A Health Needs Assessment and Community-Led Intervention to Reduce Waterborne Diseases in Rural Nepal

A Case Study

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A person carrying a bucket and a red bucket

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*Image: A woman carries water from the source to her house (UNICEF,2015)*

# 1. Introduction:

## Access to safe drinking water and improved sanitation remains a critical challenge for many rural and remote communities in Nepal, particularly in hilly regions. Geographical constraints, coupled with natural hazards such as landslides and floods, frequently disrupt water supply systems, leaving communities vulnerable to unsafe drinking water sources. The consequences of poor water quality are severe, contributing to high rates of waterborne illnesses that negatively impact child health, nutrition, and overall community well-being (UNICEF, Nepal).

This study presents a realistic scenario based on Primary Health Care Centre (PHCC) data in Nepal, using privacy-protected hypothetical data that closely reflects actual statistical patterns, drawing from my experience as a data assistant. Over recent years, the country has witnessed recurrent outbreaks of waterborne diseases, particularly following the monsoon season. Reports from the World Health Organization (WHO, 2021) and the Nepal Ministry of Health (2020) indicate that conditions such as cholera, diarrhoea, dysentery, hepatitis A, typhoid, and polio persist in multiple regions due to inadequate access to clean drinking water.

## During routine data analysis of PHCC records in a remote municipality, an unusual pattern emerged. While cases of waterborne diseases typically rise during the rainy season, a persistent increase was noted beyond the expected seasonal trend. Further investigation was required to identify the underlying factors contributing to this sustained high prevalence.

### Waterborne Diseases as per World Health Organisation (WHO)

The following diseases are prevalent in areas with limited access to clean drinking water:

A diagram of waterborne diseases

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## Following a routine data analysis, a health needs assessment was initiated to understand the factors contributing to the observed trends in waterborne diseases. This assessment aims to explore potential gaps in water accessibility, sanitation practices, and preventive measures to identify key public health interventions.

# 2. Problem Identification & Ranking as a Public Health Concern

Based on the initial data review, this study draws upon Primary Health Care Centre (PHCC) data from a remote municipality in Nepal. The dataset includes socio-demographic and disease-related information, allowing for a comprehensive exploratory data analysis (EDA) to assess health-related concerns within the community. The data analysis was conducted using Power BI, enabling interactive visualisation and in-depth trend identification.

The dataset features are summarised below:

#### Socio-demographic Features

* Age, Gender, Sex, Weight, Height
* Address (Municipality, Ward)
* Education, Employment Status
* Household Size (Members in Household)

#### Disease-related Data

* Date of Visit
* Reason for Visit
* Diagnosis
* Information on other household members affected by communicable diseases

## 2.1. Municipality-Level Exploratory Data Analysis:

To better understand patient demographics and disease burden, an exploratory data analysis was conducted at the municipality level. The following visualisations were generated to provide insights into different aspects of the data:

**Patients by Age and Weight**: A bar chart revealed that young adults constitute the most affected age group. A histogram of patient weight distribution indicated that most patients weigh between 60-70 kg.

A graph of blue bars

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**Patients by Education Level and Employment Status**: A bar chart analysis showed that individuals with no formal education had the highest incidence of disease, followed by those with primary, secondary, and higher education. A comparison between employed and unemployed individuals suggested a slightly higher number of cases among the employed.

A graph of a graph with text

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**Patients by Household Size:** Households with five members showed the highest patient count, suggesting a correlation between household size and disease prevalence.

**Patients by Disease Category:** The analysis revealed 6,600 cases of infectious diseases and 3,200 cases of waterborne diseases within the dataset.

A graph of a patient size

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**Patients by Ward and Disease Category:**

A breakdown of cases across different wards highlighted highest cases in Ward no 5 followed by Ward no 6. A combined visual clearly demonstrates that Ward no 5 has the highest concentration of waterborne disease cases.

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These visuals collectively illustrate the demographic and disease distribution across the municipality, highlighting critical areas (especially Ward no 5 and 6) that warrant further investigation from a public health perspective.

## 2.2. Ward no 5 Focused Exploratory Data Analysis:

Upon identifying significant disease prevalence patterns across the municipality, a focused analysis was conducted to explore key socio-demographic and environmental factors within the most affected ward.

**Key Metrics:**

* Total Patients: 2.96K
* Average Age: 44.9 years

The mean age of patients is 44.9 years, suggesting that the majority of cases are occurring in middle-aged and older adults.

* Average Weight: 60.5 kg

A screenshot of a graph

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**Patient Distribution by Age & Disease Category :** Young adults and middle-aged groups have the highest number of cases, with waterborne diseases being the dominant issue. Elderly individuals also show significant cases, while children and adolescents are relatively less affected. The trend suggests that exposure to contaminated water sources is impacting working-age individuals the most.

**Patient Distribution by Weight & Disease Category:** The majority of cases occur in individuals weighing around 60 kg, indicating that average-weight adults are most vulnerable. Infectious diseases are spread across all weight categories, while waterborne diseases peak in middle-weight individuals. Underweight and overweight individuals have fewer cases, suggesting that exposure patterns rather than body weight drive disease prevalence.

**Education Level & Disease Impact:** An analysis of patients by education level and disease category indicated that individuals with no formal education were the most affected, followed by those with primary education. This suggests a higher vulnerability of less-educated groups to waterborne diseases.

**Employment Status & Disease Distribution:** A comparison of patients by employment status and disease categories demonstrated a relatively even distribution of cases between employed and unemployed individuals, suggesting that employment status was not a significant determinant of disease burden in this context.

A chart with blue and yellow squares

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**Monthly Breakdown of Disease Category:** The monthly patient breakdown by disease category shows that waterborne diseases peak in September, followed by high case counts in August, October, and June. Although waterborne diseases typically decline during the summer and autumn months, the monthly breakdown reveals an unusual increase. In this case, waterborne disease cases peak in September, with high counts also observed in August, October, and June, indicating a deviation from the normal seasonal pattern.

A graph of blue and yellow bars

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**Monthly Trends in Affected Households:** A line chart tracking affected households over the months reveals that October has the highest number of affected household members, with September coming in second. This insight underscores the social and familial impact of waterborne diseases during peak periods.

A graph showing the growth of household prices

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## 2.3. Conclusion

The exploratory data analysis underscores the profound seasonal impact on waterborne disease prevalence in hilly regions of Nepal. These areas rely heavily on open water sources such as rivers and streams, which are highly susceptible to contamination, particularly during monsoon and post-monsoon periods. Natural disasters such as landslides contribute significantly to water contamination by introducing soil, debris, and organic waste into these sources. Additionally, the high risk of sewage seepage into natural bodies of water exacerbates the likelihood of outbreaks, creating an ongoing public health crisis.

The findings indicate that specific wards with limited access to filtered drinking water experience disproportionately high rates of waterborne diseases. However, the root causes require deeper analysis to determine whether this trend is driven by environmental, infrastructural, or behavioural factors. The data also suggests a strong link between education levels and disease vulnerability, with individuals from lower educational backgrounds being more affected, potentially due to lower awareness of water safety measures.

# 3. Problem Statement & Focus Group Insights

## 3.1. Problem Statement

Exploratory data analysis suggests that while waterborne diseases typically peak during the rainy season, Wards 5 and 6 exhibit persistently high incidence rates even into winter. A detailed investigation revealed that this anomaly is linked to a lack of access to government-provided filtered drinking water. A landslide during the rainy season destroyed the water filtration facility, forcing residents of Ward no 5 to travel up to 2 km to the nearest safe drinking water source. In contrast, most areas of Ward no 6 are located closer to an alternative clean water source, resulting in a relatively lower disease burden. This disruption has led to Ward no 5 accounting for the highest number of waterborne disease cases, highlighting a critical public health concern.

## 3.2. Focus Group Discussion

To gather qualitative insights on water access issues and potential interventions, Focus Group Discussions (FGDs) were conducted with key community stakeholders, including:

* **Female Community Health Volunteers (FCHVs)** – Frontline Health Workers providing community-based healthcare and health education.
* **Auxiliary Nurse Midwives (ANMs)** – trained healthcare professionals offering maternal and child health services.
* **Ward Representatives and Local Leaders** – key decision-makers and advocates for community well-being and policy implementation.
* **Primary Health Care Centre (PHCC) Staff** – healthcare providers responsible for diagnosing and managing waterborne diseases.

## 3.3. Insights:

1. **Access Challenges:**  
   The inability to access government-provided filtered water was confirmed as a critical barrier, leading to reliance on untreated water sources. This lack of access has increased vulnerability to waterborne diseases, particularly in households without alternative purification methods.
2. **Further Investigation:**  
   Focus Group Discussions (FGDs) highlighted the need for a deeper examination of the ward’s existing water filtration and storage practices. Given the potential access challenges to safe drinking water, stakeholders recommended further investigation to identify additional risk factors and inform targeted interventions.
3. **Immediate Need for Intervention:**  
   Stakeholders advocated for a dual approach: first, to assess the association between water access and disease prevalence using statistical methods, and second, to implement a community-based intervention to educate households on alternative water purification methods.

# Study Design & Methodology

Following the insights gathered from the Focus Group Discussions (FGDs), a quantitative analysis was deemed necessary to assess the impact of household water filtration and storage practices on the incidence of waterborne diseases. This study aims to validate the concerns raised by community stakeholders and provide empirical evidence to inform targeted interventions.

### 4.1. Study Aim:

The primary objective of this study is to evaluate whether the availability of a household water filtration system and proper storage practices reduces the incidence of waterborne diseases in the affected ward.

### 4.2. Hypotheses

**Hypothesis 1:**

Null Hypothesis (H₀): Household water filtration does not significantly affect the incidence of waterborne diseases.

Alternative Hypothesis (H₁): Household water filtration significantly affects the incidence of waterborne diseases.

**Hypothesis 2:**

Null Hypothesis (H₀): Household storage practices do not significantly affect the incidence of waterborne diseases.

Alternative Hypothesis (H₁): Household storage practices significantly affect the incidence of waterborne diseases.

### 4.3. Sampling & Data Collection

**Population**: Households in the affected ward. The exact number of households could not be identified due to the absence of a postcode system in Nepal. However, an estimated number of households per ward is available.

**Sampling Strategy**: Stratified random sampling based on the presence or absence of a household water filtration system.

**Data Collection Instruments:**

* Structured Household Surveys: Capturing socio-demographic characteristics and water-related practices.
* Survey Methodology: Face-to-face interviews and direct observation conducted with the assistance of schoolteachers and Female Community Health Volunteers (FCHVs) to ensure comprehensive data collection.

**Dataset Description:**

This dataset contains 200 household survey responses collected as part of a study on waterborne diseases in a hilly ward of Nepal. It includes demographic, water treatment, and disease incidence data before and after the loss of government-provided clean drinking water.

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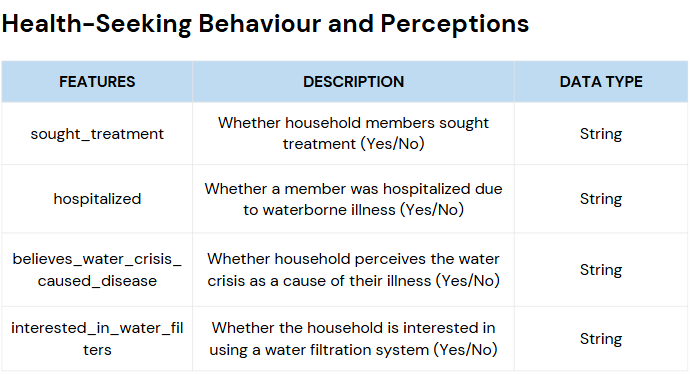
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A close-up of a list of water treatment practices

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A table with text on it

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This methodology ensures that the quantitative analysis is rooted in real-world observations and community experiences, strengthening the validity of the findings.

# Statistical Analysis & Hypothesis Testing

The data analysis was conducted using Python and its statistical libraries to explore trends, distributions, and associations between water-related practices and disease prevalence.

[Link to Statistical Analysis & Hypothesis Testing can be found here.](https://colab.research.google.com/drive/1PlFTnCE3DZFc38ewf_sVtPGPPvq90j8G?usp=sharing)

## 5.1. Exploratory Data Analysis:

### 5.1.1. Distribution of Household Size:

The household size distribution ranges from 2 to 7 members, with 5-member households being the most common, indicating a key demographic for water demand and intervention planning. The boxplot shows a median household size of 5 with no significant outliers, suggesting a fairly uniform distribution of household sizes.

A graph of a number of household size and a number of household size

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### 5.1.2. Distribution of Under 5 Children:

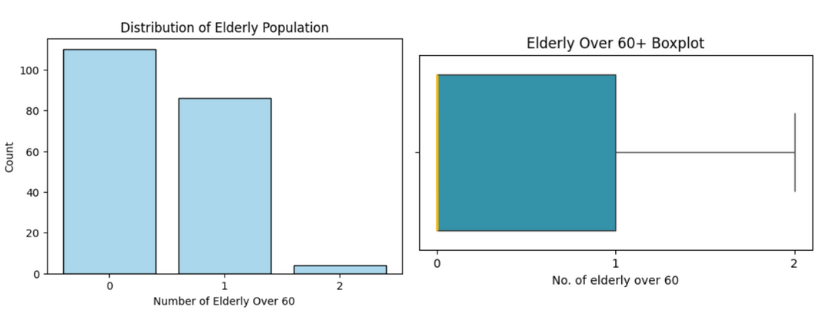
The distribution of children under 5 years shows that most households have 0 or 1 child, while fewer households have 2 children, indicating a lower prevalence of large young families. The boxplot confirms this pattern, with a median at 1 and a spread between 0 to 2 children, showing no extreme outliers.

A graph of a bar and a bar

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### 5.1.3. Distribution of Elderly Over 60 years:

The distribution of elderly individuals (over 60 years) shows that most households have no elderly members, while a significant number have one, and very few have two. The boxplot confirms this, with a median at 1 and a spread between 0 to 2 elderly members, showing no extreme outliers.



5.1.4. Distribution of Education Level & Occupation:  
The majority of individuals have primary or secondary education, while a significant number have no formal education. Limited education may impact awareness of safe water practices, increasing the risk of waterborne diseases.

Agriculture is the dominant occupation, followed by business, while government jobs, private jobs, and labour make up a smaller portion.

A comparison of a bar graph

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### 5.1.5. Distribution of Water Filtration Method:

Before the landslide, households relied on clean, government-provided drinking water, so filtration and treatment were largely unnecessary. Post-landslide, with the disruption of this supply, many have turned to home water treatment, with boiling being the most common method, followed by chlorination, filtration, and SODIS. However, some households still drink untreated, unsafe water, highlighting a critical gap in awareness and access to proper filtration methods, increasing their risk of waterborne diseases.

A diagram of water treatment method

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### 5.1.6. Distribution of Water Storage Type:

Water storage has been a crucial factor in waterborne disease risk both before and after the landslide. Pre-landslide, households had access to clean, government-provided drinking water, but improper storage in open or unclean containers could still lead to contamination. Post-landslide, as people now filter water at home, unsafe storage practices—such as using open buckets or unclean containers—pose an even greater risk, potentially negating the benefits of filtration and leading to waterborne illnesses.

A diagram of a distribution of water storage type

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### 5.1.7. Comparison of Waterborne Disease Cases Before and After Loss of Access to Government-Provided Clean Drinking Water:

The number of waterborne disease cases has significantly increased post-landslide, with typhoid and diarrhoea cases rising the most, indicating a direct impact of disrupted access to clean, government-provided drinking water. While diarrhoea cases were already present before, their post-landslide surge suggests increased exposure to contaminated water sources

A graph of cases of disease

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## 5.2. Hypothesis Testing using Chi-Square Test:

**Purpose:** To investigate the association between household water filtration and storage practices and the incidence of waterborne diseases.

### 5.2.1. Hypothesis 1: Water Filtration and Waterborne Disease

The total burden of waterborne diseases is assessed by summing diarrhoea, typhoid, and cholera cases. This is then categorized as "High" or "Low" based on the median, enabling a clear comparison between severely and less-affected groups. This classification is essential for the Chi-Square Test, which examines whether access to filtered water or alternative purification methods significantly reduces disease prevalence. Finally, verifying the classification ensures accuracy before statistical analysis.

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The Chi-Square Test for water treatment and disease burden showed a test statistic of 3.41, degrees of freedom = 1, and a p-value of 0.0647, indicating a weak association. However, given the small sample size of 200 households, this association is still notable.

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### 5.2.2. Hypothesis 2: Water Storage and Waterborne Disease

To explore whether water storage type influences the prevalence of waterborne diseases, households were categorized into open storage (using open buckets) and closed storage (using closed drums or metal containers). Exploratory data analysis revealed the following case distributions:

* Open Storage: 31 high-case and 47 low-case disease occurrences.
* Closed Storage: 54 high-case and 68 low-case disease occurrences.

While there were more cases in the closed storage group, it was necessary to determine whether this difference was statistically significant using a Chi-Square test.

A diagram of water storage

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The Chi-Square test for association between water storage type and waterborne disease cases resulted in a p-value of 0.628, indicating no statistically significant relationship between storage type and disease prevalence. This suggests that water storage type alone may not be a key factor influencing disease outcomes in this population. Other factors, such as water source contamination, household hygiene practices, and water treatment methods, may play a more significant role. Further studies with a larger dataset and multivariate analysis could help uncover hidden patterns affecting disease prevalence.

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## 5.2. Conclusion:

The statistical analysis and hypothesis testing provide valuable insights into the relationship between household water filtration, storage practices, and the incidence of waterborne diseases. While household water filtration showed a potential protective effect, the association was not strongly significant, likely due to sample size limitations. Storage practices alone did not demonstrate a statistically significant impact on disease prevalence; however, improper storage remains a contributing risk factor, particularly in environments with high contamination risks.

These findings reinforce the qualitative insights gathered from the Focus Group Discussions (FGDs), highlighting the need for immediate action. The results indicate that while some households have adopted filtration and treatment practices, gaps in accessibility, awareness, and proper storage continue to pose significant public health risks.

To address these challenges, the findings will be shared with key stakeholders, including community health workers, ward representatives, and healthcare providers. A series of follow-up FGDs will be conducted to collaboratively develop targeted interventions that focus on improving water treatment, storage practices, and community awareness. These strategies will be further detailed in the next section on targeted health interventions.

# Targeted Health Intervention

The statistical analysis and insights from the Focus Group Discussions (FGDs) confirm that waterborne diseases remain a critical public health issue in the hilly, rural ward affected by the landslide. Due to limited access to alternative clean drinking water sources and persistent reliance on untreated water, an immediate and targeted intervention is necessary to reduce disease prevalence and promote long-term behavioural change.

**Aim**: To improve community water safety by promoting simple, sustainable, and affordable water treatment and storage practices.

## 6.1. Rationale and Scope:

The Micro Health Project was implemented to address unsafe drinking water practices in a rural Nepalese community, where access to safe drinking water was disrupted due to a landslide that destroyed the government-provided filtration facility. Even households with home filtration systems were at risk, as individuals frequently consumed untreated water outside their homes. Given that household-level solutions alone were insufficient, the intervention aimed to promote knowledge on effective water purification methods and drive behaviour change to ensure safe drinking water practices in all settings.

## 6.2. Education on the Safest Water Filtration Practices:

Recognising that sustained behavioural change requires education and community involvement, the project implemented structured awareness programmes that leveraged key community members to promote safe water habits.

### Key Education Strategies:

* **School-Based Education**: Secondary school teachers incorporated water safety education into the curriculum, teaching students about the importance of water purification. Students were encouraged to practise safe water habits at home and educate their families, creating a ripple effect within the community.
* **Female Community Health Volunteers (FCHVs):** FCHVs conducted household visits and community meetings to educate residents on safe water practices. By demonstrating proper filtration and storage techniques, they served as role models for their local communities.
* **Ward-Level Awareness Campaigns**: Community-wide awareness sessions were conducted at ward meetings, led by health officials and local leaders. These sessions reinforced the importance of continuous water purification, especially in the aftermath of the landslide.
* **Religious and Cultural Gatherings**: Safe water education was integrated into community events, ensuring that information reached a broad audience beyond schools and formal meetings.
* **Local Radio Announcements**: Public service messages on water purification and storage were broadcasted through community radio to reach households with limited access to in-person training.

## 6.3. Influencer-Led Behaviour Change for Safe Water Consumption

Even with proper household filtration, individuals often consume unsafe water outside their homes. This intervention focused on changing community behaviour by encouraging people to carry safe drinking water with them at all times.

### Key Influencers & Their Role in Behaviour Change:

1. **Teachers & Schools**

* Teachers carried filtered water to set an example for students.
* Schools encouraged students to bring boiled/filtered water from home.

1. **Female Community Health Volunteers (FCHVs)**

* Conducted household visits to teach safe water habits.
* Encouraged families to always carry purified water when leaving home.

1. **Local Leaders & Workplaces**

* Advocated for safe drinking water stations in public spaces.
* Employers encouraged workers to bring clean drinking water from home.
* This approach normalized safe drinking water practices beyond the household level.

## 6.4. Agenda for Ward Officials

For long-term sustainability, ward officials were encouraged to integrate safe drinking water initiatives into their local governance framework. The following priority actions were identified:

1. Strengthen Household-Level Water Purification Practices

* Implement ongoing education programs on boiling, SODIS, and household filtration methods.
* Provide training for Female Community Health Volunteers (FCHVs) to conduct household visits and reinforce safe water habits.

2. Establish Community-Based Safe Water Access Points

* Set up low-cost community water filtration stations in schools, markets, and high-traffic areas.
* Encourage community-managed boiling stations where water can be purified in bulk and shared among families.

3. Promote Safe Water Habits in Schools and Workplaces

* Make carrying filtered water a community norm by encouraging teachers, students, and workers to bring purified water from home.
* Integrate water safety education into school curricula, ensuring that students develop long-term safe water habits.

4. Develop Partnerships for Affordable Filtration Access

* Engage NGOs and government programs to provide subsidized ceramic filters for low-income households.
* Advocate for the reconstruction of the government filtration facility damaged by the landslide.

5. Monitor and Evaluate Long-Term Adoption of Safe Water Practices

* Conduct follow-up health assessments to track disease incidence trends and measure the effectiveness of the intervention.
* Review community participation rates in safe water programs and identify areas for improvement.

Ward officials are encouraged to work closely with community leaders, teachers, and health volunteers to ensure that safe drinking water remains a long-term priority in the region. By embedding these practices into daily life, the intervention aims to create lasting behavioural change and safeguard public health in the community.

# Conclusion

The project highlighted the critical link between water accessibility, filtration practices, and the persistence of waterborne diseases in a vulnerable hilly community. This project identified Ward no 5 as the most affected area for waterborne diseases following a landslide that disrupted access to clean drinking water. A health needs assessment and Focus Group Discussions (FGDs) confirmed that residents struggled with water access, leading to increased reliance on unsafe sources.

Data analysis showed that households without filtration had higher disease rates, reinforcing the importance of water treatment. However, statistical testing indicated that storage methods alone were not a major factor, suggesting external contamination as a key contributor.

To address these issues, the Micro Health Project focused on education, behaviour change, and community-led interventions. Teachers integrated water safety lessons into schools, Female Community Health Volunteers (FCHVs) conducted household awareness sessions, and public outreach efforts promoted safe water practices.

While immediate health outcomes were not measured, the intervention laid a foundation for long-term improvements. Sustained community engagement and support from local authorities will be key to ensuring lasting reductions in waterborne diseases.

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