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THE WATER, SANITATION AND HYGIENE SITUATION IN THE CENTRAL KHYBER PAKHTUNKHWA PROVINCE OF PAKISTAN

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***Abstract**: One of the objectives of sustainable development is water, sanitation, and hygiene, or WASH. Developing countries, however, continue to face the difficulty of sophisticated WASH. There are disparities regarding how the WASH project for sustainable development is being implemented among different administrative units. In the three central districts of Khyber Pakhtunkhwa, Pakistan – Charsadda, Mardan, and Nowshera – the current study sought to evaluate the relative WASH conditions. Using a structured questionnaire and simple random sample, data in the knowledge, attitude, and practices (KAP) domains about WASH was gathered. Composite indices for each domain (knowledge, attitude and practices) and an overall composite WASH index were calculated. Based on the WASH index values, the results showed that Nowshera had a relatively better WASH status than Mardan and Charsadda. The study's findings suggested that while a sizable section of the study region may have access to enough water and toilets, attention should also be paid to the water's quality and the toilets' outlets.*

***Keywords:** Clean water; Escherichia coli; Diseases; Khyber Pakhtunkhwa; Sanitation*

1. Introduction

All people have a right to access clean water, yet only a few have that entitlement (Qamar et al. 2022). The United Nations (UN) through a resolution of the General Assembly, explicitly recognized water and sanitation as a right for all (United Nations, 2010). It is reported that more

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than 2 billion people reside in water-stressed countries, which are predicted to get worse in some areas due to population expansion and climate change (World Health Organization, 2022). In 2030, 1.6 billion people will lack access to safely managed drinking water, 2.8 billion people will lack access to access to adequate sanitation, and 1.9 billion people will lack even the most basic facilities for performing hand hygiene (United Nations, nd). Pakistan is one of the countries that also facing the issue of not only water scarcity and adequate hygiene. The WaterAid Organization (2021) reported in its policy paper that despite Pakistan's significant progress in the areas of water supply and sanitation while ensuring the achievement of the Millennium Development Goals, a sizeable portion of the population, particularly the marginalized and poor, continue to lack access to necessary water, sanitation and hygiene (WASH) services. Over 79 million people in Pakistan lack access to decent toilets, and there are still significant gaps in access to basic WASH services among the rural, poor, and marginalized populations. Pakistan continues to rank among the top 10 countries with the highest percentage of people without access to safe water. Salman (2021) posits that Pakistan used to have a surplus of water (nearly 6000 cubic meters per capita in 1960), but today suffers a water shortage (1017 cubic meters per capita). The Pakistan's water supplies are under tremendous strain due to rapid population growth, urbanization, ongoing industrial development (Soomro et al. 2011), climate change, and ineffective management (Salman 2021). It is evident that WASH and health are interconnected. Millions of the world's impoverished die each year from preventable diseases as a result of poor hygiene, inadequate amounts and quality of drinking water, and a lack of sanitation facilities (The World Bank, 2003). Soomro et al. (2011) posits that a serious water scarcity is the outcome of the growing gap between water supply and demand. Due to growing demands, Pakistan's water and sanitation department has been emphasizing water quantity over water quality (Daud et al. 2017). As a result, the quality of the water is impacted negatively and hence water is a factor in the majority of reported health issues, either directly or indirectly (Soomro et al. 2011). In Pakistan, only 20% of the total population has access to clean drinking water. Due to the lack of clean and healthy drinking water sources, the remaining 80% of the population is forced to use contaminated water. Waterborne diseases account for around 80% of all diseases and 33% of mortality and are brought on by human activities (Daud et al. 2017). Khyber Pakhtunkhwa

is one of the four provinces of Pakistan that has quite diverse geographical, geological, climatic, hydrological, social and economic setups (Nazeer, 2019). The province is facing severe issues regarding WASH. The bad drinking water quality, sanitation and hygiene issues have resulted in the outbreak of several water-borne diseases in Khyber Pakhtunkhwa. According to a report by the World Health Organization (WHO), water-borne diseases account for 60% of the total diseases in the province (WHO 2018). According to a report by the United Nations Children's Fund (UNICEF), the infant mortality rate in the province is 74 deaths per 1,000 live births (UNICEF, 2021). The bad drinking water quality and sanitation have also resulted in economic losses in Khyber Pakhtunkhwa. The outbreak of water-borne diseases has led to increased healthcare costs, reduced productivity, and loss of income (Khalid, 2017).

Finding out what people know, think, and do about a particular problem of interest can be accomplished through conducting studies using the Knowledge, attitude and practices (KAP) survey (Hosen et al. 2022). The KAP is utilized in different part of the world for COVID-19 (Noreen et al. 2020; Sujarwoto 2022; Anaam & Alsahali 2023), Dengue infection (Hairi et al. 2003; Chng et al. 2022), education (Heck et al. 2023), WASH (Sridhar et al. 2020; Berhe et al. 2020) and so on. However, disparities exit between and within communities that need to be identified for appropriate policy development. In order to assess the current situation amongst various administrative units and to devise sustainable WASH' plans or programs, there is a need of a holistic approach for the comparative analysis. Composite indicators can be a useful tool for comparative analysis, as they provide a more comprehensive view of complex phenomena and allow for meaningful comparisons across different entities. According to OECD (2008), a composite indicator is a tool for reducing complexity by summarizing various implications or indicators into a single variable, making information easier to manage and enabling decision-makers to concentrate on the most crucial elements. Composite indicators are important for several reasons as they provide a more comprehensive and nuanced assessment of complex phenomena, allow for comparison and evaluation of different entities (regions, states, communities and so on), assist policy-makers and raise public awareness and accountability (OECD 2008; Hurdlikova 2013; Kroll and Scholz, 2014; Baptista 2014; Greco et al., 2019; Nazeer and Bork 2019). The aim of the current study to assess the WASH situation in the central Khyber

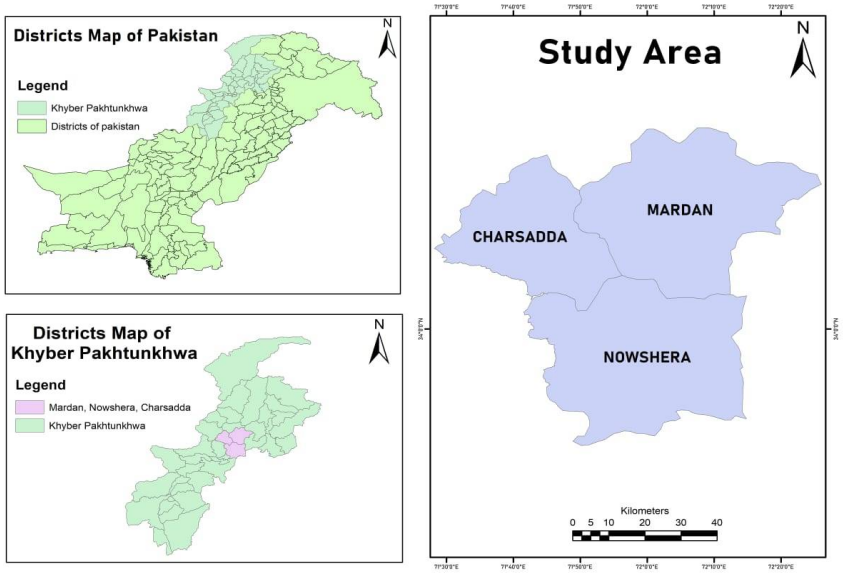
Pakhtunkhwa province of Pakistan through KAP survey and composite indices for to assist the policy makers in devising best management practices in WASH sector.

2. Materials and Methods

2.1. Study Area

Pakistan is a country in South Asia that borders India to the east, China to the north, Afghanistan to the northwest, Iran to the west, and the Arabian Sea to the south. Its approximate latitude and longitude ranges are 24-37o N and 62-75o E, respectively. The province of Khyber Pakhtunkhwa is one of the four provinces and lies northwest of Pakistan. The province covers an area of approximately 74,521 km2. The exact location of the province is 31°15'–36°57' North and 69°5'–74°7' East (Kruseman & Naqvi, 1988; Khan, 2012, Nazeer 2019). The study area of the current study is the three main towns of Central Khyber Pakhtunkhwa including the Charsadda, Nowshera, and Mardan (Figure 1).

Figure 1: Map of the Study Area



Source: Author's contribution

2.2. Data Collection

Solvin's approach (Nazeer and Bork, 2021) was used for the determination of the appropriate sample size, as shown in Eq.1:

$$n = \frac{N}{(1 + Ne^2)} \qquad \text{(Eq.1)}$$

Where

n= sample size

N= Population, and

e= Margin of error (that is 5% in our case)

Based on the 2017 Government of Pakistan's latest census, the sample size was determined. The urban population of district Charsadda, district Mardan, and district Nowshera were 1,610,960; 2,373,399, and 1,520,995 respectively. The margin of error was kept at 5%. The appropriate sample sizes were discovered to be 117, 172 and 111 for the Charsadda, Mardan and Nowshera, respectively. The household' head was the targeted person to be interviewed, where the second elder was considered in case of his absence. Similarly, in case of combined family only the eldest person was interviewed. The data was collected through hired personal that was trained by the principal investigator. All ethical considerations were taken into account during data collection process. The study borrowed the Berhe et al.'s (2020) questionnaire, which was modified to fit local conditions. Extraneous items that weren't relevant to the study area were removed, and new items were added whenever required. The three main components of the questionnaire were the knowledge, attitude and practices (KAP) related to WASH. Except the attitude component of the questionnaire that was composed on 4 Likert scale (as opposed to the study of Berhe et al. (2020) that used the 5 Likert scale) included strongly agree (4), agree (3), disagree (2), and strongly disagree (1), the knowledge and practices components were composed on binary questions.

2.3. The Index Development

As concerned to the WASH indices for knowledge and practices part of the study, the simple arithmetic additive function (Nazeer and Bork, 2019; Nazeer and Bork 2020) is used as given in Eq.2;

$$WASH_{(K,P)} = \frac{\sum X}{N} \qquad \text{(Eq.2)}$$

Where X stands for percent of respondents for the "yes" answers, and N for the total number of questions.

Whereas, for the attitude part, that is in ordinal form, the current study adopted the approach of relative important index (Raja et al. 2018) as given in Eq.3;

$$WASH_{(A)} = \frac{\sum W}{AN} \qquad \text{(Eq.3)}$$

Where W is the respondent's weighting of each factor (question in this case) on a scale of 1 to 4 (where 1 stands for strongly disagree to 4 for strongly agree). The total number of respondents is N (100 in this case using percentage) and the maximum weight is A (in this case, 4). The Relative Importance Index is a number between 0 and 1, which is multiplied by 100 to get the percentage.

The final WASHI is the arithmetic mean of the composite indices of knowledge, attitude and practices domains as shown in Eq.4;

$$WASHI = \frac{\sum WASH_{(K,A,P)}}{3} \qquad \text{(Eq.4)}$$

3. Results

3.1. Socio-economic characteristics

The socio-economic characteristics of the study' respondents has been shown in Table 1. No significant variation has been observed in the mean age, education and family size in all the three selected areas. Noted that all the respondents of the study are male.

Table 1: Socioeconomic Characteristics (Field Survey: 2023)

Variables	Charsadda	Mardan	Nowshera
Mean Age (years)	52.19	55.06	49.52
Mean Education (years)	6.48	7.42	7.49
Mean Family Size (number)	8.67	8.78	7.49

Source: Prepared by the author.

3.2. Knowledge

Table 2 shows the finding of the respondents' knowledge in the selected three districts of Khyber Pakhtunkhwa. 71% in Charsadda, 80% in Mardan and 77 % of respondents in Nowshera are aware that water could get contaminated. Similarly, 83%, 89%, and 81% of respondents in Charsadda, Mardan and Nowshera, respectively, knew that diseases are caused by fluid waste exposure. As compared to Nowshera (79%) and Charsadda (74%), respondents in District Mardan had a considerably higher level of knowledge (91%) of the potential health risks associated with animal' waste exposure. In Mardan as well as Nowshera, 98% of respondents indicated they were more cognizant of the need to wash their hands after using toilets. Similarly, 99% of people in Nowshera, 98% in Mardan, and 88% in Charsadda have knowledge of the significance of clean water for washing their hands. In each of the three districts that were chosen, almost all of the residents are aware of the need of good hand hygiene in preventing disease.

Table 2: The Respondents' Knowledge (Field Survey 2023)

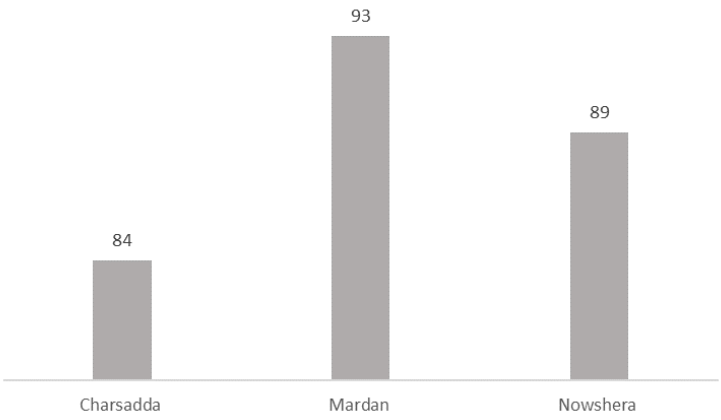
Variables	Charsadda	Mardan	Nowshera
Water get contaminated	71	80	77
Liquid waste exposed to diseases	83	89	81
Animal waste causing diseases	74	91	79
Hand wash is necessary after toilet	92	98	98
Clean water is necessary for hand wash	88	98	99
Not washing hands can cause diseases	98	99	100

Source: Prepared by the author.

Based on the average knowledge scores across various factors the regions of Charsadda, Mardan, and Nowshera, the water, sanitation and hygiene

index for knowledge (WASHK) was computed as shown in Figure 2. It was found that people in district Mardan has comparatively high level of awareness related to WASH followed by Nowshera and Charsadda.

Figure 2: Comparative Scores for WASHK



Source: Prepared by the author.

3.3. Attitude

Table 3 shows the results of attitude domain in the three selected districts of Khyber Pakhtunkhwa, Pakistan. 88%, 90% and 95% respondents showed positive attitude that safe and sufficient water can prevent waterborne diseases. Almost all respondents in all the three selected region are in the view that boiling water before consumption eliminate the diseases causing agents. Sizable proportion of 94%, 92% and 97% of the respondents in Charsadda, Mardan and Nowshera, respectively, were agreed and strong agreed that disposing liquid waste inside the compound causing health problems. 100% respondents in Charsadda, 91% in Mardan and 97% Nowshera considered that poor personal hygiene and sanitation caused diarrhea. 100% respondents in all the selected districts considered that diarrhea is transmitted from one person to other. Except Charsadda where only 5% respondents considered that the purpose of latrine is only privacy, a sizeable portion of respondents in Mardan (73%) and Nowshera (62%) considered privacy is the sole purpose of a house' latrine. Similarly,

83% respondents in Charsadda, 94% in Mardan and 95% in Nowshera considered that the improper waste disposal in the community is a risk factor for their family members. In Charsadda, Mardan, and Nowshera, respectively, 97%, 100%, and 99% of respondents agreed that washing hands after using toilets helps avoid diarrhea. Only 2% of respondents in Nowshera stated that water alone could sterilize hands after using toilets, compared to 7% in Charsadda and 7% in Mardan. In Charsadda and Nowshera, none of the respondents considered that the children's stool was germ-free, whereas 95% of the respondents in Mardan disagreed with this statement.

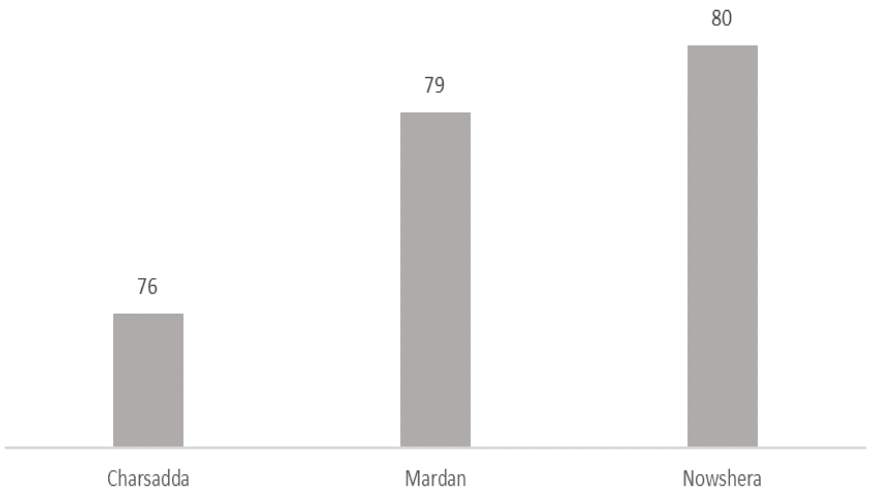
District Nowshera has comparatively higher value of WASHA followed by Mardan and Charsadda as shown in Figure 3.

Table 3: The Respondents' Attitude (Field survey 2023)

	Charsadda				Mardan				Nowshera			
Variables	Strongly Agree	Agree	Disagree	Strongly Disagree	Strongly Agree	Agree	Disagree	Strongly Disagree	Strongly Agree	Agree	Disagree	Strongly Disagree
Safe and enough water can prevent waterborne diseases	70	18	10	2	70	20	8	2	91	4	2	3
Boiling water before consumption helps to remove disease causing microorganisms	100	0	0	0	89	10	1	0	95	5	0	0
Disposing liquid waste inside the compound does cause health problems	79	15	5	1	83	9	5	3	89	8	3	0
Diarrheal diseases are caused by poor personal hygiene and sanitation	90	10	0	0	80	11	8	1	84	13	2	1
Diarrheal diseases are transmittable	50	50	0	0	76	8	13	3	90	10	8	8
The significance of latrine is for privacy only	4	1	23	72	13	14	40	33	21	17	39	23
Improper waste disposal of neighbours is risk factor for the respondent' family	33	50	15	2	71	23	4	2	31	54	10	5
Washing hand after using latrine prevents diarrheal diseases	93	4	3	0	89	11	0	0	90	9	1	0
Washing hands with water alone is enough to sanitize hands	0	7	34	59	3	4	46	47	0	2	49	49
Children's stool is free from disease causing germs	0	0	80	20	0	5	78	17	0	0	58	42

Source: Prepared by the author.

Figure 3: Comparative Scores for WASHA



Source: Prepared by the author.

3.4. Practices

Table 4 presents the practices component of the WASH in the three selected districts of Khyber Pakhtunkhwa, Pakistan. 54% respondents in Charsadda, 64% in Mardan and 71% in Nowshera had their own water sources while majority rely on government tube-wells. Similarly, 49%, 51% and 67% respondents in Charsadda, Mardan and Nowshera, respectively, disposing their household' waste in a proper manner. Interestingly, a sizeable proportion of 67% in Charsadda, 61% in Mardan and 45% in Nowshera had their latrine connected with the open drains. 52%, 56% and 63% respondents in Charsadda, Mardan and Nowshera, respectively, had sophisticated wash basins installed in their houses.

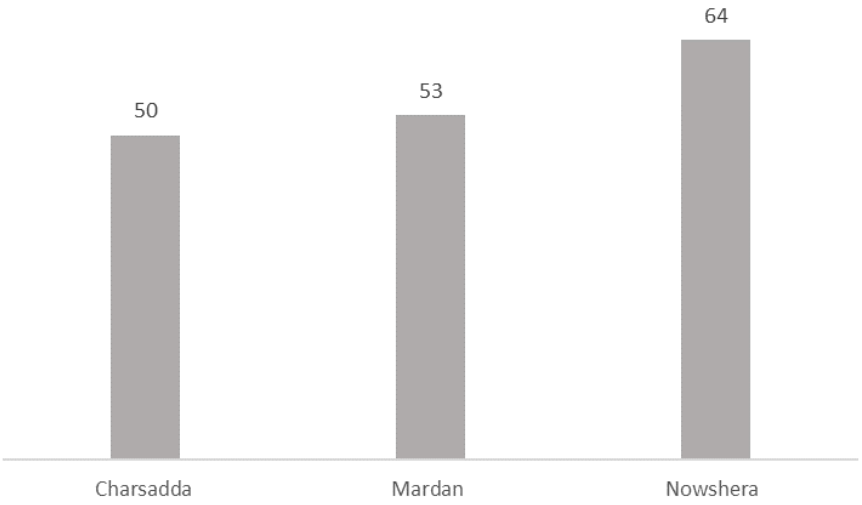
The Water Supply and Sanitation Index for practices component (WSSIp) was computed as shown in Figure 4. Respondents in Nowshera has comparatively the highest level of good WASH' practices followed by Mardan and Charsadda.

Table 4: The Respondents' Practices (Field Survey 2023)

Variables	Charsadda	Mardan	Nowshera
Own source of water supply	54	64	71
Proper disposal of household' waste	49	51	67
Latrine connected with proper septic tank	43	39	55
Sophisticated hand wash basin system	52	56	63

Source: Prepared by the author.

Figure 4: Comparative Scores for WASHP

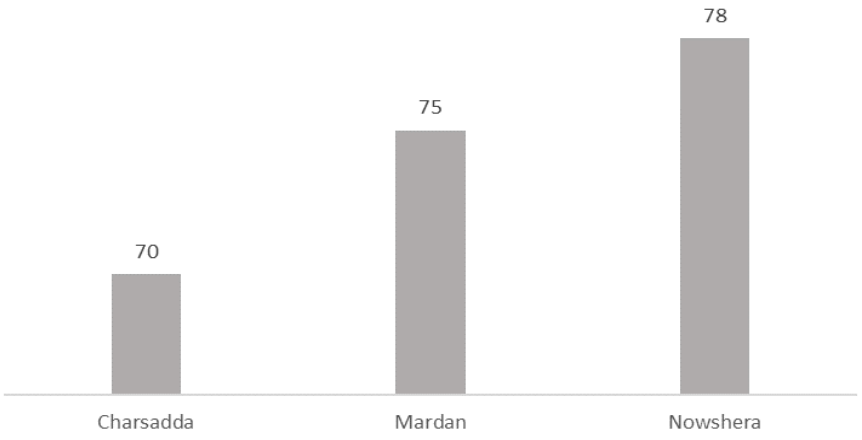


Source: Prepared by the author.

3.5. Overall Situation

Figure 5 illustrates the overall WASH situation in the selected districts of Khyber Pakhtunkhwa, Pakistan. The comparatively higher WASH index value indicates robust approach towards water, sanitation in hygiene. The value of WASH index is Mardan is comparatively higher than Charsadda and lesser than Nowshera imply that efforts are needed to improve the WASH situation in Mardan. While the comparatively less value of WASH index in Charsadda means that much is needed in this sector for sustainable development.

Figure 5: Comparative Scores of WASHI



Source: Prepared by the author.

4. Discussions

Evaluating the WASH is one of the important issues for devising the target-oriented policies. The main aim of this study to find the comparative WASH situation in the three selected districts of central Khyber Pakhtunkhwa, Pakistan. It was confirmed that water supply and sanitation is not a critical issue in the central part of Khyber Pakhtunkhwa as like other parts of the province. These results are in agreements with the Pakistan Bureau of Statistics (2020) that 97% of urban Khyber Pakhtunkhwa has accesses to improved drinking water and 87% to flush toilets. Comparatively higher good situation of WASH is found in district Nowshera followed by district Mardan and Charsadda. Such results are not unexpected as the socio-economic factor is one of the main reason for these variations. The district-wise human development index (HDI) of Khyber Pakhtunkhwa province indicated that Nowshera has comparatively higher HDI than Mardan and Charsadda having the values of 0.58, 0.56 and 0.53, respectively (Haroon, 2021). However, questions are arsising that the water is sufficient in the area either it is also of good quality? And sizeable portion of the area' people has flush toilets in their houses so are these toilets are hygienically covered?

There is plethora of research studies that indicated that the water quality in all the selected districts are not quite good for human consumption. For instance, Awan, et al. (2022) reported that Escherichia coli (E. Coli) positive samples were high in Mardan District. Ali, et al. (2014) posits that majority of the water sample in the Mardan city are contaminated with different types of micro-organisms and considered unfit for human consumption. Similarly, another study conducted by Rahman, et al. (2021) described that E.coli is a problem in the water of Mardan district. The findings of Khan, et al. (2012) is not different than others in terms of faceal contamination in the district of Mardan and they linked this to the contamination sources nearby the water sources or unimproved sanitation system for the proper disposal of sewage sludge, garbage, animal wastes and so on. Khan, et al. (2012) reported that the major part of water from different sources in Charsadda has physical, chemical and biological impurities quite larger in quantities than the prescribed standards set by different well-known organizations like World Health Organization, Environmental Protection Agency of the US and so on. They further added that different kind of diseases are linked with the bad quality of water in Charsadda. Improper disposal of solid waste, sludge and sewage were also one of the main reason in their study for water contamination. The situation of water quality in district Nowshera is not different than the other selected districts. High level of turbidity, nitrates, fluorides and microbes were detected in the water samples of district Nowshera (Naveed, et al. 2020). The finding of only a minor portion of latrines connected with septic tanks is in agreement with the earlier studies (Cooper 2018; Asian Devlopment Bank 2021) that effluent from toilets in Khyber Pakhtunkhwa is discharged into open drains that implying poor hygiene (Figure 6).

The study has some limitations. For instance, omitting an important and sizable part of the community, the female gender, due to cultural norms might influence the study results. In similar way, developing composite indicators in a simpler manner is another issue. However, advocacy exists that composite indicators must be simple, open and transparent (Nazeer and Bork 2019) that is strictly observed in the current study. Despite these issue, the importance of the adopted methodology in the current study cannot be underestimated as neither only KAP nor composite indices alone can convey it massage so easily to a wide range of stakeholders. The study definitely provided not only a baseline for future studies, but also provided an innovative way for developing WASH indices through KAP survey.

5. Conclusion

It is concluded from this study that WASH situation is comparatively better in Nowshera followed by Mardan and Charsadda. Sufficiency in water and toilets in all the selected three districts may not be an issue but quality of the water and the appropriateness of the toilets' outlets into open drains and streets are cause of concern. The approach adopted in the study will have broader impact for comparative analysis to formulate target-oriented WASH programs and policies. It is recommended that female respondents.

Figure 6: Snapshots of the study area

(a) Top-view of the main water supply pipeline laid down at the bank of main sewage drain (b) A water supply pipe is just beneath the gutter pipe and openly flowing on ground, and (c) The commode pipe open at a drain (Pictures by author with permission)

(a)

(b)

(c)

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Declaration of conflicting interests

The author declares no conflicting interests.

Ethical Considerations

All ethical considerations were followed using research standards. Prior consent was duly obtained from all the respondents. The data collection process was kept entirely undisclosed, and no individually recognizable information was obtained.

References

Ali, J., Hassan, S., Ziaurhman, R. I., Abbas, S., & Ullah, S. (2014). Bacteriological Quality of Drinking Water in Mardan, Khyber Pakhtunkhwa, Pakistan. *Ecoprint: An International Journal of Ecology*, 1-6. doi:10.3126/eco.v21i0.11897

Awan, F., Ali, M., Afridi, I. Q., Kalsoom, S., Firyal, S., Nawaz, S., ... & Rafique, N. (2022). Drinking water quality of various sources in Peshawar, Mardan, Kohat, and Swat districts of Khyber Pakhtunkhwa, Pakistan. *Brazilian Journal of Biology*, 84. doi:10.1590/1519-6984.255755

Baptista, S. R. (2014). Design and Use of Composite Indices In Assessment of Climate Change Vulnerability. Tetra Tech ARD.

Cooper, R. (2018). Water sanitation and hygiene. Birmingham, UK: University of Birmingham.

Daud, M. K., Nafees, M., Ali, S., Rizwan, M., Bajwa, R. A., Shakoor, M. B., ... & Zhu, S. J. (2017). Drinking Water Quality Status and Contamination in Pakistan. *BioMed Research International*, 1-18. doi:10.1155/2017/7908183

Devlopment Organisation for Economic Co-operation and Devlopment. (2008). Handbook on Constructing Composite Indicators: Methodology and User Guide. Devlopment Organisation for Economic Co-operation and Devlopment and European Commission.

Haroon, J. (2021). Potential Versus Actual HDIs: The Case of Pakistan. Social Policy and Development Centre (SPDC). Munich Personal RePEc Archive (MPRA). Retrieved from https://mpra.ub.uni-muenchen.de/105091/1/MPRA_paper_105091.pdf

Hosen, I., Moonajilin, M. S., & Hussain, N. (2022). Predictive factors of vaccination status knowledge, attitudes, and practice towards prevention of hepatitis B infection among Bangladeshi people: A cross-sectional study. *Health Science Reports*, e1000. doi:10.1002/hsr2.1000

Hudrliková, L. (2013). Composite Indicators as a Useful Tool for International Comparison: The Europe 2020 Example. *Prague Economic Papers*, 22(4), 459-473. doi:10.18267/j.pep.462

Khan, M. A. (2012). Agricultural Development in Khyber Pakhtunkhwa: Prospects, Challenges, and Policy Options. *Pakistaniaat: A Journal of Pakistan Studies*, 4(1), 49-68.

Khan, N., Hussain, S. T., Saboor, A., Jamila, N., Shabir, A., Ullah, R., ... & Lee, S. K. (2012). Bacteriological investigation of ground water sources in selected urban areas of district Mardan, Khyber Pakhtunkhwa, Pakistan. *African Journal of Biotechnology*, 11(51), 11236-11241. doi:10.5897/AJB12.914

Khan, S., Shahnaz, M., Jehan, N., Rehman, S., Shah, M. T., & Din, I. (2012). Drinking water quality and human health risk in Charsadda district, Pakistan. *Journal of Cleaner Production*, 1-9. doi:10.1016/j.jclepro.2012.02.016

Kruseman, G. P., & Naqvi, S. A. (1988). Hydrogeology and groundwater resources of. Delft/Peshawar: Government of Pakistan. Retrieved from https://www.ircwash.org/sites/default/files/822-PK.NO89-5660.pdf

Naveed, M., Yaseen, M., Shaheen, S., & Muhammad, S. (2020). Drinking water quality assessment for geochemical and microbial parameters in Nowshera District, Khyber Pakhtunkhwa, Pakistan; In an aspect of Geo-ethical Consideration. 22nd EGU General Assembly. doi:10.5194/egusphere-egu2020-5890

Nazeer, M., & Bork, H. R. (2019). Composite Indicators for Measuring Progress towards Sustainable Development: A Pakistan Case Study. *Environmental Economics and Policy Studies*, 21, 665-692.

Nazeer, M., & Bork, H. R. (2020). Methodology for Constructing Composite Indicators for Assessing Sustainable Development. *Sustainability*, 12(12), 5073. doi:10.3390/su12125073

Organisation for Economic Co-operation and Development. (2008). Handbook on Constructing Composite Indicators: Methodology and User Guide. OECD Publishing.

Qamar, K., Nchasi, G., Mirha, H. T., Siddiqui, J. A., Jahangir, K., Shaeen, S. K., ... & Y, E. M. (2022). Water sanitation problem in Pakistan: A review on disease prevalence strategies for treatment and prevention. *Annals of Medicine and Surgery*, 82, 104709. doi:10.1016/j.amsu.2022.104709

Rahman, Z., Ahmad, S., Fidel, R., Khalid, S., Ahmad, I., Humphrey, O. S., ... & Khan, B. (2021). Faecal and nitrate contamination in the groundwater of Mardan district, Pakistan. *Environmental Geochemistry and Health*, 43(09), 3615-3624. doi:10.1007/s10653-021-00848-8

Reckien, D. (2018). What is in an index? Construction method, data metric, and weighting scheme determine the outcome of composite social vulnerability indices. *Regional Environmental Change*, 18, 1439-1451. doi:10.1007/s10113-017-1273-7

Salman, A. (2021, November 13). East Asia Forum. Retrieved from Pakistan's looming water crisis: https://www.eastasiaforum.org/2021/11/13/pakistans-looming-water-crisis/

Soomro, Z. A., Khokhar, M. I., Hussain, W., & Hussain, M. (2011). Drinking Water Quality Challenges in Pakistan. *World Water Day*, 17-28.

The Pakistan Bureau of Statistics. (2017). District Wise Results / Tables (Census - 2017) Khyber Pakhtunkhwa. Islamabad. Retrieved from https://www.pbs.gov.pk/census-2017-district-wise

The World Bank. (2003, December). Public Health at a Glance. Retrieved from Water Sanitation & Hygiene: http://web.worldbank.org/archive/website01213/WEB/0__CO-75.HTM#How

United Nations. (2010, August 03). UN Digital Library. Retrieved from The human right to water and sanitation: resolution / adopted by the General Assembly: https://digitallibrary.un.org/record/687002?ln=en#record-files-collapse-header

World Health Organization. (2022, March 21). Drinking-water. Retrieved from https://www.who.int/news-room/fact-sheets/detail/drinking-water