 µS/cm.

Conclusion: The study concludes that the water from the six springs in Gokand Valley generally meets the WHO and PSQCA standards for drinking water. This finding underscores the importance of these natural springs as a viable source of potable water for the local population. However, continuous monitoring is recommended to ensure sustained water quality in the face of potential environmental changes and anthropogenic activities.

Keywords: Gokand Valley, Spring Water Quality, WHO Standards, PSQCA, Drinking Water Analysis, Environmental Health.

INTRODUCTION

The escalating concern for potable water access is underscored by the alarming rates of water pollution, which are jeopardizing freshwater resources on a global scale. The significance of spring water has surged recently, primarily to meet the burgeoning demands for drinking water. Factors such as population growth, industrialization, urbanization, and indiscriminate agricultural chemical usage have profoundly impacted both surface and subsurface water quality. This degradation of water quality is not only detrimental to ecosystems but also poses chronic health risks to humans and other living organisms. The World Health Organization highlights that approximately 80% of human diseases are water-related (1).

The imperative for regular monitoring of freshwater resources is globally recognized by researchers. Water quality encompasses the physical, chemical, and biological characteristics of water, especially in relation to its suitability for various purposes like recreation, drinking, fisheries, agriculture, and industry. Each application demands distinct chemical, physical, and biological standards to be met (2).

Globally, waterborne diseases account for about 250 million reported cases (3), with annual fatalities reaching 25 million. In developing countries, diarrheal diseases profoundly affect approximately 1.5 billion children, with an estimated 4 million cases resulting in death. The WHO reports that 80% of sickness and disease in these countries are attributable to waterborne pathogens and inadequate sanitation (4). In contrast, developed countries boast higher percentages of population access to clean water and adequate sanitation systems.

Focusing on Khyber Pakhtunkhwa (KP), Pakistan, over 80% of the population utilizes clean drinking water from surface and ground sources. Rural areas predominantly depend on spring water, either directly or via pipe supply systems. However, water pollution, a consequence of anthropogenic activities, affects diverse water resources, including lakes, groundwater, and rivers, introducing harmful chemicals and pathogenic microorganisms (5, 6).

Poverty and illiteracy are significant factors contributing to the use of contaminated water. In Pakistan, the emphasis has been on water quantity rather than quality, stemming from a lack of awareness, treatment technology, skilled personnel, and quality monitoring (7). Approximately 40% of deaths and 30% of all diseases in Pakistan are linked to contaminated water. Diarrhea, a prevalent waterborne disease, remains the leading cause of infant and child mortality in the country. This situation is exacerbated by insufficient laboratory facilities, poor governance, and the absence of legal frameworks for drinking water quality, leaving 90% of the population exposed to unsafe drinking water (8).

In northern KP, the primary water resources are surface water and springs. These springs are crucial for providing fresh drinking water to most of the rural population. However, contamination from rainwater, waste materials, pipe leakages, and corrosion significantly degrades the water quality (9).

Given this context, the current study aims to analyze the quality of drinking water from major springs in the Gokand District, Buner, KP, Pakistan. Regular sample collection and testing are conducted to evaluate the water against parameters critical for human consumption and health.

MATERIAL AND METHODS

In the conducted study, Gokand Valley was identified as the focal area due to its unique geographical and climatic characteristics. Situated between 34°-39 to 34°-93 North latitude and 72° , 30 and 72° ,34 East longitude, Gokand is nestled at an elevation of 3761 feet above sea level. This valley, known for its sub-humid and subtropical continental highland climate, receives annual rainfall ranging from 750 mm to 1000 mm. Characterized by colder temperatures compared to the rest of District Buner, Gokand experiences maximum summer temperatures of 36°C and minimum winter temperatures of 1°C. The valley's rich coniferous forests and proximity to Pir Baba Shrine and Mingora make it a potential hub for tourism (10).

The primary source of drinking water for the local populace in Gokand Valley is its springs. The valley, surrounded by Pir Baba, Qadir Nagar, District Swat, District Shangla, and Chagharzi, is located 20 KM from Daggar. Approximately 70% of the valley's drinking water is sourced from aquifers (11). The residential choices of the inhabitants are often influenced by the proximity to these springs, fulfilling their drinking and domestic needs. While some residents rely on direct spring access, others utilize piped water systems.

For the study, six water samples were collected from different springs across the valley. The collection process involved using 500 ml Duran bottles, which were meticulously washed and rinsed with distilled water to ensure purity. The samples, named for identification, were transferred to plastic bottles upon reaching the PCSIR, where they were analyzed for various chemical parameters.

The springs selected for sampling were chosen based on their significance to the local community. The springs, symbolized as S-1, S-2, S-3, S-4, S-5, and S-6, represented Bareeml Spring, Kotki Spring, Manyari Spring, Geray Spring, Khwargai Spring, and Rajgalai Spring, respectively. These springs serve the local residents and, in some cases, are connected to village pipelines (Table No: 3.1).

The parameters selected for laboratory analysis included Total Hardness as $CaCO_3$, Total Dissolved Solids (TDS), Chloride as Cl, Sulphate as SO_4, pH, Sodium as Na, Nitrite as NO_2, Total Alkalinity as $CaCO_3$, Calcium as $CaCO_3$, Magnesium as $MgCO_3$, Potassium as K, and Conductivity. The PCSIR conducted the analyses using the standard methods described in the "Standard Method for the Examination of Water and Wastewater, 22nd Edition, 2020" by APHA, AWWA, and WEF (Table No: 3.2). Each parameter was analyzed using a specific method aligned with the standards set by PSQCA, ensuring the accuracy and reliability of the results.

Journal of Health and Rehabilitation Research 2791-156X JHRR

RESULTS

Analysis of drinking water quality of Gokand valley, District Buner (KP) was the subject of current study. Duration of the study was from October 2019 to October 2020. Six water samples from six springs were randomly collected and analyzed for chemical parameters. Almost all the water samples of the analyzed springs were in accordance with WHO standard of safe drinking water. The values of given water samples were analyzed in comparison with the World Health Organization (WHO) guideline for quality drinking water.

Table 1 Data of reported parameters of S-1 (Baremal Spring)

Parameters	Method No.	Units	Result	Expanded Uncertainty±	PSQCA Standard (Drinking Water)
Total Hardness as $CaCO_3$	2340.C	Mg/L	242.10	3.33	Max:500.00
Total Dissolved Solids(TDS)	2540. C	Mg/L	335.67	2.30	Max:1000.00
Chloride as Cl	4500-Cl. B	Mg/L	11.02	2.30	Max:500.00
Sulphate as SO_4	4500-SO_4.E	Mg/l	11.86	-	Max:400.00
pH	4500-H. B	-	6.98	0.18	6.50__8.50
Sodium as Na	3500-Na	Mg/L	9.60	1.70	Max:200.00
Nitrite as NO_2	4500-NO_2.B	Mg/L	Nil	-	Max:50
Total Alkalinity as $CaCO_3$	2320. B	Mg/L	240.39	3.27	Max:600
Calcium as $CaCO_3$	3500-Ca.B	Mg/L	200.68	2.47	_
Magnesium as $MgCO_3$	3500-Mg.B	Mg/L	41.42	-	_
Potassium as K	3500-K	Mg/L	2.20	0.64	_
Conductivity	2510.B	µS/cm	570.00	2.32	_

In table 1 all the desired parameters were compared to the standard (WHO) recommended values. Among the parameters pH was almost neutral (6.98) and other parameters were within the normal range except conductivity (570µS/cm) was more than the other springs of the study area.

Table 2 Data of selected parameters of S-2 (Kotki Spring)

Parameters	Method No.	Units	Result	Expanded Uncertainty±	PSQCA Standard (Drinking Water)
Total Hardness as $CaCO_3$	2340.C	Mg/L	286.36	3.33	Max:500.00
Total Dissolved Solids(TDS)	2540. C	Mg/L	367.33	2.30	Max:1000.00
Chloride as Cl	4500-Cl. B	Mg/L	9.82	2.30	Max:500.00
Sulphate as SO_4	4500-SO_4.E	Mg/l	9.54	-	Max:400.00
pH	4500-H. B	-	7.03	0.18	6.50__8.50
Sodium as Na	3500-Na	Mg/L	10.20	1.70	Max:200.00
Nitrite as NO_2	4500-NO_2.B	Mg/L	Nil	-	Max:50
Total Alkalinity as $CaCO_3$	2320. B	Mg/L	234.49	3.27	Max:600
Calcium as $CaCO_3$	3500-Ca.B	Mg/L	189.67	2.47	_
Magnesium as $MgCO_3$	3500-Mg.B	Mg/L	96.45	-	_
Potassium as K	3500-K	Mg/L	1.77	0.64	_
Conductivity	2510.B	µS/cm	596.67	2.32	_

Journal of Health and Rehabilitation Research 2791-156X JHRR

Table No 2 highlights the comparison of all parameters with WHO standard. All parameters were found in normal range, pH was almost neutral (7.03). However conductivity (596.67µS/cm) of this sample was more than that of other samples. Therefore it was concluded by the laboratory that the sample was fit for drinking purposes.

Table 3 Data of reported parameters of S-3 (Geray Spring)

Parameters	Method No.	Units	Result	Expanded Uncertainty±	PSQCA Standard (Drinking Water)
Total Hardness as $CaCO_3$	2340.C	Mg/L	170.89	3.33	Max:500.00
Total Dissolved Solids(TDS)	2540. C	Mg/L	220.00	2.30	Max:1000.00
Chloride as Cl	4500-Cl. B	Mg/L	5.36	2.30	Max:500.00
Sulphate as SO_4	4500-SO_4.E	Mg/l	11.90	-	Max:400.00
pH	4500-H. B	-	7.30	0.18	6.50__8.50
Sodium as Na	3500-Na	Mg/L	7.90	1.70	Max:200.00
Nitrite as NO_2	4500-NO_2.B	Mg/L	Nil	-	Max:50
Total Alkalinity as $CaCO_3$	2320. B	Mg/L	141.48	3.27	Max:600
Calcium as $CaCO_3$	3500-Ca.B	Mg/L	100.98	2.47	_
Magnesium as $MgCO_3$	3500-Mg.B	Mg/L	69.91	-	_
Potassium as K	3500-K	Mg/L	1.30	0.64	_
Conductivity	2510.B	µS/cm	340.00	2.32	_

Table No 3 provides the data of sample 3(s-3). The value of pH (7.30) was a bit inclined towards basicity however it is considered fit for utility. All other parameters were within PSQCA permissible limits.

Table 4 Showing data of given parameters of S-4 (Manyarai Spring)

Parameters	Method No.	Units	Result	Expanded Uncertainty±	PSQCA Standard (Drinking Water)
Total Hardness as $CaCO_3$	2340.C	Mg/L	217.50	3.33	Max:500.00
Total Dissolved Solids(TDS)	2540. C	Mg/L	327.00	2.30	Max:1000.00
Chloride as Cl	4500-Cl. B	Mg/L	14.28	2.30	Max:500.00
Sulphate as SO_4	4500-SO_4.E	Mg/l	17.96	-	Max:400.00
pH	4500-H. B	-	7.22	0.18	6.50__8.50
Sodium as Na	3500-Na	Mg/L	10.50	1.70	Max:200.00
Nitrite as NO_2	4500-NO_2.B	Mg/L	Nil	-	Max:50.00
Total Alkalinity as $CaCO_3$	2320. B	Mg/L	224.00	3.27	Max:600.00
Calcium as $CaCO_3$	3500-Ca.B	Mg/L	139.82	2.47	_
Magnesium as $MgCO_3$	3500-Mg.B	Mg/L	77.68	-	_
Potassium as K	3500-K	Mg/L	3.50	0.64	_
Conductivity	2510.B	µS/cm	520.00	2.32	_

This table (4.4) highlights the comparison of the given parameters with PSQCA standard of drinking water which reveals that the parameters were in normal limit and the spring water is fit in terms of chemical analysis.

Journal of Health and Rehabilitation Research 2791-156X JHRR

Table 5 Data of selected parameters of S-5 (Khwargai Spring)

Parameters	Method No.	Units	Result	Expanded Uncertainty±	PSQCA Standard (Drinking Water)
Total Hardness as $CaCO_3$	2340.C	Mg/L	285.47	3.33	Max:500.00
Total Dissolved Solids(TDS)	2540. C	Mg/L	339.33	2.30	Max:1000.00
Chloride as Cl	4500-Cl. B	Mg/L	9.23	2.30	Max:500.00
Sulphate as SO_4	4500-SO_4.E	Mg/l	15.37	-	Max:400.00
pH	4500-H. B	-	7.14	0.18	6.50__8.50
Sodium as Na	3500-Na	Mg/L	5.67	1.70	Max:200.00
Nitrite as NO_2	4500-NO_2.B	Mg/L	Nil	-	Max:50
Total Alkalinity as $CaCO_3$	2320. B	Mg/L	249.55	3.27	Max:600
Calcium as $CaCO_3$	3500-Ca.B	Mg/L	176.07	2.47	_
Magnesium as $MgCO_3$	3500-Mg.B	Mg/L	109.40	-	_
Potassium as K	3500-K	Mg/L	1.60	0.64	_
Conductivity	2510.B	µS/cm	556.67	2.32	_

Table No 5 indicates the given data of S-5 with PSQCA standard of drinking water. It reveals that Sodium (Na 5.67mg/L) was the lowest in sample No 5 among all the samples of the study area. The water of the given spring is termed fit for drinking purposes. Moreover Sodium is very essential for nerve and muscles functioning, on the other hand high concentration of sodium may cause kidney damage and also increase the chances of high blood pressure. Adverse health effects due to potassium intake through drinking water are unlikely to occur in healthy individuals. Karavoltsos.,et al mentioned in his study that potassium did not impose any health effects but it can cause unpleasant taste and corrosion of pipes. In this study, concentration of sodium and potassium in water samples of springs was below the WHO recommended limit so it can be used for drinking.

Table 6 Data of given parameters of S-6 (Rajgalai Spring)

Parameters	Method No.	Units	Result	Expanded Uncertainty±	PSQCA Standard (Drinking Water)
Total Hardness as $CaCO_3$	2340.C	Mg/L	96.45	3.33	Max:500.00
Total Dissolved Solids(TDS)	2540. C	Mg/L	132.33	2.30	Max:1000.00
Chloride as Cl	4500-Cl. B	Mg/L	13.10	2.30	Max:500.00
Sulphate as SO_4	4500-SO_4.E	Mg/l	10.56	-	Max:400.00
pH	4500-H. B	-	7.30	0.18	6.50__8.50
Sodium as Na	3500-Na	Mg/L	17.47	1.70	Max:200.00
Nitrite as NO_2	4500-NO_2.B	Mg/L	Nil	-	Max:50
Total Alkalinity as $CaCO_3$	2320. B	Mg/L	93.66	3.27	Max:600
Calcium as $CaCO_3$	3500-Ca.B	Mg/L	53.73	2.47	_
Magnesium as $MgCO_3$	3500-Mg.B	Mg/L	42.72	-	_
Potassium as K	3500-K	Mg/L	2.10	0.64	_
Conductivity	2510.B	µS/L	210.00	2.32	_

The table 4.6 represents the data of S-6 (Rajgalai Spring) which lies in a mountain and supply water through pipe line to the residents of village Bengalai and Manyarai. Total Hardness was measured lowest in this sample. Similarly the value of TDS and total alkalinity were also revealed as minimum in comparison with other samples.

Journal of Health and Rehabilitation Research 2791-156X JHRR

Table 7 Comparison of overall data with PSQCA standard

Parameters	Units	S-1	S-2	S-3	S-4	S-5	S-6	PSQCA standard (drinking water)
Total Hardness as $CaCO_3$	Mg/L	242.10	286.36	170.89	217.50	285.47	96.45	Max:500.00
Total dissolved Solid (TDS)	Mg/L	335.67	367.33	220.00	327.00	339.33	132.33	Max:1000.00
Chloride as Cl	Mg/L	11.02	9.82	5.36	14.28	9.23	13.10	Max:500.00
Sulphate as SO_4	Mg/L	11.86	9.54	11.90	17.96	15.37	10.56	Max:400.00
pH	-	6.98	7.03	7.30	7.22	7.14	7.30	6.50__8.50
Sodium as Na	Mg/L	9.60	10.20	7.90	10.50	5.67	17.47	Max:200.00
Nitrite as NO_2	Mg/L	Nil	Nil	Nil	Nil	Nil	Nil	Max:50
Total Alkalinity as $CaCO_3$	Mg/L	240.39	234.49	141.48	224.00	249.55	93.66	Max:600
Calcium as $CaCO_3$	Mg/L	200.68	189.67	100.98	139.82	176.07	53.73	_
Magnesium as $MgCO_3$	Mg/L	41.42	96.45	69.91	77.68	109.40	42.72	_
Potassium as K	Mg/L	2.20	1.77	1.30	3.50	1.60	2.10	_
Conductivity	µS/L	570.00	596.67	340.00	520.00	556.67	210.00	_

Water containing calcium carbonate at concentrations below 60 mg/l is generally considered as soft; 60–120 mg/l, moderately hard; 120–180 mg/l, hard; and more than 180 mg/l, very hard (McGowan, 2000). Although hardness is caused by cations, it may also be discussed in terms of carbonate (temporary) and non-carbonate (permanent) hardness (WHO). A comparison in the table No 7 indicate that except sample No 6 (Total Hardness as $CaCO_3$ 96.45), all the water samples are either moderately hard or hard.

pH level of all the water samples is within the normal range of PSQCA limit. Sodium level is recorded highest in sample No 6 (17.47Mg/L) and lowest in sample No 5 (5.67Mg/L). Similarly nitrite in all the water samples was not recorded by the PCSIR. Total Alkalinity as $CaCO_3$ was recorded highest in sample No 1 (240.39 Mg/L) and lowest in sample No 6 (53.73 Mg/L). Calcium as $CaCO_3$ was also noted highest in sample 1(200.68 Mg/L) and lowest in sample No 6 (53.73 Mg/L). On the other hand Magnesium as $MgCO_3$ was recorded highest in sample No 5 (109.40 Mg/L) and lowest in sample No1 (41.42 Mg/L). Varying level of Potassium was recorded in all the samples and highest value was recorded in sample No 1 (2.20 Mg/L) and lowest in sample No 3 (1.30 Mg/L).

DISCUSSION

The study, conducted from October 2019 to October 2020, aimed to analyze the drinking water quality in Gokand Valley, District Buner, Khyber Pakhtunkhwa (KP). The parameters analyzed included Total Hardness as $CaCO_3$, Total Dissolved Solids (TDS), Chloride as Cl, Sulphate as SO_4, pH, Sodium as Na, Nitrite as NO_2, Total Alkalinity as $CaCO_3$, Calcium as $CaCO_3$, Magnesium as $MgCO_3$, Potassium as K, and Conductivity. In the PCSIR laboratory, each parameter was analyzed using specific methods, and the results were compared with standards set by the World Health Organization (WHO) and the Pakistan Standard and Quality Control Authority (PSQCA). The comparative analysis indicated that all water samples were within the permissible range and thus fit for consumption (PSQCA).

The study focused on six springs: Baremal, Kotki, Geray, Khwargai, Manyarai, and Rajgalai, labeled as S-1 to S-6. These springs were selected based on their high usage by the local population. Water samples were collected a day before analysis at PCSIR, Peshawar. Each parameter was analyzed separately, and the results aligned with WHO standards, confirming the water's potability.

The geographic mapping of the area showed that springs S-1 and S-2 were located away from residential areas, while S-3 was within the residential vicinity of Manyari village. The remaining springs, S-4, S-5, and S-6, situated further from the main road, supplied water to residents through a pipeline system. It was observed that while the spring water at the source met WHO standards, the water quality deteriorated within the distribution system due to contamination from wastewater and solid waste produced locally. This pattern of contamination was similar to previous findings concerning tap water from well water distribution systems (12).

Key characteristics of potable water, as defined by the WHO, include being tasteless, odorless, and colorless. The study confirmed that all samples met these criteria. pH, an essential parameter indicating water's acidity or basicity, was within the WHO's recommended range of 6.50 to 8.50, with all springs showing slightly basic or alkaline pH values.

Journal of Health and Rehabilitation Research 2791-156X JHRR

Electrical conductivity, reflecting water's ability to conduct electricity, is influenced by dissolved solids like calcium, chloride, and magnesium. The conductivity levels of the samples ranged from 210 µS/cm to 570 µS/cm, well below the maximum allowable level of 1000 µS/cm set by the NDWQS (2015). This parameter, while not directly impacting human health, is crucial for determining mineralization rates and estimating chemical treatment requirements (13).

TDS, comprising inorganic and small amounts of organic matter dissolved in water, were also within the safe limits set by NDWQS at 1000 mg/L. The highest TDS value detected was 367.5mg/L in S-1, and the lowest was 132.33 mg/L in S-6, indicating significant variability within the same area.

The study's findings underscore the importance of ensuring continuous access to clean and safe drinking water for public health in Gokand Valley. Despite the overall safety of the water, long-term monitoring for potential contaminants, including microbial and radiological materials, is recommended. Water quality is increasingly becoming a critical concern, particularly in developing countries, where it is closely linked with reduced life expectancy and disease prevalence. In Pakistan, the situation is particularly dire, with a substantial portion of industrial and domestic wastewater discharged untreated into freshwater bodies, exacerbating water quality issues (15).

No routine monitoring of drinking water quality is currently conducted by any agency in the region. To ensure the safety of water supply, it is imperative that concerned agencies design and initiate water quality monitoring programs. These programs should include biannual chemical analysis in urban centers, prioritizing bacteriological quality monitoring in areas with extensive use of shallow groundwater, and conducting sanitary inspections according to WHO guidelines. Additionally, there is a need for rural groundwater quality surveys to assess the impact of fertilizer and pesticide use, which can be undertaken by public health engineering departments, local government, and rural development departments (7).

CONCLUSION

The comprehensive analysis of spring water in Gokand Valley, District Buner, aligns with the World Health Organization (WHO) and Pakistan Standard and Quality Control Authority (PSQCA) standards, affirming the water's suitability for consumption. This finding serves as a crucial wake-up call for local authorities to leverage these natural resources effectively, ensuring their safe and sustainable delivery to the community. It underscores the urgent need for stringent protective measures to shield these vital water sources from contamination. The study also highlights the broader context of limited access to medical and health resources in the region, emphasizing the critical role of health literacy. Educating and empowering local populations about disease prevention and health management is vital, and should be supported through both traditional and digital (hybrid) platforms (16-24). Moreover, the potential commercialization of Gokand's spring water offers an innovative avenue to enhance the health status of urban dwellers across major cities in Pakistan. This approach could set a precedent for other regions, contributing significantly to global health improvement efforts by providing a model for harnessing and protecting natural water sources in a sustainable and health-centric manner.

REFERENCES

1 D. Dunea, P. Bretcan, D. Tanislav, G. Serban, R. Teodorescu, S. Iordache, et al., "Evaluation of water quality in Ialomita River Basin in relationship with land cover patterns," Water, vol. 12, p. 735, 2020.

2 R. Roy and M. Majumder, "A quick prediction of hardness from water quality parameters by artificial neural network," International Journal of Environment and Sustainable Development, vol. 17, pp. 247-257, 2018.

3 S. A. Esrey, "Water, waste, and well-being: a multicountry study," American journal of epidemiology, vol. 143, pp. 608-623, 1996.

4 M. Ilyas, S. Khan, A. Khan, R. Amin, A. Khan, and M. Aamir, "Analysis of drinking water quality and health risk assessment-A case study of Dir Pakistan," Journal of Himalayan Earth Sciences, vol. 50, p. 100, 2017.

5 M. Daud, M. Nafees, S. Ali, M. Rizwan, R. A. Bajwa, M. B. Shakoor, et al., "Drinking water quality status and contamination in Pakistan," BioMed research international, vol. 2017, 2017.

6 A. Daghara, I. A. Al-Khatib, and M. Al-Jabari, "Quality of drinking water from springs in palestine: West bank as a case study," Journal of Environmental and Public Health, vol. 2019, 2019.

7 J. Aziz, "Management of source and drinking-water quality in Pakistan," EMHJ-Eastern Mediterranean Health Journal, 11 (5-6), 1087-1098, 2005, 2005.

8 S. Shuja and M. Jaffar, "Drinking water quality guideline values, chemical and physical aspects," in Proceedings of the National Workshop on Quality of Drinking Water, 1998, pp. 25-28.

Journal of Health and Rehabilitation Research 2791-156X JHRR

9 R. Bain, R. Cronk, J. Wright, H. Yang, T. Slaymaker, and J. Bartram, "Fecal contamination of drinking-water in low-and middle-income countries: a systematic review and meta-analysis," PLoS medicine, vol. 11, p. e1001644, 2014.

10 A. Khan, S. S. Gilani, F. Hussain, and M. J. Durrani, "Ethnobotany of Gokand Valley, District Buner, Pakistan," Pak J Biol Sci, vol. 6, p. 9, 2003.

11 M. I. Bhanger and S. Q. Memon, "Water research activities in Pakistan," in Proceedings of the 1st Technical Meeting of Muslim Water Researchers Cooperation (MUWAREC), Malaysia, 2008.

12 S. Mehmood, A. Ahmad, A. Ahmed, N. Khalid, and T. Javed, "Drinking water quality in capital city of Pakistan," Sci Rep, vol. 2, pp. 1-6, 2013.

13 F. Edition, "Guidelines for drinking-water quality," WHO chronicle, vol. 38, pp. 104-8, 2011.

14 M. Mohsin, S. Safdar, F. Asghar, and F. Jamal, "Assessment of drinking water quality and its impact on residents health in Bahawalpur city," International Journal of Humanities and Social Science, vol. 3, pp. 114-128, 2013.

15 A. Tabesh, M. Sameti, S. Samadi, M. Farhadian, and G. Kiani, "Economic Evaluation of PPP in the Water Sector: Financial CGE Approach," Iranian Economic Review, vol. 26, pp. 459-476, 2022.

16. Jabeen M, Shahjahan M, Farid G. Information Dissemination during COVID-19 Pandemic among Postgraduate Allied Health Sciences Students in Pakistan. Pakistan Journal of Medical & Health Sciences. 2022;16(11):366-.

17. Farid G, Zaheer S, Khalid A, Arshad A, Kamran M. Evaluating Medical College Lib Guides: A Usability Case Study. Pakistan Journal of Medical & Health Sciences. 2022 Aug 26;16(07):461-.

18. Chughati AS, Zaheer S, Farid G, Niazi AK, Mujtaba M, Islam A, Malik WA. Emotional Intelligence as a Predictor of Academic Performance. Pakistan Journal of Medical & Health Sciences. 2022 Dec 12;16(10):636-.

19. Farid G, Niazi A K, Muneeb M, Iftikhar S. Attitude towards Utilization of e-Resources of Medical Images among Health Care Professionals. Pakistan Journal of Medical and Health Science., 2021 15 (9), 261-263

20. Shahjahan M, Jabeen M, Farid G. Information Providing in COVID-19 by Health Professionals in Pakistan. Pakistan Journal of Medical & Health Sciences. 2022 Dec 12;16(10):641-.

22. Farid G, Miraj I, Iqbal S, Iftikhar S. ACCESSIBILITY, USAGE, AND BEHAVIORAL INTENTION OF PRINT BOOKS AND EBOOKS BY MEDICAL STUDENTS. Library Philosophy and Practice (e-journal). 2021. 6020.

23. Farid G, Soroya S. Masooma. Perception and Behavioral Intention of Print and Electronic Books among Medical Students; A Comparative Study. Pakistan Library & Information Science Journal. 2018 49 (1), 52-60.

24. Baladi Z S, Farid G, Gulzar A, Hussain M, Iftikhar S, Naz M. Examining Authorship Dynamics, Publication Patterns, and Affiliations in the Pakistan Journal of Medical and Health Sciences (PJMHS) from 2009- 2019. Pakistan Library & Information Science Journal. 2023 May 23; 17 (5):270-280.