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An Evaluation of Water Sanitation and Hygeine (WASH) and Water Borne Diseases in Rural Bist Doab, Punjab

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ABSTRACT

Recently, in 2023, WHO and UNICEF published a report on water, sanitation and hygiene (WASH) progress. Report highlighted that there is a need to increase WASH progress rate by 3 to 6 fold to achieve clean water and sanitation (SDG) 6 by 2030. Main aim of this research paper is to assess progress of WASH and identify risk factors which are yet barrier in attaining SDG 3 and SDG 6 in Bist Doab area of Punjab. Household survey was conducted to assess level of WASH in study region through well-structured questionnaire using multistage random purposive sampling. Village environmental conditions were also observed and included in the study to identify risk factor present for water – borne diseases. Survey revealed that level of WASH has improved in Punjab in drinking water sources, sanitation level and personal hygiene. In addition, survey disclosed people are not satisfied with quality of water supplied in their villages. Also, study found low awareness level among people regarding water borne diseases and presence of permanent water logged areas, improper waste disposal, open drainage are some favorable grounds for outbreak of water borne and other water associated diseases such as malaria and dengue.

Keywords: Punjab, Risk factors, Rural Bist Doab, WASH, Water borne diseases

Introduction:

One of the goals of Sustainable Development Goals 2017 is to ensure the availability of clean water supply and sustainable management of water sanitation and hygiene (WASH) to all by 2030 (UN, 2015). However, a recent report on WASH published by WHO and UNICEF suggests that there is a need to increase several fold levels of progress in order to meet > 99% WASH standards (Girmay et.al, 2023). Currently, 780 million people do not have access to clean water and approximately 2.5 billion people in low-income nations do not have access to improved sanitation (Kumar et al, 2022) (Biduari et.al, 2019). Contaminated water and Poor sanitation levels give birth to several health issues, particularly waterborne diseases. WHO in 2015, reported that 6.5% of deaths occurred due to unsafe water, inadequate sanitation, and poor hygiene. Further WHO Suggested that 4% of the global disease burden could be prevented by improving water supply, sanitation, and hygiene(Nagpal et al., 2024).

UNICEF estimated that 37.7 million Indians are affected by water-borne diseases annually and around 1.5 million children are estimated to die due to diarrhea alone and each year a total of 73 million days are wasted due to water-borne diseases (UNICEF, 2019). It is also estimated that waterborne diseases produce a high disease burden significantly impacting the economic growth of the nation (Pathak, H, 2015). Mostly, waterborne disease outbreaks in summer and rainy seasons due to poor management of water supply, sanitation, and hygiene (Saravanan et al, 2016). In rural India, there is a lack of proper management of water and sewerage systems. Several factors contribute to the contamination of drinking water such as infiltration, leaching, surface runoff, and sewerage disposal system (Rehman et al., 2023). According to one study, a common cause of water-borne diseases

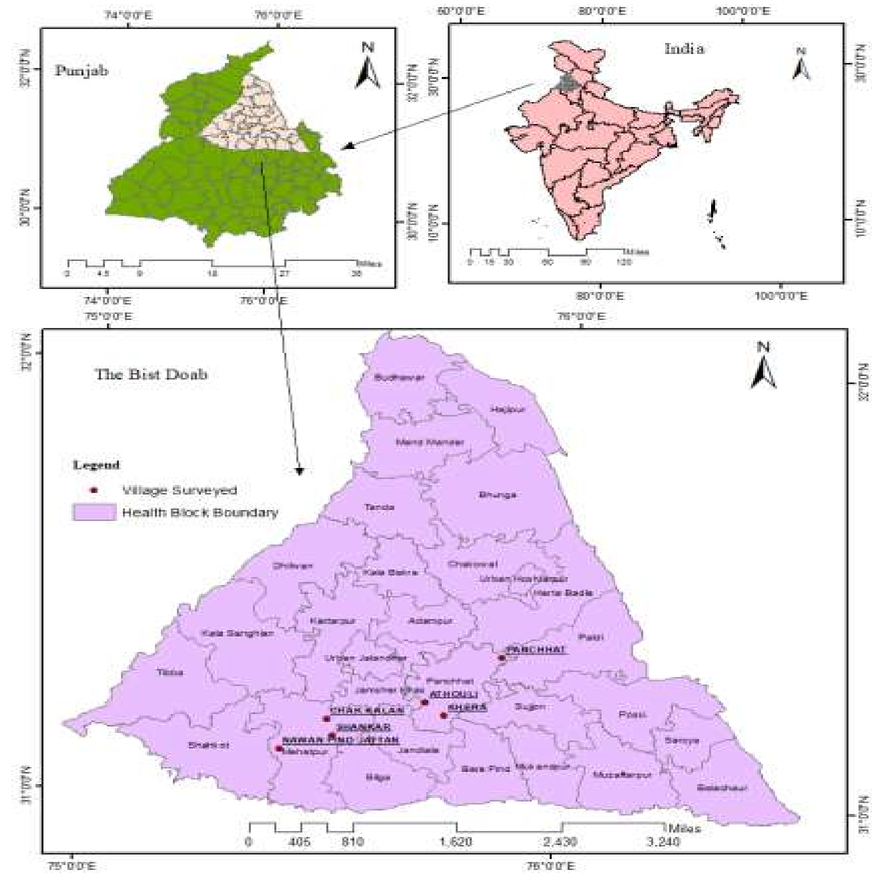
in rural India was a lack of Knowledge, Attitude, and Practices (KAP) with regard to water handling, sanitation, and defecation practices (Banda et al, 2007, Purohit, BC, 2012).
World Health Organisation in 2007 estimated that change in the environment could prevent up to 90% of waterborne diarrhoeal cases. These changes include an increase in the availability of clean water for drinking and to improve sanitation and hygiene practices (WHO, 2007). Several studies have attempted to provide solutions to waterborne diseases such as improved water supply, sanitation, proper hand washing, household water storage, and safe storage can actually prevent diarrhoeal cases up to a large extent (Fewtrell et al, 2005). Another study revealed that chlorine disinfection and storing drinking water in an appropriate container significantly improved the microbiological quality of non-piped households drinking and reduced the risk of waterborne diseases especially diarrhea (Sobsey, 2003). A study conducted in Cameroon also suggested the same finding that people having poor hand-washing practices are more prone to waterborne diseases (Fonyuy, 2014).
Environmental sanitation is another dimension, which is necessary to address to minimize waterborne disease in any area (Rappaport, 2010). Undoubtedly, it is well understood that the separation of fecal waste and other wastes is important to prevent contamination of drinking water (Rehman et al., 2024). Therefore toilet facilities, drainage facilities, and waste disposal facilities are significant infrastructural needs of any area to limit waterborne diseases at their lowest (Moraes et.al, 2003). Improper waste disposal particularly, industrial waste can contaminate groundwater and can cause several health issues too (Anwar. F, 2003, Kass, et.al, 2005).
WHO is committed to achieving Sustainable development goals by 2030. Hence, it is important to assess the status of WASH and risk factors present in any regional setting to reduce the burden of water-related diseases and to attain SDG3 and SDG6. Therefore, the present research paper aims to assess the progress of WASH in the rural Bist-Doab region by conducting a primary sample survey in the region. During the survey along with the questionnaire tool, observations of environmental conditions were also recorded to identify other risk factors that can contribute to the outbreak of waterborne and water-related diseases.

Data Source and Methodology

Study setting

SDG 3 aims to combat WBD effectively by 2030 and SDG 6 aims to provide clean and safe drinking water to all by 2030. Therefore, regional studies on WASH and risk factors associated with WBD provide regular monitoring of the progress of SDG 3 and SDG 6. The study region is part of Punjab state and located between 30˚58´ to 32˚05´ north latitude to 74˚57´ to 76˚31´ east longitude in the state of Punjab, India, bordered by river Sutlej and river Beas (Mavi, et.al, 2003). Water availability and water quality remained a concerning issue for authorities in Punjab as well as in the study region because most of the area of Punjab suffered from over-exploitation of underground water and chemical contamination which is the source of several kinds of diseases (Virk, 2020, CGWR, 2018).On the other hand, the frequency of outbreaks of waterborne diseases especially acute diarrhoeal disease, burden of water-borne diseases particularly diarrhoea and typhoid was high in 3 districts of the study region namely Jalandhar, SBS, and Kapurthala district (NFHS, 2014-15). Hence, Assessment of WASH and identifying potential risk factors is imperative to achieve SDG3 and SDG 6 in the study region. The study region consists of 29 health blocks (NHM). Out of 29, health blocks with rural-dominated areas are 27. Two rural sample health blocks i.e. Panchhat and Mehatpur were selected for the primary survey. Further, a total of 6 villages were selected from 2 health blocks for the primary survey using a sampling procedure.

Map 1: Location map of study area



Source: Generated by author through ArcGIS 10.6

Material

Source of data: Qualitative interviews were conducted in 6 sample villages in the study region selected through multistage random purposive sampling from April 2023 to June 2023.A well-framed questionnaire containing closed-ended questions on water usage, sanitation practices, and awareness regarding waterborne diseases. Prior ethical approval for the sample survey was taken from the office of the Chief Medical Officer of the respective districts.

Outcome variables: Water-borne diseases.

Predictor variables (Kumar et.al, 2022)

Water:

Source of water: Public water supply or other source

Location of water source: In own dwelling or elsewhere,

Perception of Water Quality: Clean or Unclean

Method to clean water: Traditional method or RO,

Daily usage of water by households: Less than 450 L or More than 450 L

Sanitation and Hygiene

Type of toilet facility: Drain into piped system or other

Location of toilet facility: In own dwelling or elsewhere

Toilet in sharing: Yes or No

Drainage facility: open or closed

Availability of soap and water: YES or No

Knowledge/Perception regarding waterborne diseases

Whether heard about diarrhoea, typhoid, cholera, Hepatitis YES or No

Whether any family member suffered from diarrhoea, typhoid, cholera, hepatitis Yes or No
Do you know reason behind suffering from diarrhea, typhoid, cholera and hepatitis? YES or No
Observation of surroundings

a. Shortage of drinking water supply : Yes or No
b. Improper drainage system : Yes or No
c. Existence of any water-logged area : Yes or No
d. Improper waste disposal: Yes or No.

Sample procedure and sample size
Cross sectional survey. The survey was conducted from April 2023 to July 2023.
The scheme of the study is presented in the following figure1. Sample units were selected using multistage random purposive sampling. The Bist Doab region consists of 29 health blocks. Number of households at each stage is taken to select sample units. In the first stage, two sample health blocks was selected. Block Mehatpur from Jalandhar District and Block Phagwara from Kapurthala district was selected as sample health blocks. At the second stage, sample health blocks were zoned into three categories ie. High, moderate and low based on the number of households to select sample villages. In each category, villages with the maximum number of houses were selected as sample villages. Therefore, a total of 6 sample villages were selected from two sample health blocks. In the third stage, the first house was identified with the help of Asha worker where a family member suffered from typhoid, diarrhoea, cholera and hepatitis in the last 6 months, further houses were selected randomly.
Sample size
Sample size was decided by yamene's formula (Abanyie et.al, 2023)

$$n = \frac{N}{1 + N(\dot{\alpha})^2}$$

n = Sample size
N = Total number of households in sampled villages,
$\dot{\alpha}$ = margin of error (0.1)

Sample size obtained after calculation is 97.56. Total surveyed houses were 101 using Probability Proportional to Size sampling.
Multistage Random Purposive Sampling

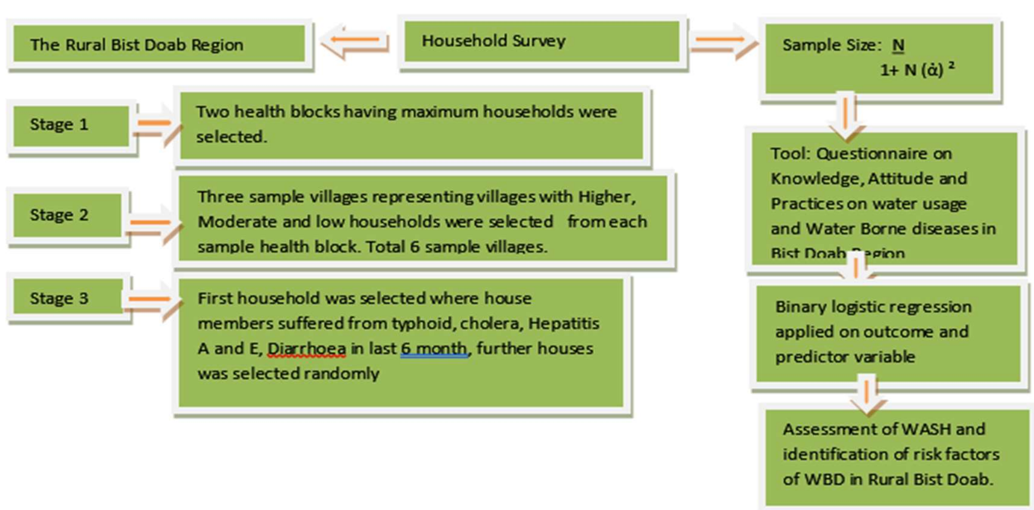


Fig1: Scheme of the study

Data Analysis:

Data collected through primary survey was analysed with the help of MS Excel and SPSS 26.0. Binary logistic regression is performed on outcome variable and predictor variables to identify risk factors for water borne disease. Data is presented through Statistical tools.

Results:

Table 1 shows the characteristics of surveyed households. The main aim of the survey was to assess the prevalence of water-borne disease, assess WASH and identify risk factors contributing to water-borne disease in study region. A total of 101 houses were surveyed from 6 sample villages selected randomly through multistage random purposive sampling. Questions were asked through a well-framed questionnaire, mostly having closed-ended questions. To assess the prevalence of WBD, a question was asked whether any family member suffered from diarrhea, typhoid, Cholera, or Hepatitis (Only Hepatitis A and E are included in the study) in the last 6 months. In response, out of 101, 29 families replied yes and 72 replied no. Results infer that WBD prevalence was there in 28.71% of families in which majority single WBD Patient (26.7) had. Further, the Population covered under the survey was a total of 478. Out of a total of 478 persons, 37 persons suffered from typhoid, diarrhoea, cholera, or viral hepatitis in last 6 months which accounted for 7.81% of total population covered. Hence, Disease occurrence rate for water borne diseases in Doaba region was 7.81% as per study conducted. In addition, Survey recorded no WBD case in 71.3% families. Major Water borne disease found in the study region was typhoid (76.47 %) cases. Diarrhoea with 20.58 % was second and Hepatitis with 0.2 % was third. No case of cholera was found during survey.

Table1: Basic information of surveyed households

Characteristics of surveyed households	Total number	%
Total surveyed households	101	-
Total persons covered under survey	478	-
Houses affected with Water borne diseases	29	28.71
Persons affected with Water borne diseases	37	7.81
Family with no WBD sufferer	72	71.3
Family with one WBD sufferer	23	26.7
Family with two WBD sufferer	4	2.0
Family with three WBD sufferer	2	1.0
Typhoid	30/37	76.47
Diarrhoea	6/37	20.58
Viral Hepatitis	1/37	0.02

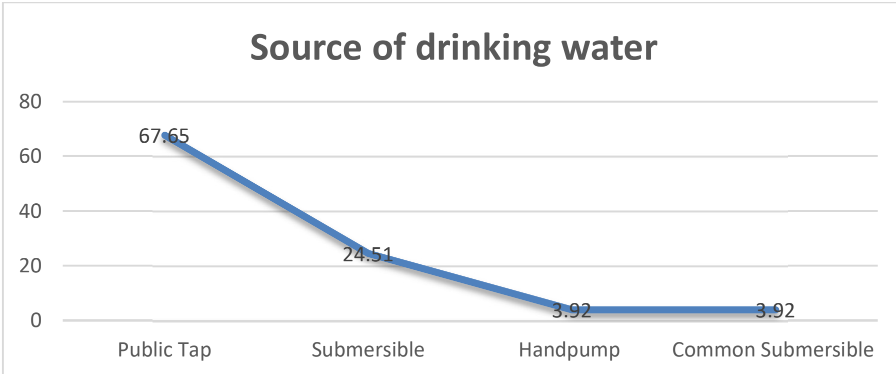
Source: Author’s analysis

Water:

***Source of drinking water**:*

It was found during survey that most common source of water in sample villages was public water supply accounting 67.65% total houses surveyed. Several houses had submersible installed in their premises i.e. 24.51% of total surveyed houses. Practice of common submersible i.e. Using one submersible by group of houses, came into light during survey. Practice of common submersible was observed in only one village out of 6 villages, therefore, not a general thing. Hand pump was another source of water used by residents of study region, however, only 3.92% households had to use hand pump water.

Figure 2: Source of drinking water

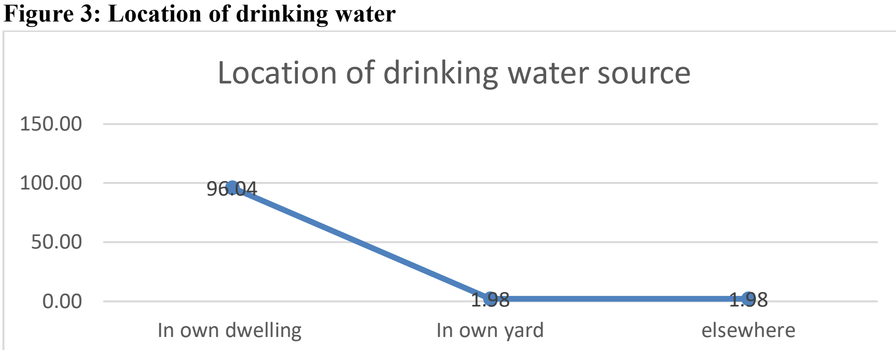


Source: Primary data collection by author.

Location of Drinking water:

During primary survey it was found that 96.04% households had source of water inside their dwelling. However, few families (1.98%) had common hand pump locating in their yard and few families (1.98%) had to bring water from nearby hand pumps or public filtered water taps.

Figure 3: Location of drinking water

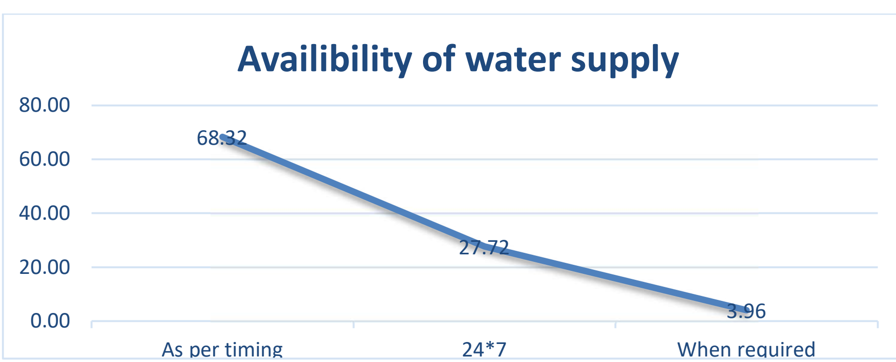


Source: Primary data collected by author.

Availability of water supply

It was found during the survey that all families had easy access to water. As public supply is available as per timings, users of public supply had to wait for water sometimes. 68.32% families had accessibility of clean drinking water as per timings. On the other hand, user of submersible had availability of water 24*7. Few hand pump user families i.e. 3.96% had accessibility of water 24* 7, However, categorised as when required because they have to carry water from outside their dwellings.

Figure 4: Availability of water supply

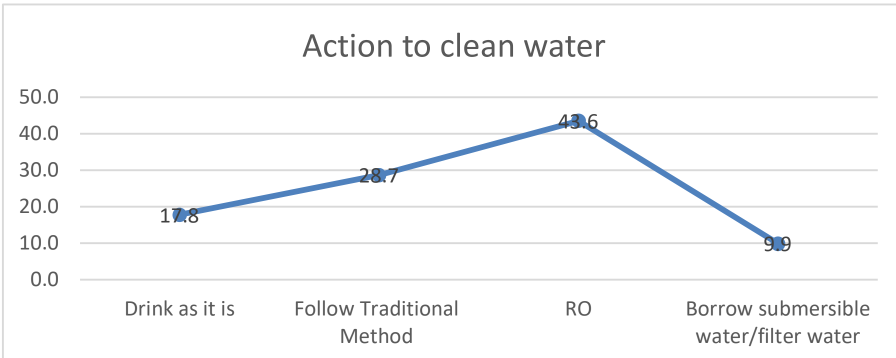


Source: Primary data collected during survey

Action to clean water:

It was found during the survey that different kind of action was adopted by rural residents to clean water. Most of the families (43.6%) have installed electronic RO's in their kitchens to clean supplied water. On the other hand, 28.7 % of families used the traditional method of cleaning method which included straining with clothes, boiling, and letting water stand for some time to settle down dust. Several families i.e. 17.8% do not treat water before drinking and 9.9% of households borrow filter water some nearby houses or from the public water supply.

Figure 5: Action to clean water

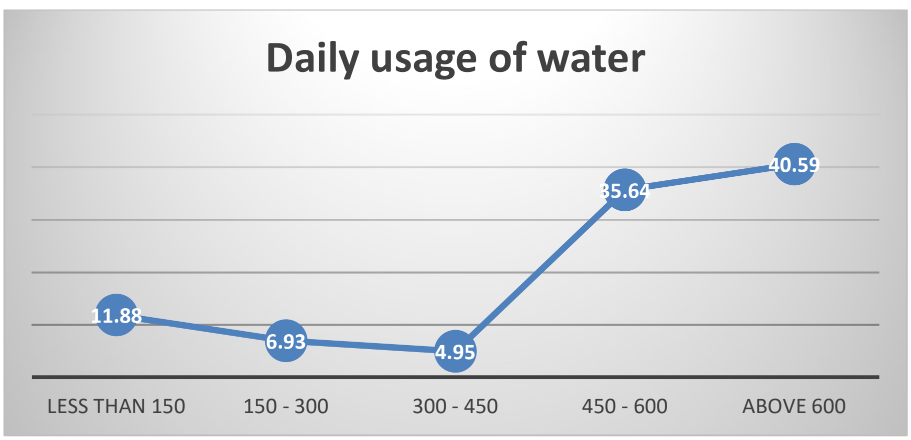


Source: Primary data collected during survey

Daily Usage of water:

It was found during the survey that 76.23% families use more than 450 litres which is above minimum requirement of water recommended by UN. On the contrary, 23.76% uses less than 450 litres per day. Most of them do not have water tank installed in their houses. They have to store water in big container having 100 litre capacities or in buckets.

Figure 6: Daily Usage of Water



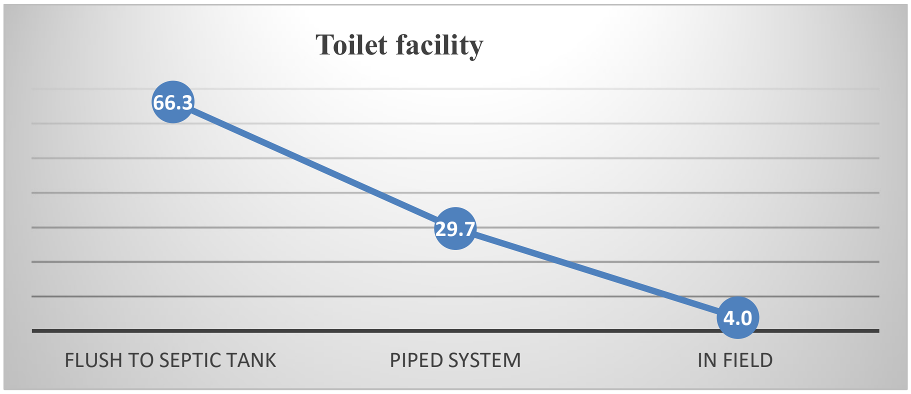
Source: Primary data collected by author

Sanitation and hygiene standards:

Type and location of toilet facility:

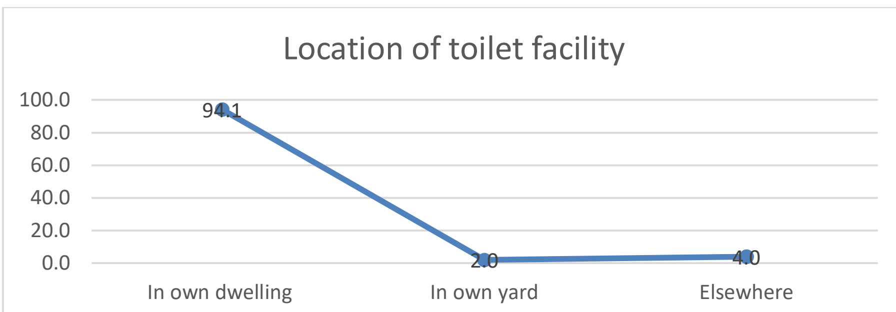
During survey in sample village, it was found that toilet facility was available in 96.0% families. However, 66.3% families had toilet facility flushed into septic tank. 29.7% houses had toilet facility draining into piped system. Practice of open defecation was there in 4% of families as they do not had toilet facility in their homes. Fig 8 shows that 94.1% families had toilet facility in their own dwellings, 2 % had toilet in yards and mostly in sharing with other family. 4% had no toilet facility in their houses and they practice open defecation.

Fig 7: Type of toilet facility



Source: Primary data collected by author

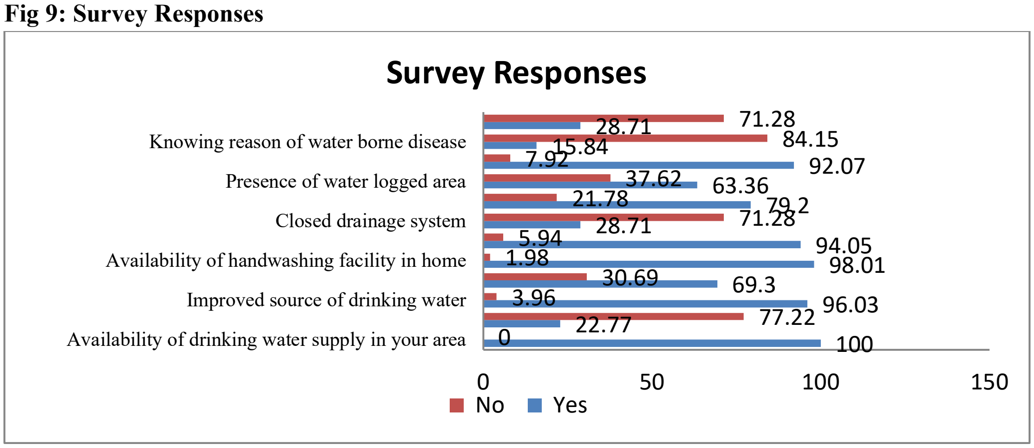
Fig 8: Location of toilet facility



Source: Primary data collected by author

Fig 9 "Survey Responses" shows that improved toilet facility is available in 94.05% families and 5.94 % families were having limited toilet facility either sharing or practicing open defecation. Similarly variable "availability of hand washing facility in home" was there in 98.01% families and only 1.98% families do not had availability of soap and water in their houses during survey.

Fig 9: Survey Responses



Source: Primary data collected by author

Awareness Level:

It was found during primary survey that only 15.84% respondents were having idea that drinking contaminated water can cause typhoid, diarrhoea, cholera and viral hepatitis. Most of the respondents i.e. 84.15% said that they do not know why their family member got suffered from typhoid, or diarrhoea or viral hepatitis. Therefore, survey revealed very low awareness level about water borne diseases in rural areas (Fig 9).

Environmental Aspects:

The presence of water-logged areas, improper waste disposal, and open drainage is favourable grounds for several waterborne diseases such as typhoid, diarrhoea, cholera and hepatitis A and E, etc. (Manetu et. Al, 2021) and undoubtedly invites several water-related diseases, for instance, dengue, malaria, etc.

During the survey, it was observed water logged area was there in all sampled villages. Out of 6 sampled villages, only 2 villages had closed drainage systems and 4 had open channels for drainage. It can be concluded that 60% of villages did not have proper drainage facilities during the survey. Further, survey results shown in fig,9, highlight that Improper waste disposal was visible in 5 villages, out of 6, constituting 83.33% of villages. On the question of the presence of waterlogged near your house, 63.36 % replied yes and 37.62% replied no. Similarly, on the question "improper waste disposal in the area," 79.2 % replied yes and 21.78% said no. On the query "closed drainage system," 28.71% of respondents replied yes and 71.28% replied no.

General Observation of villages surveyed *Potential environmental risk factors of water borne and water related diseases present in villages during survey*

a) Water logged area and improper disposal of garbage in khera village
b) Open drainage and drinking water source near drainage in khera village
c) & d) Open drainage in a village khera
e) Water logged area in village Athouli
f)& g) Open drainage in village Panchhat
h) & i) Heap of grabage in village Panchhat
j) & k) Interaction between author and respondents
l) Water logged area and waste accumulation in village shankar. Huts are located near water logged area.
m) & n) Water logged area and grabage accumulation in village Nawan pind Jattan
o) Water logged area in village chak kalan
p) Water logged area and waste accumulation in village khera

Association between outcome variable and predictor variable using logistic regression
Binary logistic regression was applied to outcome variables i.e. water-borne diseases and predictor variables. The

model is fit at the omnibus test of the model coefficient at a significance value of 0.19. Estimated Odds ratio (EOR) and Confidence Interval (CI) at 95% values are used to show the relationship between outcome variable and predictor variable. EOR = 1 shows the probability of falling in the target group i.e. WBD group and the non-target group i.e. "No WBD" is the same. EOR > 1 reflects the probability of falling in the target group is more and EOR < 1 infers that the probability of falling under the target group is less.

Table 2: Association between outcome and predictor variables

Independent Variables	EOR CI:95%
Source of drinking water	
Public Tap	Ref
Other source	.000
Location of drinking water source	
In own dwelling	Ref
Elsewhere	18.08(.245 -1337.66)
Perception of water quality	
Clean to drink	Ref
Unclean to drink	2.116 (.521 – 8.5)
Daily usage of water	
Less than 450	Ref
More than 450	1.081(.194 – 6.0)
Action to clean water	
Traditional method	Ref
RO	2.34(.178 – 30.8)
Drainage system	
Open	Ref
Closed	.935 (.231- 3.7)
Improper waste disposal	
Yes	ref
No	.131 (.017 – 1.002)
Presence of water logged area	
Yes	ref
No	1.993(.509 - 7.7)
Facility of hand washing available in home	
Yes	ref
No	.000
Knowing reason of WBD	
Yes	ref
No	.784 (.185 – 3.32)
Shortage of drinking water	
Yes	ref
No	.118 (.009 – 1.4)

Source: Author's analysis using SPSS 26.0

Table 2 shows the estimated odd ratio for predictors of the occurrence of waterborne disease in the study area. It is revealed that odd ratios are higher for drinking water sources located elsewhere (18.08 CI (.245 -1337.66) in reference to own dwellings. It infer that people using water source located somewhere else had more chances of getting ill with WBD. Similarly, the likelihood of waterborne diseases is higher among people who perceive that the water supply is unclean to drink (2.116 CI (.521 – 8.5) than those who think water is clean to drink. Moreover, the odds of waterborne diseases increase with the increase in daily usage of water (1.081 CI (.194 – 6.0). The risk of waterborne diseases is higher in families using electronic RO for cleaning water (2.34 CI (.178 – 30.8) than in traditional methods of cleaning method. Closed drainage systems lessen the probability of waterborne diseases in rural areas by 6.5 % (935 CI (.231- 3.7) in reference to open drainage. The likelihood of waterborne diseases is 86.9% higher where improper waste disposal persists than its counterpart (.131 CI (.017 – 1.002). The presence of waterlogged areas has shown less likelihood for waterborne diseases than the non-presence of waterlogged areas (1.993 CI (.509 - 7.7). Awareness level regarding WBDs among residents was very low. The odd ratio for awareness level about WBD is higher among target groups than non-target groups (.784 CI (.185 – 3.32). Shortage of drinking water has a higher odd ratio and higher chances of falling into the target group than the non- target group. The source of drinking water and facility of hand washing both variables have an odd ratio of (.000), compared to their reference groups which signifies that WBD and Non WBD both have equal chances of falling into the reference group.

Discussion:

As sustainable development goals are set to be achieved by 2030, it becomes imperative to work continuously on these targets to ultimately reach up to goals. WHO report On WASH published on July 6th, 2023highlighted that several nations are behind targets to attain SDG by 2030. Even, the report concluded that to reach >99% WASH status, countless efforts are yet needed especially in low-income nations (WHO & UNICEF, 2023). SDG 3, target 3.3 talks about combating infectious diseases in general and waterborne diseases in particular. Hence, such a study that deals with WASH and risk factors for the outbreak of waterborne diseases becomes really important.

Fundamentally poor water supply, poor water quality, and sanitation issues which include toilet facilities and personal hygiene give birth to water borne disease outbreaks directly. Other contributing factors for water-related and water-borne diseases are environmental which cause outbreaks indirectly. For instance, improper waste disposal, water-logged areas, open drainage, and finally practices of people which include handling of drinking water and food (Manetu et al, 2021). According to NFHS 2019-21, approximately 96% households of in India and 98.5% of families in rural Punjab were using improved drinking water sources (NFHS, 2019-20). Consumption of water through public taps is near about 14% at all India levels. Figure 2, sources of drinking water, displayed that public water supply users are 67.65% in the Bist Doab region. Submersibles were utilized by (28.73%) and hand pumps were used by 3.96% of people in the study region. Hence, 96.38 % of households were using improved sources of drinking water in the study region. Hand pumps were used mainly by migrant labourers who were residing on rent or living in temporary huts and had to use hand pumps and share toilet facilities. Logistic regression odd ratio suggest that the source of water is no longer a determining factor for waterborne diseases prevalence in Bist doab as there is no longer use of an unimproved source of drinking water such as a hand pump, well etc., which is located far from houses. Several previous and recent studies have also shown a progressive decline in waterborne diseases with increasing use of improved drinking water sources (Abanyie et.al, 2023). The present study result is concurrent with other research work as drinking source located not in own houses has very high chances of getting infectious water-borne diseases.

Quality of water has a certain impact on diarrhoea, typhoid, and viral hepatitis. Several studies have published positive relations between waterborne disease morbidity and mortality with unclean water usage (Salkai, 2023, Lee et. al, 2023). In the study region, 30% of households' heads think that the water supply is not clean enough to drink directly. The statistical analysis shown in Table 2,also infers that people who think water is unclean to drink without treatment (Odd ratio 2.116) have more chances of falling into the target group of waterborne disease. Therefore, this study recommends that the quality of water should be regularly monitored by public authorities to control typhoid, diarrhoea, viral hepatitis cases in the study region. Also, making people aware regarding treating water before use in rural areas would also be supportive.

People were asked during the survey how they treat water before drinking. Results shown in Figure 5 revealed that 17.8 % of respondents replied that they do not treat water and drink as it is available. However, 28.7 % of household treat water with traditional method which includes boiling, straining with cloth, or letting water stand for some time. Moreover, 43.6% of houses have electronic RO facilities available in their homes during the survey and 9.9% of people borrow clean water from other houses. Therefore, it is concluded from the study that the problem of unclean water persists in the study region. Interestingly, logistic regression performed (table 2) on the treatment of water and WBD prevalence in the study region produced a higher odd ratio for electronic RO with reference to the traditional method. It infers that RO use is less effective in treating bacteriological pollutants. Recent research work "Treatment of waterborne pathogens by reverse osmosis" by R. Wlodarczyk and A. Kwarciak–Kozlowska concluded that RO basically removes dissolved salts and very little literature supports removal of pathogens through RO. Therefore, this study put forward that the traditional method of treatment of water particularly boiling is the best method to remove microbes from water, so should be practiced where water borne disease outbreak occurs. (Sherwani et.al, 2013, Malan et al, 2023).

UN recommends a minimum daily use of 50L for an individual and 450L for a family of 4-5 persons. During the survey, it was found that 76. 23 % of families were using more than 450 liters per day. Families who were using less than 450 liters did not have water tanks installed. They store water in big containers or buckets. Interestingly, the odd ratio (1.081 CI (.194 – 6.0) suggests that people who were using more than 450 liters of water have more chances of falling into the waterborne diseases group. Schafer et.al, 2012 found a significant relationship between E. coli and turbidity present in the tank with the cleaning of tanks. A lower probability of E. coli growth was found in tanks cleaned 3-4 times in a year than in tanks cleaned once a year (Schafer et. al, 2012). Therefore, a regular cleaning routine of water tanks can surely help authorities to supply clean drinking water in any area. In addition, people should also be encouraged to clean their water tanks 3 – 4 times a year.

During the survey, it was observed that people practice hand washing in their daily routine and the availability of soap and water was there in 98.01 % of houses (Akula et al., 2024). The improved toilet facility was available to 94.05 % of households at the time of the survey which is higher than Punjab rural sanitation level which was 85.9% as per NFHS 2019-20 (Figure 1). However, it is yet behind the target of > 99% of WASH. Indeed, in the study region, only 1.98 % of households were using limited toilet facilities as they had to share toilets with other families. Out of 101, 4 families were such who do not have toilet facilities. Hence, the practice of open defecation is still present in the Bist-Doab region and these families belong to very poor economic conditions and were basically migrant labourers. Therefore, attention from authorities and awareness among people about following good sanitation practices are needed to achieve the targets of SDG3 and SDG6 by 2030.

Out of 6 villages surveyed, the open drainage system was there in 4 villages which depicts that the closed drainage system is there in 33.33% of villages and open drainage is available in 66.66% of villages. Out of 101 houses surveyed, 71.28 % houses were located along open drainage and 28.71 % houses had closed drains. The odd ratio (.935) for closed drainage is less than 1, compared to open drainage, suggesting that people living along open drainage have a higher chance of getting water-borne diseases than along closed drainage. Open drainage provides suitable grounds for contamination of food and water via houseflies, insects, rodents, poor hygiene, and flood water during rain (Ntajal et.al, 2022). Integrated disease surveillance weekly reports also suggest that most of the outbreaks occurred during the rainy season in Punjab. During the investigation, it was found by officials that the mixing of sewerage water with drinking water supply was the most common cause of the outbreak (IDSP, Weekly reports 2011- 23). Illegal connections of the water supply lead to several breakage points in the water supply and during rain, overflow in open drainage contaminates drinking water(Rehman & Dhiman, 2022). Therefore, this study promotes that a closed drainage system is necessary for curtailing waterborne disease.

The problem of improper waste disposal and the presence of water-logged areas (ponds to accumulate drainage water) were also there in most of the villages. The waste collection system was there in two villages, out of 6, however, not up to standard. Open containers were placed for 10 -15 houses in one village and in another, twice a week, garbage was collected by a person appointed to collect garbage. As this service is available on some charges, many people abstain from this practice. Therefore, heaps of garbage was present in 5 villages, out of 6 surveyed (Pics a,h,l,n, p). Likewise, drainage water is accumulated in a pond in each village (pic a, e,l,m,o,p). Logistic regression performed on improper waste disposal and the prevalence of waterborne disease has produced an odd ratio of (.131) for no responses. It infers that people who have garbage disposal system have less chance of getting an infection and suffering from water borne diseases (Ntajal et.al, 2023) than those who do not have a system of waste disposal. However, no such relation was found in the case of water-logged areas and water-borne diseases. Improper waste disposal were associated with stomach problem in India (Patel et.al, 2020). Therefore, this study recommends proper waste collection in each village and one waste recycling unit installation for 4-5 villages as a measure to minimize diarrhea, typhoid, and other stomach-related infections. Although, no significant impact of water-logged areas and water-borne diseases was found in this study. However, this study proposes the treatment of drainage water before letting in ponds to get rid of foul smells and solid waste.

During the Survey, people were asked why we suffer from typhoid, diarrhea, and viral hepatitis. Although 92.07 % of respondents heard about the mentioned diseases, however, only 15.6% could reply that water contaminated with microbes caused these diseases (figure 9). Therefore, this study found that awareness about waterborne diseases was very low among people. Several studies found that generally people do not know the real cause of diseases. (Arya et al, 2019). Therefore, work on increasing awareness levels through TV ads, special talk shows, some plays in villages, information through posters, pamphlets, trained Asha workers, etc should be encouraged by the health department. Such actions will support meeting the targets of the SDGs by 2030.

Conclusion

The study found that the availability of public drinking water supply was in 100% of villages in the study region (e- jalsakti, Govt. of India). Improved drinking water sources and improved sanitation facilities were available to 96.08% and 94.05% of households respectively. Handwashing facility was available in 100% of households. Therefore, it can be concluded that the study region is very near to meeting the standards of WASH i.e.> 99% by 2030. Major risk factors determining waterborne diseases in the study region are location of drinking water source, water quality perception, Daily usage of water, RO usage, Open drainage, improper waste disposal, and shortage of public supply water.

As waterborne disease occurrence, indicates bacteriological pollutants in water, therefore, it is highly recommended to conduct routine bacteriological testing of drinking water, especially in illegal colonies to avoid outbreaks. Health guidelines can be introduced especially during the onset of summer seasons such as April and May. Before the rainy season, an extensive survey of drinking water pipelines and sewerage pipelines is necessary to identify the breakage and maintenance of pipelines in the study region. In addition, increasing awareness regarding disease can be a precautionary measure towards disease as witnessed during covid 19. Therefore, introducing health as a curriculum in educational institutes to all students can bring big changes in people's sanitation and hygiene practices. Further, closed drainage, and waste disposal mechanism for each village is necessary to combat waterborne disease effectively and meet sustainable development goals 3, target 3.3 by 2030.

Conflict of interest

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