ISSN No:-2456-2165

# Knowledge & Awareness of Safe Drinking Water & Impact of Chlorine Treated Water on the Incidence of Waterborne Diseases: A Cross Sectional Study at Rohingya Settlement, Kutupalong, Cox's Bazar, Bangladesh

Mohammad Abdul Mazed
Master of Public Health, University of Creative Technology Chittagong, Chattogram, Bangladesh, Bachelor of Civil and Environmental Engineering, Shahjalal University of Science and Technology, Sylthet, Bangladesh. Post Graduate Diploma on Project Management, A Humanitarian aid worker

**Abstract:- Safe and widely accessible water is critical for people's health. Due to the violence against their ethnic group in Myanmar, an estimated one million Rohingyas have fled. They are currently residing in a makeshift settlement on the steep terrain of Cox's Bazar, where there are insufficient water and sanitary services, which has led to the spread of diseases like cholera, typhoid, and diarrhea. This is a descriptive type of cross-sectional study that reports socio demographic characteristics, knowledge & awareness of potable water and the effect of chlorinated water on the prevalence of waterborne illnesses at Rohingya settlement, kutupalong, cox's bazar, Bangladesh. A pre-tested, data collection has been done properly using a semi-structured, modified interview administered questionnaire. The use of non-probability purposive sampling techniques has been tested after participant face-to-face interviews. The result shows that respondents were 38% male and 62%) female. A total of 92% people were receiving sufficient water from Chlorinated zone and 86% people were receiving water from non-Chlorinated sources. 124 respondents (83%) were found familiar with water born disease in Chlorinated zone and 113 respondents (75%) were found familiar with water borne diseases in non-chlorinated area. As water borne diseases, majority of the respondents (235 &163) mentioned Diarrhea and secondly Typhoid in this study. It was found that 25% from Chlorinated zone and 55% from non-chlorinated zone respondents' any family member/s suffered by any water borne diseases during last 3 months. A summary can be concluded from the analysis that, chlorinated water supply ensure much more water available and has significant impact on reducing the rate of water borne diseases comparatively.**

## I. INTRODUCTION

Safe water is crucial for preserving public health, whether it is used for drinking, residential usage, food production, or recreational activities. A nation's economic growth can be considerably boosted while reducing poverty with improved water supply, sanitation, and water resource management. Maintaining water quality is very important for public health. Human health and the quality of drinking water are inextricably linked. As a result, one of the most critical public health goals has been guaranteeing clean drinking water [1]. Safe water is defined as water that is devoid of pathogenic microbes, hazardous chemical contaminants, is pleasant to taste, and is suitable for residential use [2].

The problem of water contamination is an unending difficult. Thousands of people were dying because of many diseases' cholera, typhoid fever, and amoebic dysentery, during the 20s and 30s which are transmitted through polluted drinking water. One of the most significant advancements in water management of the 20th century may be seen in the use of chlorine to disinfect drinking water [4]. 32 camps holding an estimated 1.16 million Rohingya who were first evacuated from Myanmar are in the Cox's Bazar area of Bangladesh. The number of newly arriving Rohingyas living in unplanned settlements has raised the need for humanitarian aid, including housing, potable water, and sanitation. To meet the demands of the camp residents, a total of 50,087 emergency latrines and 6057 water stations have been constructed. The Bangladeshi government and humanitarian agencies have administered vaccines to 900,000 adults and kids to prevent cholera infections and about 263,000 kids were examined for malnutrition. The unplanned and unprompted settlement of Rohingyas at a very high density in the hard steep terrain of Cox's Bazar has created an unparalleled challenge for water, sanitation, and hygiene (WASH) demands [13].

Some of the insects, referred to as vectors, can breed in household drinking water containers and prefer clean water to dirty water for breeding. Covering water storage containers is an easy way to stop bugs from laying eggs, insects from reproducing, and feces from contaminating your water. Currently, 29% of refugees receive their safe water from piped distribution systems that have been chlorine-treated. The remaining refugees access their water supply through tube wells. But according to a recent study, water from 52% of tube wells still contains trace amounts of E. coli. To meet their needs, water trucking is still necessary in the Rohingya refugee camps in Teknaf Upazila, especially during the dry season [6].

ISSN No:-2456-2165

Various kinds of physical, chemical, and biological agents can contaminate water. Infections connected to water can spread via four main pathways. These include the insect vector route, the water-borne route, the water-washed route, and the water-based route [3]. Poor sanitation practices in slum areas cause water contamination, which in turn causes water-borne diseases [4]. Fecal contamination of food and water is a widespread issue in underdeveloped urban and rural communities. Children's hands, among others, spread microorganisms to household items, water, food, which may be stored or transported, to other children's hands, and ultimately to the mouths of any susceptible individuals [5].

Diseases connected to water and feces are still a major health concern for Bangladeshis. Human health is impacted by the spread of human and animal excreta through a variety of channels, including foods, sewage, drinking water, and indirect contact [7]. Water contamination is a factor in many different diseases. They include a variety of illnesses like diarrhea, typhoid, dysentery, hepatitis, jaundice, and skin conditions. Of all the water-borne illnesses, diarrhea is the most common. Diarrhea is a major cause of morbidity and mortality, particularly in children under the age of five, in less developed nations [8, 9]. 1.8 million of the nearly 2.2 million deaths caused by diarrheal diseases that occur each year are in low-income nations [10].

In Bangladesh, diarrheal diseases account for 2% of the country's under-5 mortality rate, 3.3% of which occurs in urban areas and 1.6% in rural ones [11]. Typhoid fever was initially believed to be primarily transmitted via direct fecal-oral transmission. However, one more thing has been added recently. Indirect transmission is caused by environmental factors, such as water contamination and inadequate sanitation [12].

The study assumed that Supply of treated (chlorinated) water will have less health impact rather than non-treated water regarding water borne disease to the settlement.

The findings of this study will assist the management of the camp and the numerous organizations present in providing long-term water interventions to enhance the wellbeing of the Rohingya refugees in Cox's Bazar. The findings will also be helpful information and direction for international research and development teams tackling problems with water security in refugee camps around the world. The main purpose of this study was to increase knowledge and awareness among those in various communities at the Rohingya Refugee Camp in Bangladesh's Cox's Bazar region, where health promotion is still a contentious issue.

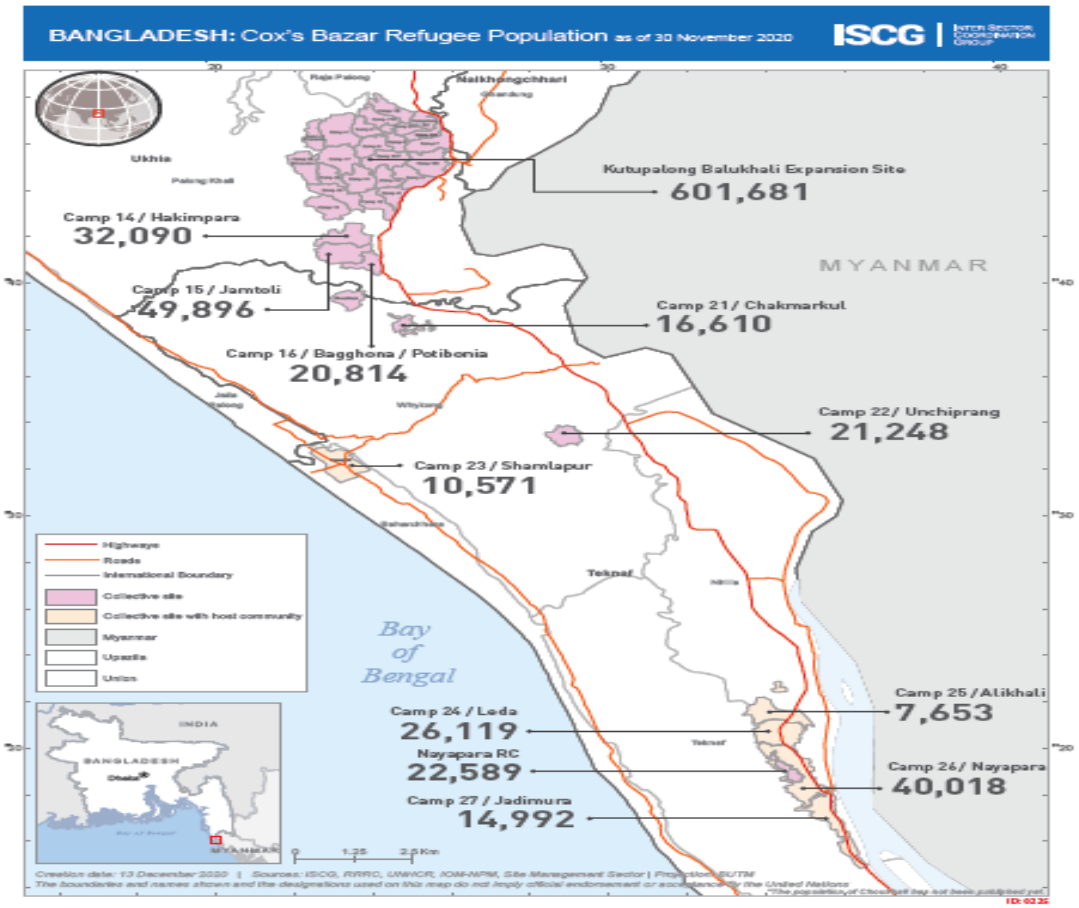


Fig. 1: Refugee camp demographic map

ISSN No:-2456-2165

## II. LITERATURE REVIEW

In the camps, 29% of the Rohingya refugees now have access to chlorinated water thanks to piping distribution networks that the Sector is building as part of the Water Network Plan. The remaining people still use handpumps in tube-wells to acquire water. Monitoring of water quality reveals that e-coli contamination is present in 52% of handpumps [6]. More than 60% of refugees registered with the UN reside in nations with freshwater availability per person that is less than half the worldwideaverage. Such influxes of refugees can accelerate the depletion of the host country's water resources.

Several studies have found that the pressure from refugee influxes has put the water supply in the host countries under stress. For example, before the Syrian refugee influx began in 2011, numerous parts of Jordan had already reached their maximum sustainable groundwater extraction levels.

As the number of Syrian refugees living in Jordanian ca mps rises to nearly two million, the pumping of groundwater needed to meet the needs of one of the densely populated ref ugee camps has accelerated, causing an overall drop in groun dwater levels across the country. leading to a significant reduction [14].

To maintain the public's health, water quality upkeep is crucial. Human health and the standard of a person's water supply are closely related. Hence, ensuring that there is clean water to drink has emerged as one of the top objectives for public health [15]. Including piped water, there is no water source that is uncontaminated by microbes. In the world, 1.8 billion people consume contaminated water that is harmful to drink. In Africa and South-East Asia, the kind of pollution is most common [16].

Chlorine began to be widely used to disinfect drinking water in Chicago, USA, in 1908 AD after being used to disinfect water in a small number of locations in 1810 AD and showing amazing results in eradicating the pathogens of many diseases [17]. There are currently 4.2 billion people without access to safely managed sanitation services and 2.2 billion without access to services that manage drinking water safely. People's health is impacted by frequent unsafe hygiene practices. With more than 297 000 children under the age of five dying each year from diarrheal diseases brought on by poor sanitation, poor hygiene, or contaminated drinking water, the effect on child mortality rates is devastating [7].

In some parts of the world, there is little or no awarene ss of good hygiene practices and their role in reducing the sp read of disease. Yet, even when individuals are aware of proper hygiene habits, they do not have access to the soap, clean water, or sanitation facilities they need to make the necessary adjustments to protect themselves and the wider community [18].

The impact of global access to WASH on global health will be profound. The 829,000 people who are currently dying each year could be saved from diseases directly caused by unsafe water, inadequate sanitation, and poor hygiene practices, and we can also significantly reduce undernutrition in children and help reduce physical and mental malnutrition. Today 50% of children's malnutrition is linked to unsafe water, inadequate sanitation, or poor sanitation. [18].

According to studies, even 20m2/person does not provide adequate room for infrastructure such as water and sewage treatment facilities. There are issues with water quality and delivery, with many people having to trek long distances through densely packed settlements to reach a water source. All of this was detailed in a report on the difficulties faced by Rohingya refugees owing to a lack of sanitary facilities and safe and appropriate water supply [14]. Water scarcity causes unsanitary conditions, leading to water-borne diseases like AWD.

More than 64,000 cases of AWD were reported in Apri l 2019 alone, of which more than 40% were children under 5 years of age [14]. To address the initial crisis, UNHCR and its partners developed WASH facilities between 2017 and 2019. By 2019, an improved water supply was accomplished by chlorinated water networks, as well as bigger pit latrines. Fifty-five networks have now been deployed, and more are being built [14].

Because of the overcrowding and subpar water, sanitation, and hygiene (WASH) procedures at the camps, particularly at the Kutupalong extension sites, the refugees are exposed to serious public health concerns [14]. Interventions in water, sanitation, and hygiene help decrease intestinal parasite infections, which cause diarrhea and have synergistic effects with malnutrition [19]. Many studies have shown how access to clean water, proper hygienic conditions, and sanitary facilities might predict child development and malnutrition [20].

The sustainable acquisition and acceptance of water, sanitation, and hygiene technologies and practices are significantly influenced by behavioral variables. While water, sanitation, and hygiene programs have the potential to be extremely beneficial, some of their success depends on context and behavior modification. The establishment and operation of water and sanitation infrastructure must be followed by the dissemination of information on how to utilize them and a shift in sustainable behavior [21]. To accomplish improvements, it is also vital to promote good hygiene practices and maintain and replace outdated services and facilities [22].

Poor water systems, utilities, sanitation, and hygiene are particularly detrimental to low-income nations [23]. Poor families would benefit most from improvements in water, sanitation, and hygiene within the first 50% of coverage; nevertheless, similar interventions are also required for richer households [24]. Every year, water-borne diseases affect hundreds of millions of people, especially those living in developing countries without safe and accessible water.

ISSN No:-2456-2165

Diarrhea is the leading symptom among the seven most common water-borne diseases worldwide.

The latest research shows that diarrhea is the second le ading cause of death in children under 5 years old, causing more infant deaths than malaria, AIDS and measles combine d. Although there have been hundreds of thousands of deaths, the future is yet hopeful. The worldwide water and sanitation issue, in the opinion of experts, may be resolved within our lifetimes [25].

Water-borne diarrhea affects children in developing countries, accounting for 3.6% of global disease burden and causing 1.5 million deaths annually. The World Health Organization estimates that 58% of this burden is due to a lack of safe drinking water, sanitation, and hygiene (WASH) [26].

The Rohingya outcasts face a wide range of difficulties, including those pertaining to water and sanitation. Thus, an important field of research is the problem of water security within the camps. To reduce the lack of access to safe drinking water, it's important to detect source gaps, research the frequency of health effects, and emphasize the attitudes and levels of knowledge that exist within the local population.

## III. AIM OF THE STUDY

General Objective: knowledge & awareness of safe drinking water & impact of chlorine treated water on a cross-sectional study of waterborne disease incidence at Rohingya settlement, kutupalong, cox's bazar, Bangladesh.
Specific Objectives:

- To find out knowledge & awareness on safe water among the respondents.
- To determine the socio-demographic characteristic of the respondents.
- To keep track of the incidence of diseases that are disseminated through communal water use of both chlorinated and non-chlorinated sources

### *A. Research Question:*

What about the current status of knowledge & awareness of safe drinking water & impact of chlorine treated water on the incidence of waterborne diseases among Rohingya Refugees?

## IV. JUSTIFICATION OF THE STUDY

### *A. Justification:*

Waterborne infections affect hundreds of millions of people each year, particularly those who live in underdeveloped nations without access to clean, safe water. The primary symptom of the seven water-borne illnesses that are most prevalent worldwide is diarrhea. According to a recent research, diarrhea kills more children than malaria, AIDS, and measles put together. It is the second greatest cause of mortality in children under the age of five. There is still hope for the future despite the hundreds of thousands of deaths. Researchers are hopeful that the global water and sanitation crises may be resolved.

Water-borne illnesses can significantly affect local and global economies. Individuals who suffer from water-borne illnesses typically incur fees and frequently shoulder a heavy financial burden. The developing world is where this is especially true. The financial losses are mostly brought on by things like the expense of medical care and medicines, the cost of transportation, the cost of specialized food, and the loss of labor. To pay for medical care at the hospital, many families are forced to sell their land. A family typically pays 10% of their monthly income per afflicted member. Each year, these water-borne illnesses are thought to cause 502,000 fatalities from diarrhea [28].

As we know, waterborne diseases are illnesses caused by microscopic organisms, like viruses and bacteria that are ingested through contaminated water or by meeting feces. These illnesses would not exist if everyone on the earth could practice good hygiene and had access to clean water. Throughout the past 20 years, governments, Organizations, and communities have achieved significant progress in the fight to eradicate water-borne illnesses.

### *B. Operational definition:*

Rohingya Settlement: Due to its location, high concentration of refugees, quantity of camps, and effects of temporary settlements on the land cover, Ukhiya, an Upazila (Fig. 1) in Cox's Bazar district, was selected as the research region. It is located between 92°03' and 92°12' east longitude and between 21°08' and 21°21' north latitude. Around 60% and 40% of the Rohingya refugees in Ukhiya Upazila are women and children, respectively, making up most of the population. [29] [30]

The Ukhia Upazila and Kutupalog Refugee Camp are in figure index map (A), and they share a border with the Bay of Bengal to the west, Teknaf to the south, Ramu to the north, and Myanmar to the east. Ukhiyah district is in Bangladesh and is depicted as a black rectangle on the index map (B). Lastly, Bangladesh's location in the world is depicted on the index map (C).

Water sources at Rohingya camps: The majority of families in the Rohingya refugee camps report using tube wells or hand pumps, 20% tap stands or pipe water, 5% water tanks, fewer than 1% protected and unprotected dug wells, and less than 1% carts with tiny tanks as their primary water sources. [14]. There are 26 refugee camps in Ukhiya Upazila, home to 152,908 homes and 700,577 people in total. [31]

- **Chlorinated Water:** Currently, 29% of refugees use a pipe system to access chlorinated water [6]. When chlorine is introduced to water, it kills bacteria by rupturing their membrane. Yet only direct contact with chlorine with living things makes this process effective. The death of organisms by chlorine takes time. Chlorine needs at least 30 minutes of contact time with water when temperatures are higher than 18 °C. As a result, it's usual practice to add chlorine to water when it enters storage tanks or long distribution lines so that the chemicals have time to work their cleaning magic before the water gets to the customer. The pH level should be between 7.2 and 6.8 and the turbidity should be 5NTU.

ISSN No:-2456-2165

A modest public water supply should have between 0.2 and 0.5 mg/l of residual chlorine (FRC), which is the recommended quantity. At least 30 minutes must pass with water and chlorine to disinfect.

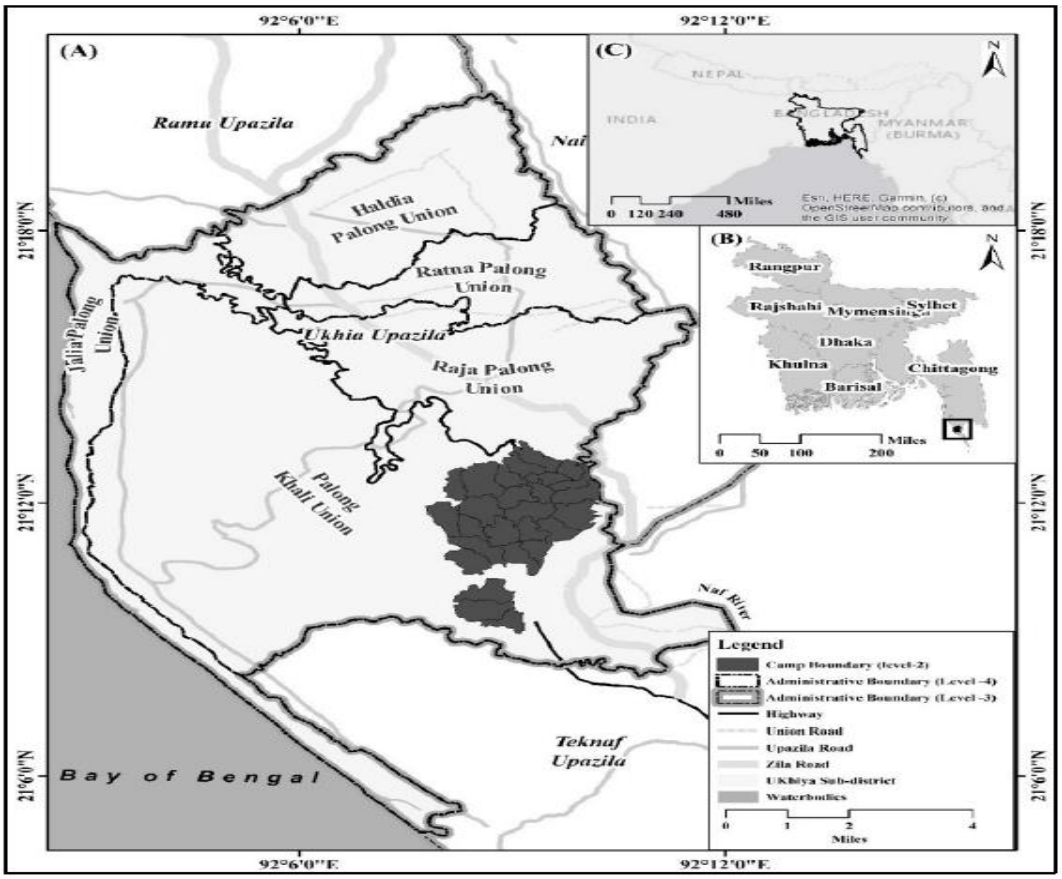


Fig. 2: Rohingya settlement

- **Water borne diseases:** Worldwide, water-borne illnesses continue to be the number one cause of morbidity and death in humans. Waterborne illness prevention is possible in over 95% of cases, and its eradication is a particular Millennium Goal target [33]. Viruses, bacteria, and other microbes can be consumed by contact with polluted water or feces and cause illnesses known as "water-borne" disorders. Giardia, Typhoid, Cholera, Dysentery, Hepatitis-A, E. coli, and Salmonella are examples of illnesses that may spread through water [34].

- **Diseases:** cholera, diarrhea, dysentery, hepatitis A, etc. are directly linked to the unhygienic and contaminated potable water[35].

- **KOBO Collect:** Kobo Toolbox is an open-source, free program that anybody may use to collect data from mobile devices. Mobile technologies like tablets and smartphones may be used in the field to collect data, in addition to paper and computers. faster. Before examining the data, there is no need to move it from paper to a computer. Many analytics may be used right away after data gathering. Yours is a better fit. Enumeration mistakes can be reduced by doing real-time data validation while data is being collected. There is no transmission fault. Even in the most difficult circumstances and distant areas, it can be quickly installed, it operates offline, and it is simple to use. Paper forms can be used as backups and combined with other data if all else fails.

It offers user-friendly support for the whole data collecting cycle, including form creation, data collection, and analysis. [36]

ISSN No:-2456-2165

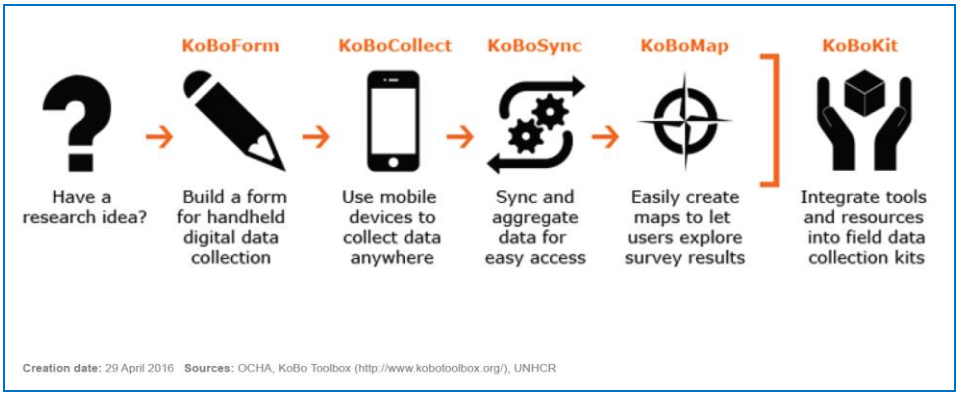


Fig. 3: Kobo tool sequence

## V. RESEARCH METHODOLOGY

A. *Conceptual Framework*

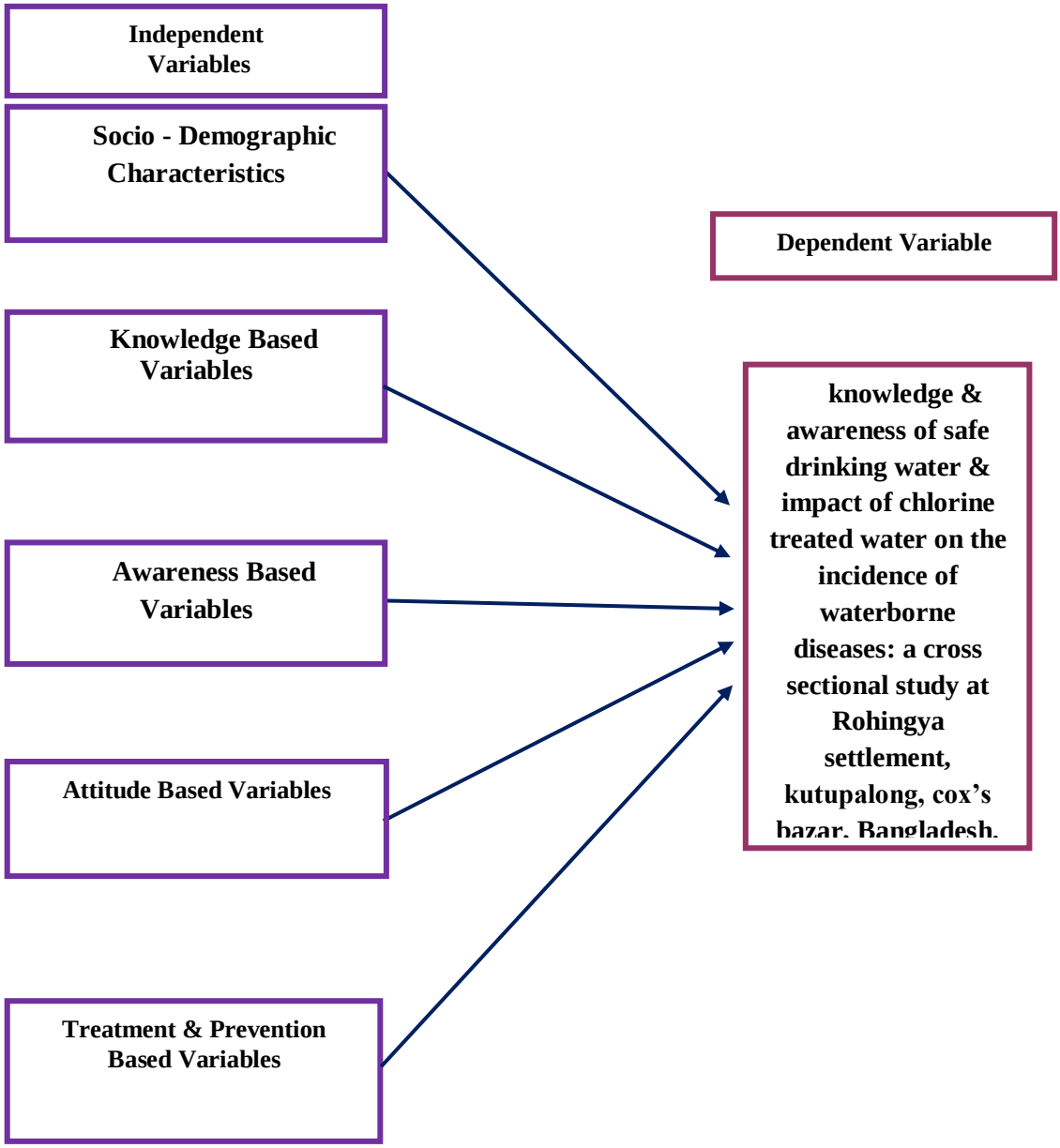


Fig. 4: Conceptual framework

*B. Study Design:*

It was cross-sectional research that was descriptive in nature. To gather data effectively, KOBO technologies were used in conjunction with a pre-tested, semi-structured, and modified interview administered questionnaire. After conducting face-to-face interviews with the participants, non-probability purposive sampling techniques have been tested.

*C. Study Population & Area:*

Different populations of different ages including both males and females of Rohingya Refugee Camp, Cox's Bazar, Bangladesh were the target population and area of the study. The study is conducted at camp3 of two block A & B of around 1000 families receiving treated supply of water and two blocks C & D of around 1000 families receiving non-treated water. The study covered around 2000 families of 9000 people at camp3 of kutupalong, Coxbazar.

*D. Study Period:*

This study started on January 21 and continued until June 21.

*E. Sample Size Calculation:*

The following formula was used to calculate the sample size:

$$n = \frac{z^2pq}{d^2}$$

Where, n = sample size

z = standard normal deviate usually set at 1.96 which corresponds to 95% CI.

p = prevalence of the target populations (50%)

d = Acceptable error limit, usually set at 5%

The samples total 384 in size. Given of funding restrictions, the pandemic crisis, and time constraints, the researchers decided to take 300 samples.

*F. Inclusion & Exclusion Criteria:*

➢ *Inclusion Criteria:*

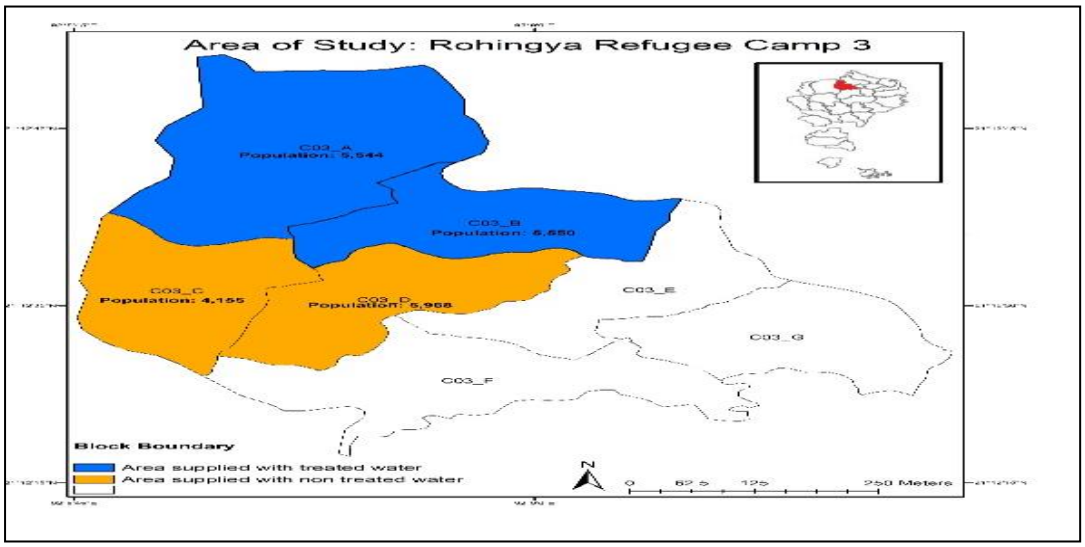


Fig. 5: Study Area

People who have voluntarily joined or participated in the study and have given their consent.

➢ *Exclusion Criteria:*

Those who were unable to provide information because of a physical or mental illness or a disability and felt unwilling to participate.

*G. Data Collection Tools:*

To properly collect data, KOBO has been used in conjunction with a pre-tested, semi-structured, and modified interview administered questionnaire.

*H. Sampling Technique:*

Non-probability purposive sampling methods was followed.

*I. Data Collection Technique:*

By following face to face interview of the participants.

*J. Data Analysis & Management Plan:*

To eliminate missing or incomplete data, all interview questionnaires were reviewed for completeness, correctness, and consistency. Before analysis, the data was once again verified, cleared, and modified. The data was examined using sophisticated Excel software. The results were interpreted using descriptive statistics.

*K. Limitations of the study:*

The following were the limitations of the study:

- The time allotted for the research was insufficient, especially in the COVID circumstance, to finish it adequately and deal with the real-world images.
- Due to the inclusion and exclusion criteria, there may be some biases in the results.

ISSN No:-2456-2165

*L. Quality Control & Quality Assurance:*

Following measures have been taken for quality control & quality assurance,

- Regular help and direction from the supervisor were obtained for performing the interview.
- The researcher himself oversaw collection and analyzing the data.
- Prior to data collection, a report was created with the respondents.
- Data were collected by skilled data collectors with specific training in these kinds of face-to-face interviewing.
- For dependability, data were double-checked.
- A questionnaire that is semi-structured is employed.
- Questionnaire described in both English and Bengali languages for better understanding of respondents.
- due to inclusion and exclusion criteria, biases are present to some extent.

*M. Ethical Consideration:*

The University of Creative Technology Chittagong (UCTC) ethics board gave its clearance for the study, which was carried out. In their native language, participants received assurances on the study's purpose, potential risks, if any, and confidentiality. Codes in the secured preserved computer data files molded the personal identity information of the study participants. Paper forms containing personal identifiable information were kept in a secure location. Data files for statistical analysis were created without any personal identifying to guarantee the privacy of any information regarding research participants.

## VI. RESULT

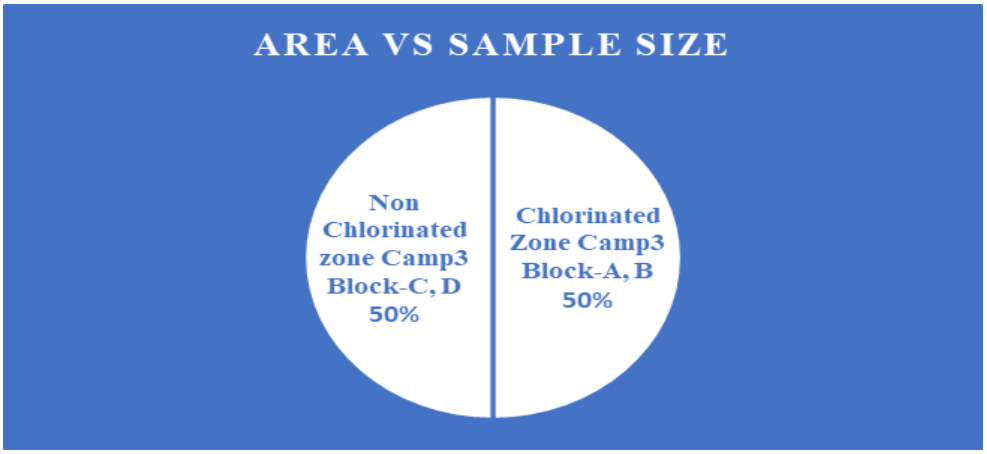


Fig. 6: Area vs sample size

The pie chart represents the camp & zone vs size of sample considered during the survey to collect data for the analysis. It describes that, study is conducted at camp3 where block A & B fall under chlorinated zone and block C & D fall under non-chlorinated zone. A total of 300 hundred sample were selected for the assessment where the size of sample for both chlorinated and non-chlorinated zone remain constant (50% on both area). In conclusion, the study was conducted in same camp of four block with equal size of samples for data collection and further analysis.

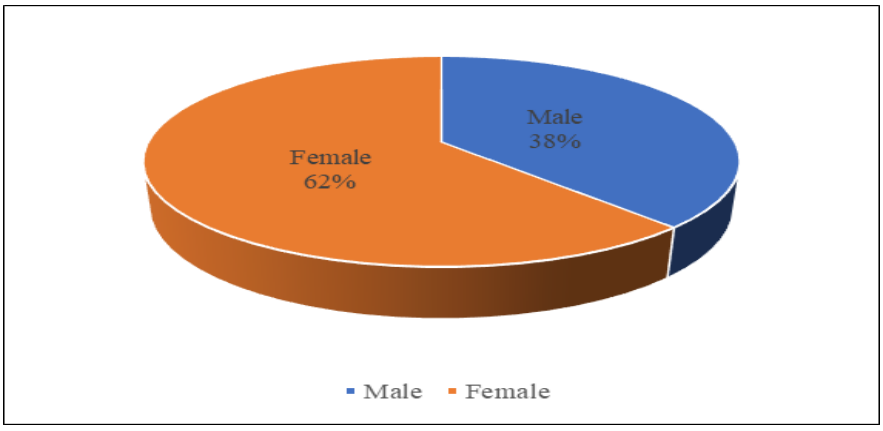


Fig. 7: Type of respondent

The bar chart shows the number of males and female were participated in survey data collection process from January 2021 to June 2021. It shows 114 Male and 186 Female out of 300 sample of household who responded during the survey. On the other hand, a total of 38% male and 62% female were participated during the survey from community. In short, A higher percentage of female were responded compared to male respondent during the survey.

ISSN No:-2456-2165

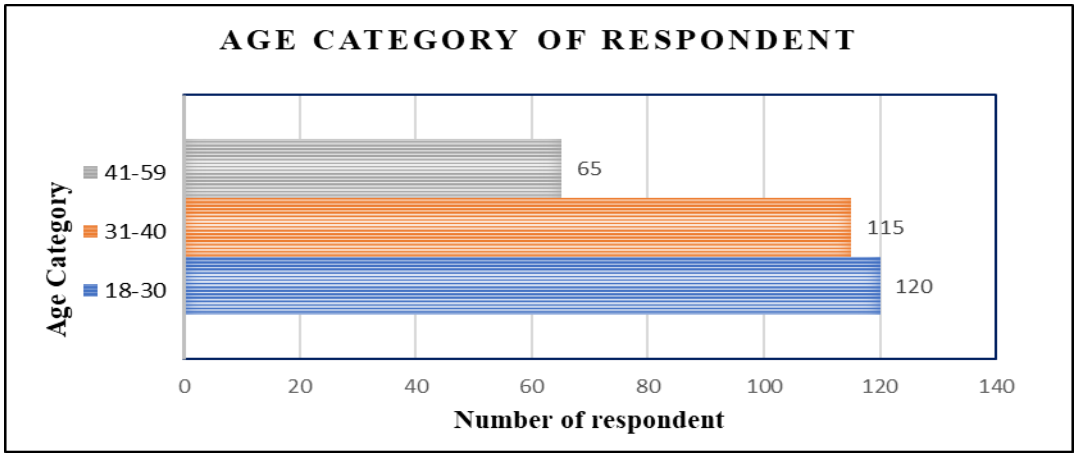


Fig. 8: Age category of the respondent

The histogram represents the age category of respondent participated during the survey of the study. It shows that, 18-30 years old age category respondents were 120, 31-40 years old age category respondent were 115- and 41-59-years old age category respondent were 65. Hence respondents were in the age range of 18-59 years. There was zero participant for age category of 13-17 year and 60+ years.

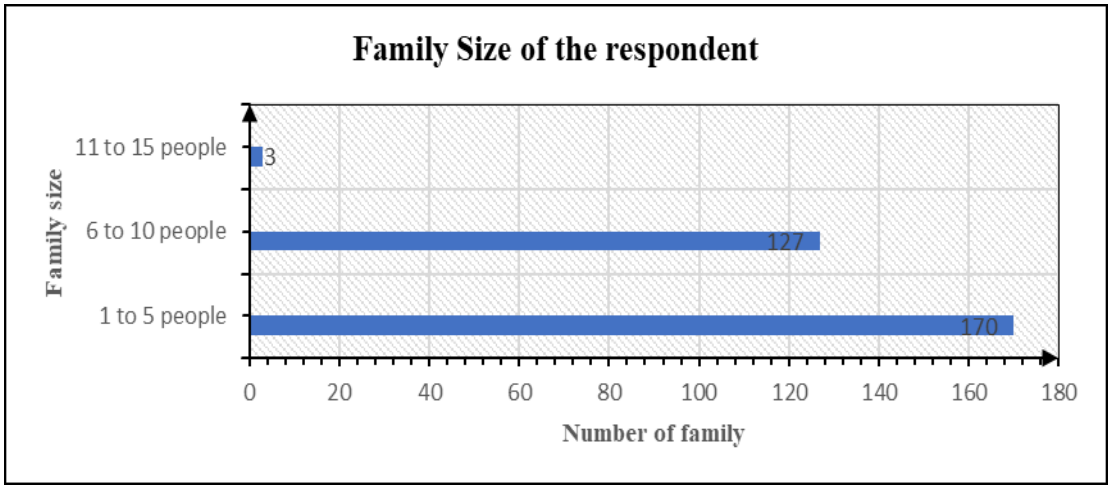


Fig. 9: Family size of the respondent

The bar chart indicates the size of family of the respondent who were participated in the survey. It clarifies that, 170 households out of 300 have family member between 1 to 5 and 127 households have family member between 6 to 10. Only three household have family member between 11 to 15. 1 to 5 people were found in 57% household and 6 to 10 people were found in 42% households. These two are the dominant factor in the population size.

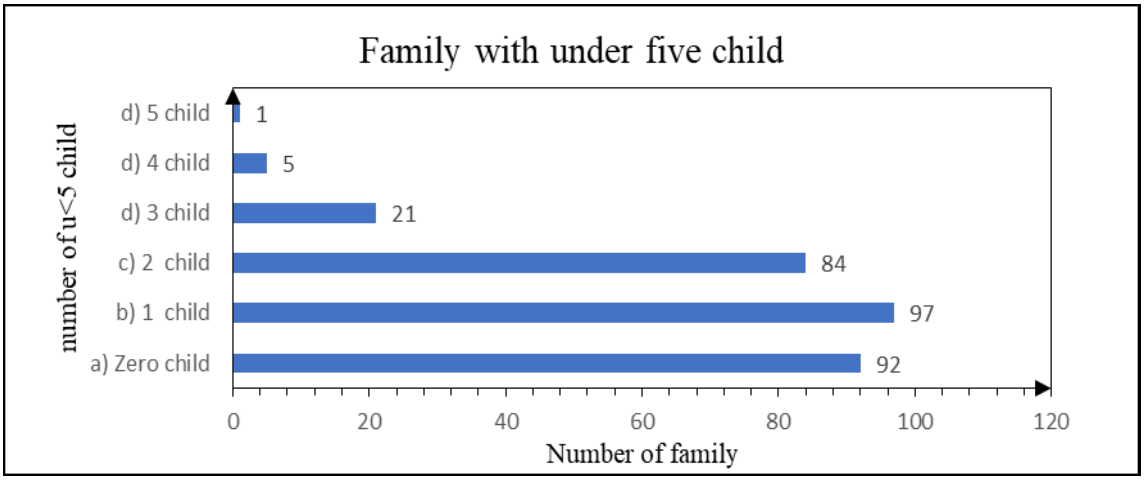


Fig. 10: Family having U>5 children

ISSN No:-2456-2165

The bar diagram shows the number of family having U>5 children in the family of respondent. It indicates that, 92 family have zero child where 97 and 84 family have under five children of one and two in each family. Three and four children were found with 21 and 5 family and only one family were found having five children. Major finding was that 31% family have zero child, 32% family with one child U>5 child and 28% family with 2 U>5 children.

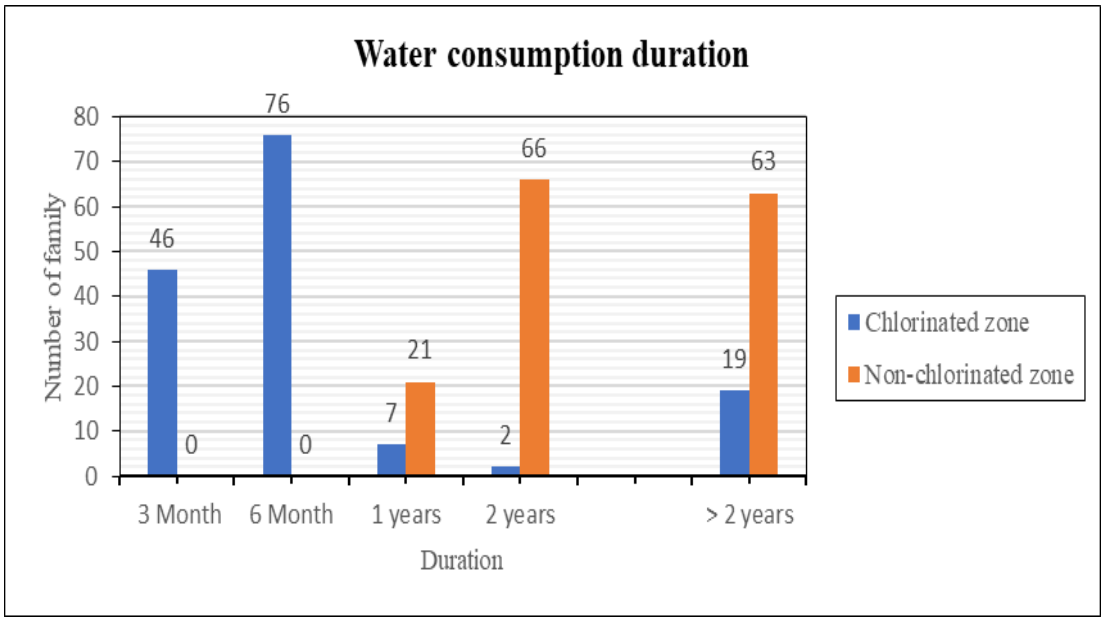


Fig. 11: Water consumption Period

The diagram below shows the period of water consumption by the families living in study area during the assessment. It describes that, a total of 122 families had been received chlorinated water from last 3 to 6 month and 28 families from more than 1 years. On the other hand, 150 families were found to consume non-chlorinated water from more than 1 years of times. More than 50% people were using chlorinated water for six month and 30% people were using for three months. Remaining 20% were using for more than six months. On the other hand, people from non-chlorinated zone were using the water from minimum one year and so on.

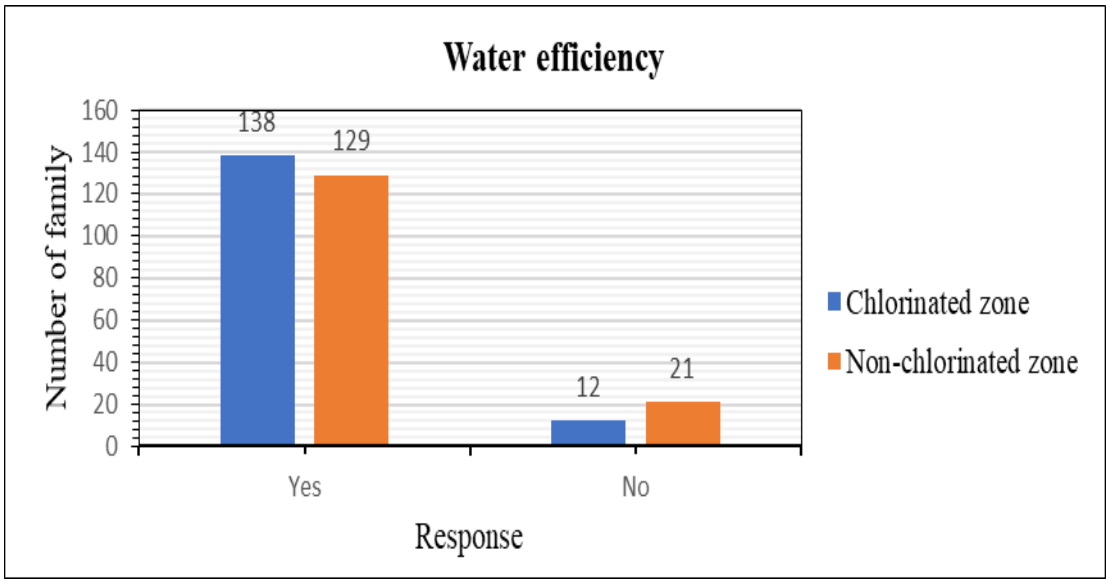


Fig. 12: Water efficiency

The chart below shows the response of water efficiency received from household level. It summarizes that, 138 family out of 150 were found receiving sufficient water and 129 out of 150 were found receiving sufficient water during the study. In percentage, 92% people were receiving sufficient water from Chlorinated zone and 86% people were receiving from non-Chlorinated zone of water source. In Conclusion, Chlorinated zone with treated water supply ensure much water available compared to non-chlorinated water.

ISSN No:-2456-2165

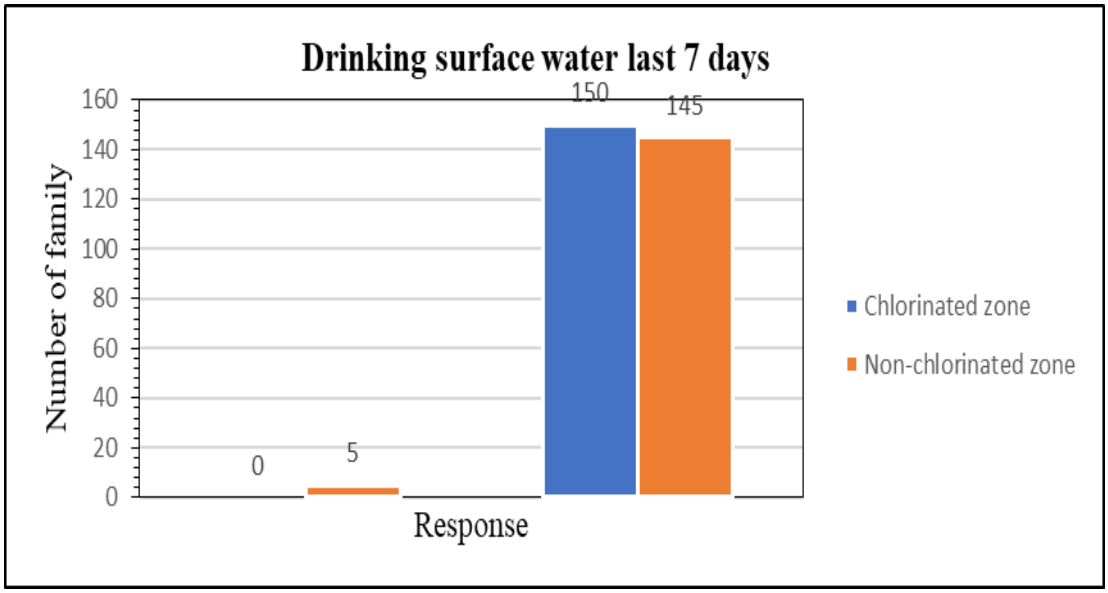


Fig. 13: Surface water using rate

The diagram shows the number of family who were drinking surface water / unsafe water last seven days from survey date. It describes that, zero family people were taking surface water in Chlorinated zone and five family people were taking surface water in non-chlorinated area. On the other hand, 150 family people out of 150 were not drinking surface water and 145 family out of 150 were not drinking surface water at non-chlorinated area. It indicates that, 3% family were found collecting drinking water from surface water source under non-chlorinated zone.

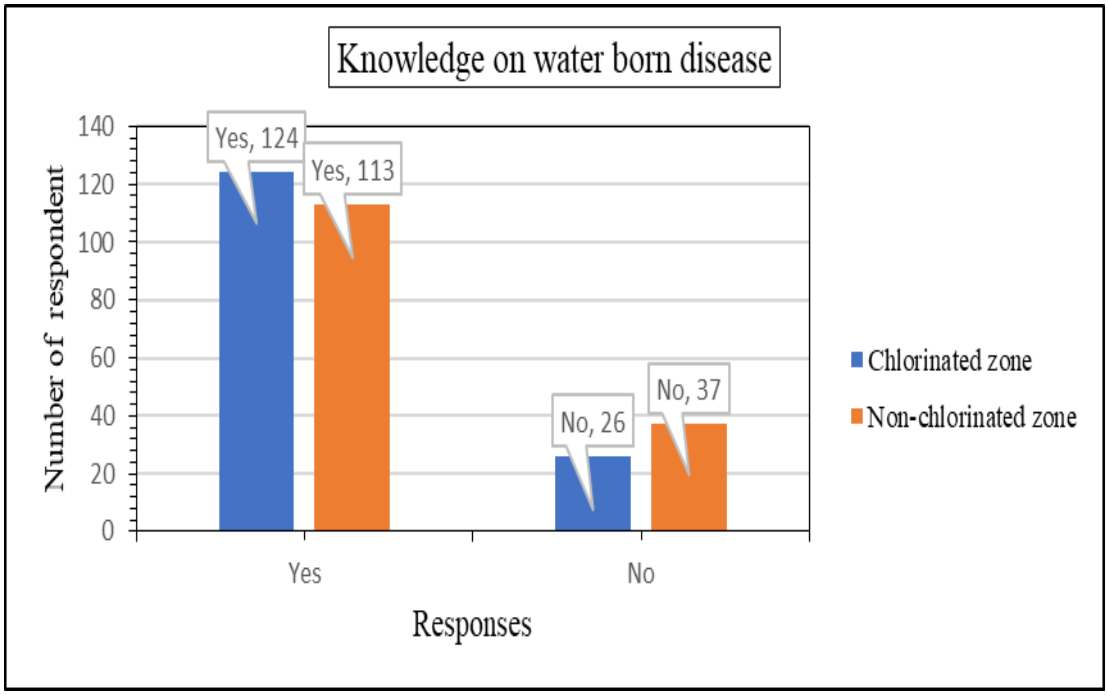


Fig. 14: Knowledge level on WB disease

The bar diagram represents the number of family having knowledge on water borne diseases. It shows that, 124 respondents out of 150 were found familiar with water born disease in Chlorinated zone and 113 respondents out of 150 were found familiar with water borne diseases in non-chlorinated area. A total of 83% respondents from chlorinated zone were found familiar with water borne diseases on the other hand 75% respondents from non-chlorinated zone were found familiar with water borne diseases.

ISSN No:-2456-2165

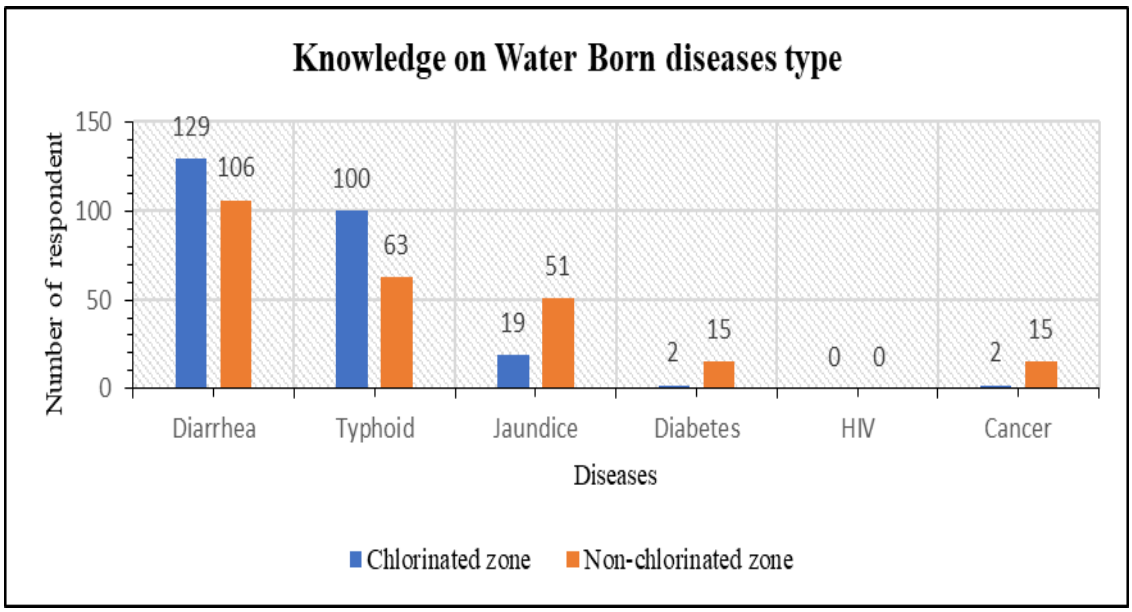


Fig. 15: Knowledge on Water Born diseases type

The bar chart represents the level of knowledge among the respondents on water borne disease from the disease list. It shows that, Diarrhea is a water borne diseases expressed by 129 family (86%) of Chlorinated zone and 106 family (71%) from non-chlorinated zone. Typhoid is a water borne disease expressed by 100 (67%) and 63 (42%) family from chlorinated and non-chlorinated zone. Jaundice is a water borne disease that was expressed by 19 (12%) and 51 (34%) family both from chlorinated and non-chlorinated zone. In short, majority of the respondent mentioned Diarrhea and typhoid as water borne disease.

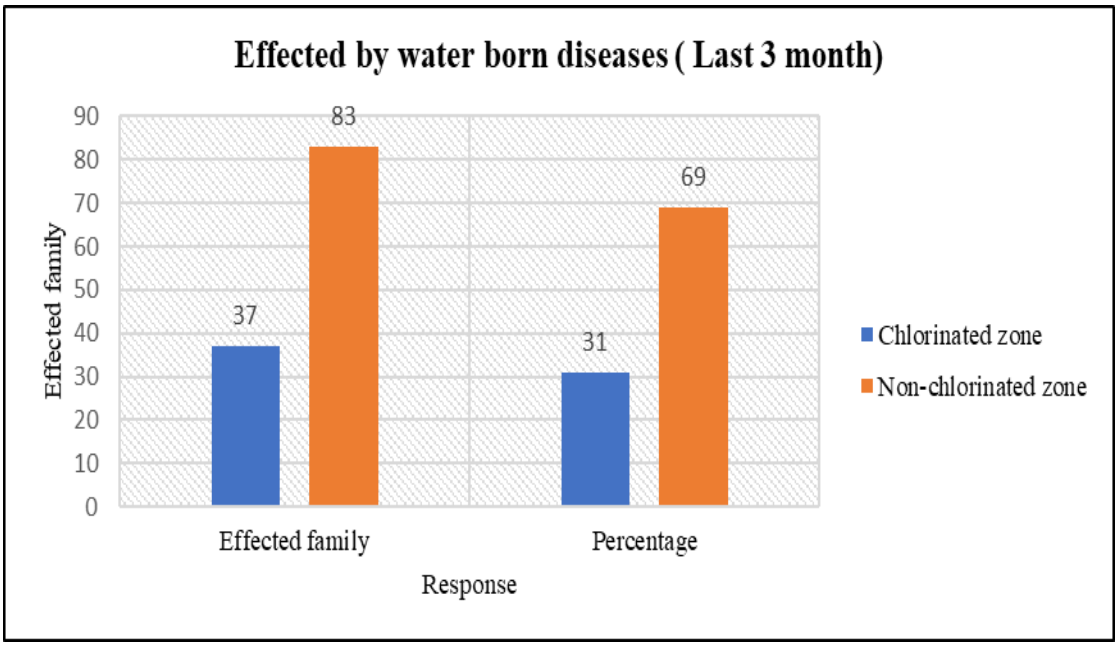


Fig. 16: Family affected by WB disease

The bar diagram shows the number of family effected by water borne diseases for last 3 month during the study. It indicates that, 37 and 83 family from chlorinated and non-chlorinated zone were affected by water borne diseases during the study period within 3 months. In percentage, 25% and 55% family of chlorinated and non-chlorinated zone were affected. In short, more family from non-chlorinated zone were affected by water borne disease compared to the Chlorinated zone.

ISSN No:-2456-2165

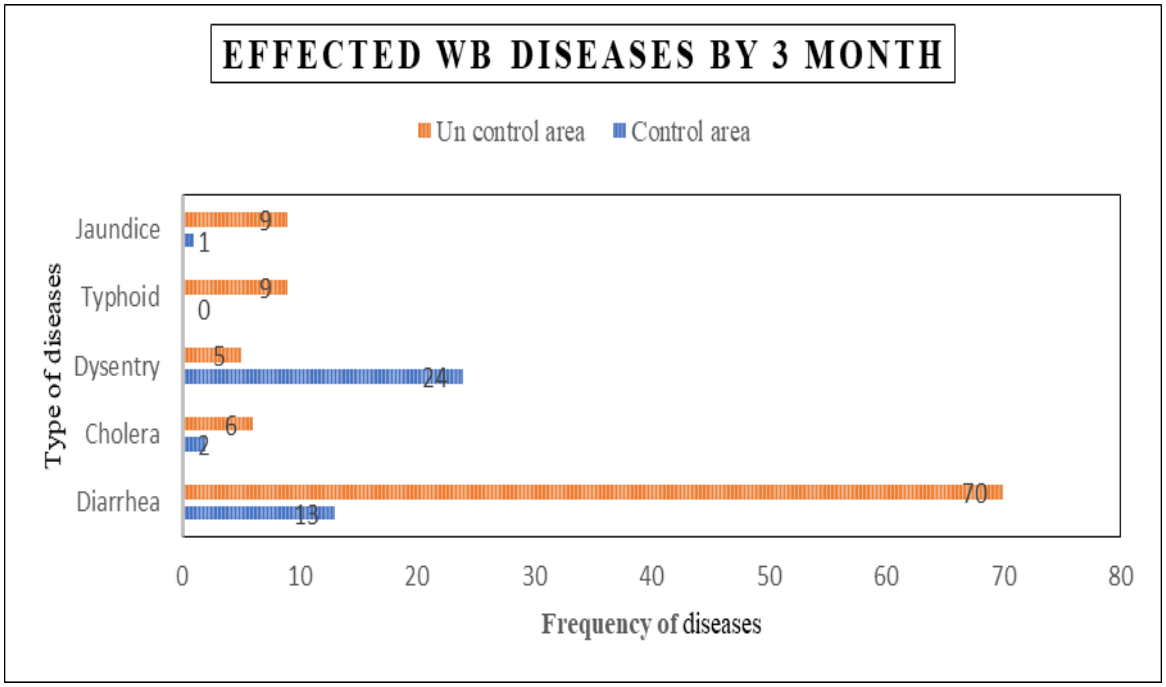


Fig. 17: WB diseases affected to family

The bar diagram shows the type of water borne disease were found as active in different degree during the study among the people. It indicates that, 13 and 70 diarrhea cases were found both at chlorinated and non-chlorinated zone, 2 and 6 cholera cases were found both at chlorinated and non-chlorinated zone, 24 and 5 dysentery cases were found both at chlorinated and non-chlorinated zone, zero and 9 cases were found both at chlorinated and non-chlorinated zone, 1 and 9 jaundice cases were found both at chlorinated and non-chlorinated zone. In short, non-chlorinated zone was more affected with diarrhea, typhoid and jaundices compare to Chlorinated zone. Major cases were found as diarrhea.

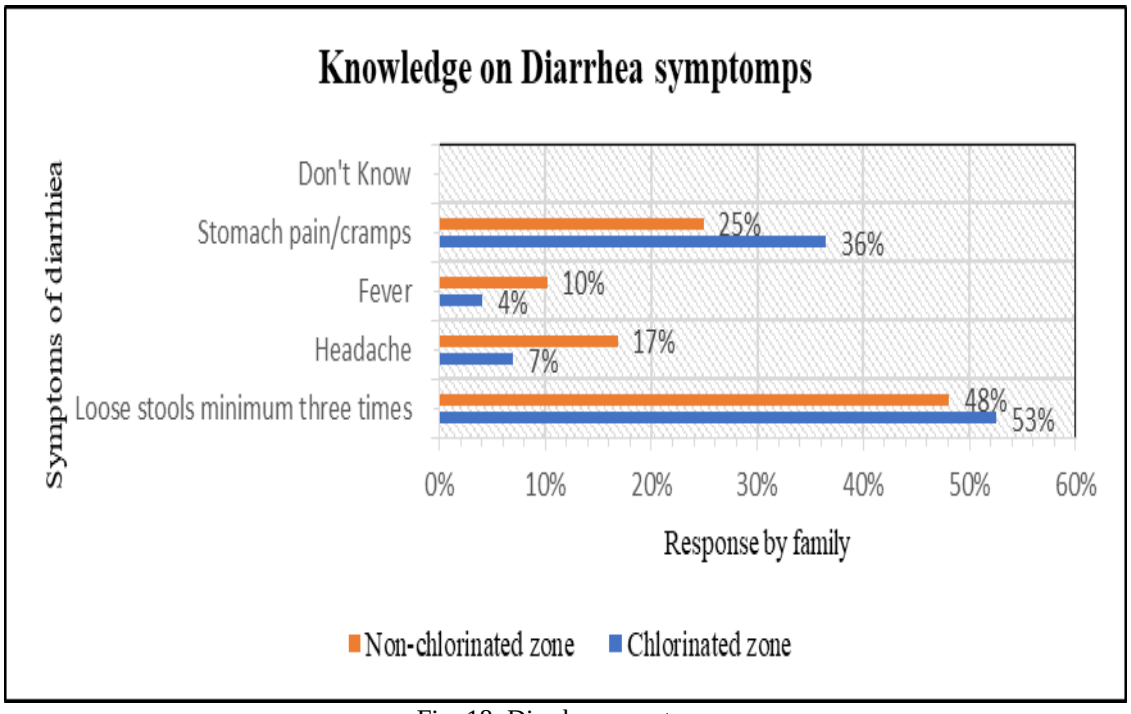


Fig. 18: Diarrhea symptoms

The bar chart represents the symptoms of diarrhea as responded by community people for both chlorinated and non-chlorinated zone. It shows that, (54 respondents) 36% and (80 respondents) 53% people from Chlorinated zone mentioned “Stomach pan” and “Loose stools minimum three times” as the major symptoms of diarrhea. On the other hand, (37 respondents) 25% and (72 respondents) 48% people from non-chlorinated zone mentioned “stomach pain and loose stools minimum three times” as major reasons of diarrhea. In short, major symptoms for diarrhea were mentioned as “stomach pain” and “loose stools minimum three times”.

ISSN No:-2456-2165

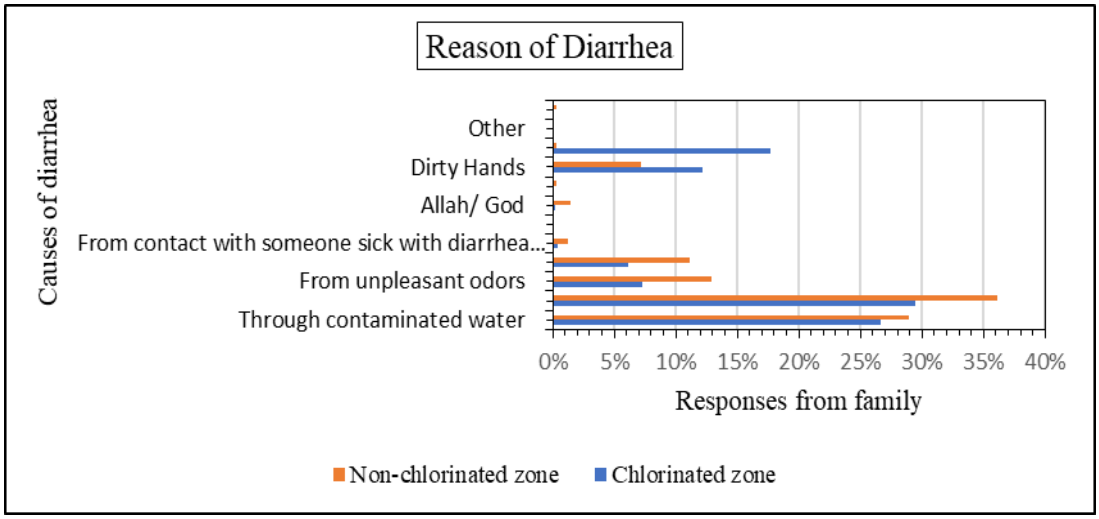


Fig. 19: Reason of Diarrhea

The bar chart shows the reasons of diarrhea came out through the survey study from community. It declares that 15, 37 and 52 respondents in percentage more than 10%, 25% and 35% people from non-chlorinated zone indicated "from unpleasant odors, contaminated water and food" as the reason of diarrhea. On the other hand 22, 37 and 37 respondents in percentage more than 15%, 25% and 25% people from Chlorinated zone indicated "open defecation, contaminated water and food" as the major reason of diarrhea. In summary, three major causes mentioned here for diarrhea are open defecation, contaminated water, and food.

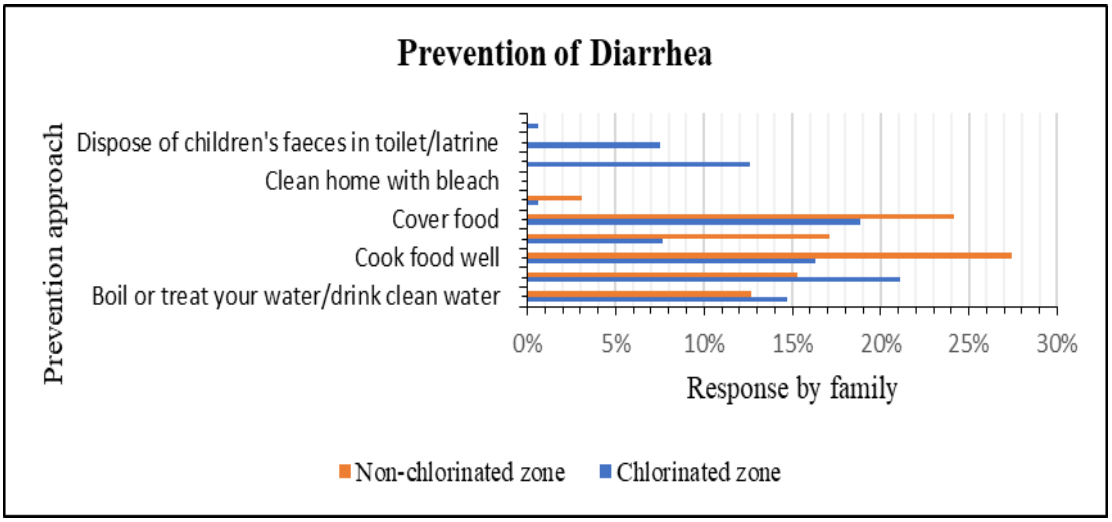


Fig. 20: Prevention of Diarrhea

The bar chart represents the way of diarrhea prevention responded by the community during the survey for both chlorinated and non-chlorinated zone. It shows that 22, 30 and 37 respondents in percentage more than 15%, 20% and 25% people from non-chlorinated zone focused 'wash fruits and vegetables", "cover food" and "cook food well" as the main way of prevention from diarrhea. On the other 22, 22 and 30 respondents in percentage more than 15%, 15% and 20% people from Chlorinated zone focused "cover food", "cook food well" and "wash hand with soap and water" as the major way out or prevention from diarrhea. Use latrine facility to defecate and dispose of children's faces in latrine were also focused in chlorinated area. In summary, the three major prevention way mentioned are covering food, cook food well and hand washing with soap and water.

## VII. DISCUSSION

The findings from previous study regarding chlorination in drinking water and impact on health to reduce water borne disease are compiled here for a better comparison.

"The intervention reduced household diarrheal illness. In Bolivia, monthly episodes of household diarrheal illness were indicating that 43% of community diarrhea was preventable by using the intervention" [37]. "We found that 28% water samples derived from tube wells were contaminated with faecal coliforms and 10.5% were contaminated with E. coli" [13].

ISSN No:-2456-2165

Using or drinking low-chlorine water has no adverse health effects and can prevent the occurrence of water-borne diseases [38]. As more water systems adopted chlorination, the incidence of waterborne diseases decreased accordingly [39]. Water from untreated water sources such as rivers, wel ls, dams, and storm tanks can contain harmful microorganis ms that can cause serious illness and even death.
Chlorine has been used to disinfect drinking water worldwid e for over 100 years. As a result, numerous water-borne illnesses like typhoid, dysentery, and cholera have been successfully managed [40].

The study was conducted with equal number of samples used (50%) for both chlorinated and non-chlorinated zone of study (Figure: 07). More than 50% people were using chlorinated water for six month and 30% people were using for three months. Remaining 20% were using for more than six months. On the other hand, people from non-chlorinated zone were using the water from minimum one year and so on (Figure: 12). A total of 92% people were receiving sufficient water from Chlorinated zone and 86% people were receiving from non-Chlorinated zone of water source (Figure: 13). 3% family were found collecting drinking water from surface water source under non-chlorinated zone for last seven days (Figure: 14).

A total of (83%) 124 respondents from chlorinated zone and (75%) 113 respondents from non-chlorinated zone were found familiar with water borne diseases (Figure: 15). Diarrhea is a water borne diseases expressed by 129 family (86%) of Chlorinated zone and 106 family (71%) from non-chlorinated zone. Typhoid is a water borne disease expressed by 100 (67%) and 63 (42%) family from chlorinated and non-chlorinated zone. Jaundice is a water borne disease that was expressed by 19 (12%) and 51 (34%) family both from chlorinated and non-chlorinated zone (Figure: 16).

A total of 37 (25%) and 83 (55%) family from chlorinated and non-chlorinated zone were affected by water borne diseases during the study period within 3 months. More family from non-chlorinated zone were affected by water borne disease compared to the Chlorinated zone (Figure: 17). A total of 13 and 70 diarrhea cases, 2 and 6 cholera cases, 24 and 5 dysentery cases were found both at chlorinated and non-chlorinated zone. Zero and 9 typhoid cases, 1 and 9 jaundice cases were also found both at chlorinated and non-chlorinated zone. In short, non-chlorinated zone was more affected with diarrhea, typhoid and jaundices compare to Chlorinated zone. Major cases were found as diarrhea (Figure: 18).

A total of 54 respondents (36%) and 80 respondents (53%) from Chlorinated zone mentioned “Stomach pan” and “Loose stools minimum three times” as the major symptoms of diarrhea. On the other hand, 37 respondents (25%) and 72 respondents (48%) from non-chlorinated zone mentioned “stomach pain and loose stools minimum three times” as major reasons of diarrhea. In short, major symptoms for diarrhea were mentioned as “stomach pain” and “loose stools minimum three times” (Figure: 19).

A total of 15, 37 and 52 respondents in percentage more than 10%, 25% and 35% people from non-chlorinated zone indicated “from unpleasant odors, contaminated water and food” as the reason of diarrhea. On the other hand, 22, 37 and 37 respondents in percentage more than 15%, 25% and 25% people from Chlorinated zone indicated “open defecation, contaminated water and food” as the major reason of diarrhea. In summary, three major causes mentioned here for diarrhea are open defecation, contaminated water, and food (Figure: 20).

It shows that 22, 30 and 37 respondents in percentage more than 15%, 20% and 25% people from non-chlorinated zone focused ‘wash fruits and vegetables”, “cover food” and “cook food well” as the main way of prevention from diarrhea. On the other 22, 22 and 30 respondents in percentage more than 15%, 15% and 20% people from Chlorinated zone focused “cover food”, “cook food well” and “wash hand with soap and water” as the major way out or prevention from diarrhea.

A summary can be concluded from the analysis and the record from different relevant studies that, chlorine water has a significant impact to reduce water borne diseases.

## VIII. CONCLUSION AND RECOMMENDATION

### *A. Conclusion*

Safe water is crucial for preserving public health, whether it is used for drinking, residential usage, food production, or recreational activities. The goal of the study was to find a better method of managing water that would increase public health protection and lower the danger of contracting illnesses transmitted through the water. The objective was to find out the socio demographic characteristic, knowledge, and awareness of Rohingya community on safe water and observing the incidence scenario due to supply of chlorinated and non-chlorinated water supply among the community. The time was considered for three months. Community People are collecting chlorinated water from supply network and non-chlorinated water from traditional hand pumps.

Supplying chlorinated water from network ensure much water available compared to non-chlorinated water. Level of knowledge was found; Respondent from chlorinated zone were found more familiar with water borne diseases than non-chlorinated zone. More family from non-chlorinated zone were affected by water borne disease compared to the Chlorinated zone. Hence, chlorinated water is more acceptable in the eyes of good health and hygiene practice.

### *B. Major Findings of the study*

- A total of 92% people were receiving sufficient water from Chlorinated zone and 86% people were receiving from non-Chlorinated zone of water source. Hence, controlled water supply system ensured more available water to the people then traditional system.
- It was found that 3% people from non-chlorinated zone were drinking surface water. It indicates the shortage of water at traditional system.

- A total of 83% respondents from chlorinated zone and 75% respondents from non-chlorinated zone were found familiar with water borne diseases.
- Diarrhea is a water borne diseases expressed by 129 family (86%) of Chlorinated zone and 106 family (71%) from non-chlorinated zone. Typhoid is a water borne disease expressed by 100 (67%) and 63 (42%) family from chlorinated and non-chlorinated zone. Jaundice is a water borne disease that was expressed by 19 (12%) and 51 (34%) family both from chlorinated and non-chlorinated zone. In short, majority of the respondent mentioned Diarrhea and typhoid as water borne disease.
- A total of 37 and 83 family from chlorinated and non-chlorinated zone were affected by water borne diseases during the study period within 3 months. In percentage, 25% and 55% family of chlorinated and non-chlorinated zone were affected. More family from non-chlorinated zone were affected by water borne disease compared to the Chlorinated zone.
- Major symptoms for diarrhea were mentioned as "stomach pain" and "loose stools minimum three times.

*C. Limitation*

- COVID19 pandemic and movement restriction is one of the major limitations for the study.
- No laboratory test was conducted for water quality check.
- Infection rate was considered based on respondent data of a limited community.
- The study was conducted for a three-month period.

*D. Recommendation*

Finally, it can be concluded that chlorinated water supply through network is reducing the rate of water borne diseases compare to non-chlorinated water source.

*E. Recommendation for future study*

- Laboratory test can be added as part of assessment to see the quality of water
- A study can be conducted for monsoon and dry period to see the incidence rate and impact of water source on health.

## REFERENCES

[1.] Hossain T, Skidder MT, Jakariya M. Assessment of public health affected by municipal piped water supply in Old Dhaka, Bangladesh. International Journal of Environmental Protection and Policy;2015, 3(2),1.

[2.] Park K. Park's textbook of preventive and social medicine;2011. Jabalpur. Banarasidas Bhanot, 463.

[3.] Drinking-water [Internet]. Who.int. 2022 [cited 11 May 2021]. Available from: https://www.who.int/news-room/fact-sheets/detail/drinking-water.

[4.] Pak J. Health effects of chlorinated water: a review article. Biotechnol. Vol. 16 (3) 163-167 (2019),

[5.] Aziz KMA, Hasan KZ, Patwary Y, et al. A study of the interpersonal spread of human faeces in rural Teknaf of Bangladesh. In Proceedings of an International Conference on Shigellosis, Bangladesh, ICDDRB: Special Publication No (Vol. 20, pp. 238-49) (1983).

[6.] Inter Sector Coordination Group (ISCG), Bangladesh. 2020 Joint Response Plan for Rohingya Humanitarian Crisis. Available online: https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/documents/files/jrp_2020_final_in-design_200422_12.2mb.pdf (accessed on 27 April 2021).

[7.] Prüss A, Kay D, Fewtrell L, et al. Estimating the burden of disease from water, sanitation, and hygiene at a global level. Environmental health perspectives, 110(5), 537-542 (2002).

[8.] Bern C, Martines J, Zoysa I, et al. The magnitude of the global problem of diarrhoeal disease: a ten-year update. Bulletin of the world health organization, 70(6), 705 (1992).

[9.] Bartram J. Estimating the burden of disease from water, sanitation, and hygiene at a global level. Environmental health perspectives, 110(5), 537-542.

[10.] Rana AKM. Effect of water, sanitation, and hygiene intervention in reducing self-reported waterborne diseases in rural Bangladesh. RED research report: Online (2009).

[11.] Mitra SN, Al-Sabir A, Anne R. Bangladesh demographic and health survey 1996-1997. National Institute of Population Research and Training (1997).

[12.] Akullian A, Ng'eno E, Matheson AI, et al. Environmental transmission of typhoid fever in an urban slum. PLoS neglected tropical diseases, 9(12) (2015).

[13.] Mahmud ZH, Islam MS, Imran KM. Occurrence of Escherichia coli and fecal coliforms in drinking water at source and household point-of-use in Rohingya camps, Bangladesh

[14.] Akhter M, Uddin SM, Rafa N. Drinking Water Security Challenges in Rohingya Refugee Camps of Cox's Bazar, Bangladesh

[15.] Clasen T, Schmidt W, Rabie T, et al. Interventions to improve water quality for preventing diarrhoea: systematic review and meta-analysis. British Medical Journal. 2007;1-10. DOI: 10.1136/bmj.39118.489931.

[16.] World Health Organization. UN-water global annual assessment of sanitation and drinking-water GLAAS): Targeting resources for better results. Geneva: WHO Press; 2010. Cited April 23, 2021. Available: http://www.unwater.org/downloads/UNWater_GLAAS_2010_Report.pdf

[17.] Lattimore. "The caravan routes of inner Asia". The Geographical Journal. 72 (6) (1998): 500. doi:10.2307/1783443. JSTOR 1783443. quoted in Wood F (2002). The Silk Road: two thousand years in the heart of Asia. p. 19.

[18.] WHO Guidelines for Laboratory and Field Testing of Mosquito Larvicides. WHO communicable disease control, prevention, and eradication. WHO pesticide evaluation scheme; 2005. WHO/CDS/WHOPES/GCDPP/2005.13

[19.] Chigor VN, Umoh VJ, Smith SI. Occurrence of Escherichia coli O157 in a river used for fresh

produce irrigation in Nigeria. Afr J Biotechnol. 2010; 9:178–82.
[20.] Kistemann T, Classen T, Koch C, et al. Microbial load of drinking water reservoir tributaries during extreme rainfall and runoff. Appl Environ Microb. 2002; 68:2188–97.
[21.] Servais P, Billen G, Goncalves A, et al. Modelling microbiological water quality in the Seine River drainage network: past, present, and future situations. Hydrology and Earth System Science 2007; 11:1581–92.
[22.] Biu AA, Kolo HB, Agbadu ET. Prevalence of Schistosoma haematobium infection in school aged children of Konduga local government area, northeastern Nigeria. Int. J. Biomed. Hlth. Sci. 2009;5(4):181-4.
[23.] Laurent, P. Household drinking water systems and their impact on people with weakened immunity, MSF-Holland, Public Health Department; 2005. Accessed 7 June2007.Available: http://www.who.int/household_water/research/HWTS_impacts_on_weakened_immunity.pdf
[24.] Adekunle IM, Adetunji MT, Gbadebo AM, et al. Assessment of ground water quality in a typical rural settlement in southwest Nigeria. Int. J. Environ. Res. Public Health. 2007;4(4):307-18.
[25.] Ibrahim M, Odoemena DI, Ibrahim MT. Intestinal helminthic infestations among primary school children in Sokoto. Sahel. Med. J. 2000;3(2):65-8.
[26.] "Burden of disease and cost-effectiveness estimates". World Health Organization. Archived from the original on February 13, 2014. Retrieved April 5, 2014.
[27.] Data2.unhcr.org. 2022 [cited 21 April 2021]. Available from: https://data2.unhcr.org/en/search?type=highlight&sv_id=34&geo_id=0&page=1&export=1
[28.] Centers for Disease Chlorinated and Prevention: National Center for Emerging and Zoonotic Infectious Diseases (NCEZID), Division of Global Migration and Quarantine (DGMQ) (2011). "Chapter 3". In Brunette GW (ed.). CDC Health Information for International Travel 2012. The Yellow Book. Oxford University Press. ISBN 978-0-19-976901-8.
[29.] UNHCR. Rohingya Emergency. The United Nations High Commissioner for Refugees. Geneva, Switzerland (2020).
[30.] OXFAM. Bangladesh Rohingya refugee crisis;2020. OXFAM International. Nairobi, Kenya.
[31.] HDX (Humanitarian Data Exchange) (2020a). Rohingya Refugees Population by Location at Camp and Union Level - Cox's Bazar. United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA). New York, USA.
[32.] TECHNICAL NOTES ON DRINKING-WATER, SANITATION AND HYGIENE IN EMERGENCIES [Internet]. 2022 [cited 21 April 2021]. Available from:https://www.who.int/water_sanitation_health/publications/2011/tn11_chlorine_levels_en.pdf?ua=1Griffiths, J.K. International Encyclopedia of Public Health, 2008
[33.] 7 Most Common Waterborne Diseases (and How to Prevent Them) [Internet]. Lifewater International. 2022 [cited 21 May 2021]. Available from: https://lifewater.org/blog/7-most-common-waterborne-diseases-and-how-to-prevent-them/
[34.] Hasan MK, Shahriar A, Jim KU. Water pollution in Bangladesh and its impact on public health (2019 Aug 2).
[35.] [Internet]https://www.humanitarianresponse.info/sites/files/documents/files/unhcr_kobo_guidelines_may2016.pdf
[36.] Sobsey MD, Handzel T, Venczel L. Chlorination and safe storage of household drinking water in developing countries to reduce waterborne disease
[37.] [Internet]. 2022 [cited 13 May 2021]. Available from: https://www.cdc.gov/healthywater/drinking/public/water_disinfection.html
[38.] Chlorination of Drinking Water | Washington State Department of Health [Internet]. Doh.wa.gov. 2022 [cited 21 April 2021].
[39.] Stewart C. Chlorinated Drinking Water. Science. 1981;212(4499):1086-1087.