

**WATER, SANITATION, AND HYGIENE (WASH) AND ITS IMPACT ON PUBLIC HEALTH OUTCOMES.**

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**Abstract**

**Introduction:** Access to safe water, adequate sanitation, and proper hygiene (WASH) is a fundamental human right and a critical determinant of public health. Globally, approximately 2.2 billion people lack access to safely managed drinking water services, and 4.2 billion people lack safely managed sanitation. Inadequate WASH conditions contribute significantly to the global burden of disease, including diarrheal diseases, cholera, respiratory infections, maternal complications, and child mortality. This study examines the relationship between WASH interventions and public health outcomes, focusing on disease reduction, economic impact, gender equity, and social development in vulnerable populations.

**Methods and Materials:** The study employed a multidisciplinary approach combining literature review, experimental field research, case study analysis, and community-based intervention. The research was conducted in a village in Sub-Saharan Africa with a population of 10,000 residents, where baseline assessments showed limited access to safe water, high rates of open defecation, and inadequate hygiene practices. Interventions included installation of community water purification systems, construction of household and school sanitation facilities, hygiene education campaigns targeting women and children, and training of local health personnel. Data collection methods included water quality laboratory analysis, household surveys, questionnaires, epidemiological monitoring, and six-month follow-up evaluations to measure health, behavioural, and socioeconomic outcomes.

**Results:** Post-intervention findings demonstrated significant improvements in public health indicators. Diarrhea morbidity decreased by 40%, and waterborne infections declined by 25%. Water purification systems reduced the prevalence of waterborne pathogens by 60%, and open defecation decreased by 80% following toilet construction. Hygiene education increased handwashing practices by 50%. Additionally, school attendance improved by 20%, particularly among girls, and local businesses reported fewer sick days and increased productivity. The

intervention also showed measurable economic benefits through reduced medical costs and enhanced labour productivity.

**Conclusion:** The findings confirm that targeted WASH interventions significantly improve public health outcomes, reduce disease burden, and promote economic and social development. Sustainable WASH infrastructure, combined with behavioural change strategies and community engagement, is essential for long-term health improvements. Scaling up WASH programs, strengthening monitoring systems, increasing funding, and addressing governance and environmental challenges are critical to achieving global public health and development goals.

**Keywords:** *Water, Sanitation, and Hygiene (WASH); Public health; Waterborne diseases; Sanitation infrastructure; Health outcomes.*

## Introduction

### *Background*

Safe, sanitary, and hygienic water supply is a basic human right and a determinant of health problems. According to the World Health Organization (WHO), approximately 2.2 billion people lack access to safely managed drinking water services, and 4.2 billion people lack safely managed sanitation services. Inadequate Water, Sanitation and Hygiene (WASH) practices cause disease outbreaks such as cholera, typhoid, and diarrhea, placing an enormous disease burden on the global scale. When, in addition to health consequences, there is poor WASH infrastructure, the cycle of poverty is perpetuated, learning is stunted, and gender inequality is deepened.

### *Objectives*

- Examine the relationship between WASH and public health outcomes.
- This paper assessed the effectiveness of WASH programs in reducing waterborne illnesses and improving the quality of life.
- A detailed implementation framework for WASH projects in marginal areas is proposed.
- Measuring the economic and social effectiveness of better WASH.
- Offer policy recommendations for scaling up WASH programs globally.

### *Impact on Public Health*

Neglect of sufficient clean water, sufficient sanitation, and sufficient hygiene facilities has devastating public health implications. The lack of WASH facilities is directly responsible for outbreaks of infectious diseases, such as cholera, diarrhea, and respiratory infections. This subsection presents a comprehensive description of the role of inadequate WASH in global morbidity and mortality. The power presentation is supported by statistical data, experimental results, and case studies that clearly illustrate the unique capabilities of the interventions' indices as health indicators in the prevention of disease incidence in society. In addition, the socioeconomic cost in terms of poor WASH conditions and the impact on health care services are described.

1. Waterborne Diseases and Mortality

Waterborne diseases continue to be one of the leading causes of morbidity and mortality in the world, particularly in low-middle-income countries (LMICs). The leading causes of infections are unsafe drinking water sources, the absence of sanitation facilities, and poor hygiene.

## 2. Key Statistics

Diarrhea diseases, largely preventable by better WASH, contribute to more than 1.6 million deaths annually, the majority of which affect children under 5 years of age.

Cholera (severe diarrhea illness caused by the bacteria, *Vibrio cholerae*) infects 1.3 to 4 million people globally each year and claims 21,000 to 143,000 lives.

## 3. Experimental Evidence

Case Study (Bangladesh): Tube well irrigation brought access to groundwater in rural Bangladesh, cutting diarrhea disease rates by 50%. This intervention highlighted the significance of delivering a safe water supply to surface water-dependent communities.

Case Study: Kenya: [School-based WASH intervention resulting in the provision of water filters and hygiene education] led to a 30% reduction in absenteeism due to waterborne diseases. This highlights the role of the school itself as an enabler of mechanisms for water, sanitation and hygiene (WASH) behaviour.

### *Economic Burden*

The economic impact of poor WASH conditions is profound. The WHO estimates that every invested in WASH yields a return of 4.3 in reduced healthcare costs and increased productivity.

Inadequately managed sanitation can compensate, with an estimated US\$260 billion per year in health care costs and lost/preventative product sales.

Case Study (India): Launched in 2014, the Swachh Bharat Mission (Clean India Mission) aimed to eliminate open defecation by providing village-level sanitation facilities. The program reduced diarrhea-related diseases by 20% and avoided an estimated \$50 billion in healthcare costs. This case study provides examples of the cost-efficiency of WASH programming at scale.

### *Gender and Social Equity*

Women and girls are particularly affected by the lack of WASH facilities. Simultaneously, without access to safe sanitation facilities, they are put at risk and also penalized in terms of the size of the study and work activities. On the other hand, it has also been reported that better WASH infrastructure leads to an increase in girls' school enrollment and a decrease in gender based violence.

### *Experimental Evidence*

Case Study: Uganda: Construction of gender-separated latrines at school by children/students resulted in 15% higher girls' enrollment. This intervention also reduced the frequency of urinary tract infection and raised the number of hygienic menstrual practices.

Case Study (Nepal): An operation-facilitated community-based total sanitation (CLTS) program prompted women leaders to act as agents of sanitation behaviour promotion, which in turn led to 40% more toilet construction and improved hand hygiene.

### **Project Definition**

The goal of this study is to determine the impact of WASH interventions on public health measures in a specified target population. The objectives include evaluating the impact of access to clean water on disease reduction, understanding behavioural changes in hygiene practices, and recommending policy measures to support sustainable WASH improvements. The work uses a combination of experimental and observational study methods for data collection and tests the impact of WASH interventions.

The project will:

Assess the current state of WASH infrastructure and practices.

Perform targeted WASH activities, including water/environmental treatment and purification technologies, sanitation facilities, and hygiene promotion events.

Attempt to estimate and measure improvements in health, economic, and social equity.

Provide evidence-based recommendations for scaling up WASH programs.

### *Final Project Overview*

This paper is organized with a multidisciplinary lens to offer an integrative examination of WASH and its public health impact. Data are synthesized in this work to offer an integrative

perspective on the field, combining epidemiological, experimental, and policy analysis to ensure a holistic understanding. The work starts by outlining the role of hygiene, sanitation, and water (WASH) in global health, and how this, in turn, affects mortality and disease.

The following section provides a comprehensive literature review, drawing on research from recognized bodies such as the WHO and UNICEF, as well as academic journals. This review develops a conceptual model which acts as an experimental working model for this research. Experimental research in target communities with high levels of WASH deficiencies was used to test the research hypotheses. The data were collected through direct fieldwork, laboratory analysis of water samples, and administered questionnaires to inhabitants. This empirical evidence offers clues about the proximate effects of insufficient WASH facilities.

Then, the work addresses a selection of case studies of WASH interventions globally, comparing the methods, findings, and scalability of their projects. These examples illustrate best practices and innovative solutions which can be extrapolated to different socioeconomic contexts.

The results are subsequently used as inputs for public health policies (e.g., the number of infections, the number of hospitalizations, and gross domestic product). The study also evaluates the effectiveness of different intervention strategies, determining which approaches yield the most sustainable improvements.

Second, the study offers recommendations for actors (e.g., government agencies, NGOs, and communities) to strengthen WASH infrastructure, induce behavioural change, and implement appropriate policies and actions. In the last section, an overview of the key findings and potential future research directions in the WASH and public health field is presented.

The research was conducted in a village in Sub-Saharan Africa with a population of 10,000 residents. Baseline data showed that 60% of households were not using safe water, 70% defecated on the street, and hygiene was inappropriate. The project implemented the following interventions:

- Installation of community water purification systems.
- Construction of household and school toilets.
- Hygiene education campaigns targeting women and children.
- Education and training of local health personnel to monitor and promote WASH activities.

*Updated Research Summary*

This section presents a discussion of more recent findings on WASH and its public health impact. The state of the literature is characterized via a literature review, case studies and experimental studies conducted in different parts of the world. The discussion further highlights technological, policy, and community-level sanitation project innovations that have been shown to be effective in improving health indicators.

The World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) reported that 2.2 billion people lack access to safe drinking (potable) water, and 4.2 billion people lack access to safe sanitation. Since it is an attending factor in the higher incidence of infectious diseases among people below 5 years of age, etc. Evidence indicates that, under these circumstances, poor water, sanitation, and hygiene are the predominant factors in about 1.7 billion pediatric diarrhea episodes per year.

There are also a few studies reporting the effects of unsafe drinking water on maternal and perinatal health. The mother's and fetus's rate of hygiene might be compromised because the mother risks maternal infections through direct contact with contaminated water and might become subject to complications, such as premature birth or low birth weight. Maternal infant mortality rates have been significantly decreased in communities with hygienic/sanitation attitudes of an improved type.

Experimental work (and intervention packages) demonstrate the effectiveness of WASH interventions. A longitudinal study conducted in rural sub-Saharan Africa found that villages receiving improved water supply and hygiene education experienced a 45% reduction in diarrhea cases compared with control villages. Another study in South Asia found that installing proper hand-washing facilities in schools led to a 30% decrease in illness-related absenteeism.

1. Water Quality and Health Outcomes

Post-intervention statistics showed a 40% reduction in diarrhea morbidity and a 25% reduction in waterborne infection. Water quality evaluations showed a dramatic reduction in fecal coliform presence in drinking water sources. Key Findings:

The installation of water purification devices reduced the prevalence of waterborne pathogens by 60%.

Families having access to clean water mentioned less diarrhea and waterborne infections,

## 2. Sanitation and Hygiene Practices

The construction of toilets reduced open defecation by 80%. Hygiene teaching led to a 50% increase in handwashing with soap during high-risk moments.

Key Findings:

The construction of household latrines improved sanitation and, as a result, reduced environmental pollution.

Hygiene education and campaigns were successful at generating behaviour change, especially for women and children.

## 3. Economic and Social Impact

According to the community, there is a 20% increase in school attendance, with male involvement predominately in girls. Local businesses reported fewer sick days and increased productivity.

Key Findings:

Improved WASH conditions, in turn, resulted in economic growth by:

- a) reducing medical costs and
- b) increasing productivity of the labour force.

The provision of gender-segregated toilets in schools enhanced girls' school attendance and academic performance.

### *Project Implementation Summary (Action Steps Taken)*

This section details the steps taken to implement the WASH project, including field assessments, community engagement initiatives, and infrastructure development. There is also participation in water treatment demonstration, hygienic teaching sessions and sanitation point buildups.

Moreover, in this section, the difficulties that have arisen during implementation are presented, and how they have been overcome are described.

### *Baseline Assessment*

- Implemented surveys to measure the community WASH status, such as access to water, sanitation facilities and hygiene behaviours.

- Submitted community water samples to assess for fecal coliforms and other contaminants.

#### *Stakeholder Engagement*

- Has collaborated with local authorities, NGOs, and community stakeholders to design and implement interventions.
- Organized community events to announce the importance of WASH and capture community opinion on project priority.

#### *Infrastructure Development*

- Equipped water treatment systems using solar-powered pumps and filtration units, in order to deliver potable drinking water.
- Developed household and school toilets from locally available material and labour.

#### *Education and Training*

- Have also done workshops on hygiene practices (hand-washing, food safety, and menstrual hygiene management).
- Trained local health workers to monitor WASH conditions and promote behaviour change.

#### *Monitoring and Evaluation*

- Collected data on health outcomes, water quality, and behavioural changes over six months.
- Completed follow-up surveys to establish intervention feasibility and identify points of change.

### **Questionnaire And Survey for WASH Project and Its Impact on Public Health**

1. What is your source of drinking water? (e.g., piped water, well, river, bottled, etc.)
2. Do you have access to improved sanitation facilities? (Yes/No)
3. Why do you wash your hands with soap and water? (Always/Sometimes/Rarely/Never)

4. Has a relative of the family (self or a person living with me) suffered due to waterborne infection (e.g., diarrhea, cholera) during the last 6 months? (Yes/No)
5. What hygiene practices are commonly followed in your household?
6. There are many roadblocks to the adoption of clean water and sanitation for my community. (If yes, please specify.)
7. How do you dispose of household waste and sewage?
8. Have you attended any hygiene education programs? (Yes/No)
9. What improvements would you like to see in your community's water and sanitation infrastructure?
10. Recommendations ranging from community efforts and behavioural changes to more systemic policies regarding water treatment (such as access to safe water, affordability), sanitation (including use of toilets), and hygiene (including hand-washing).

### **Project Analysis, Evaluation, and Recommendations**

The outcome of the WASH project is evaluated based on information obtained from experimental studies, questionnaires, and epidemiological reports. Statistical tools are used to determine the impact of the intervention on disease reduction and changes in hygiene behaviour. Results of the assessment guide policy changes to improve WASH infrastructure, strengthen capacity for public education, and provide sustainable solutions for water and sanitation.

#### *Analysis*

The research demonstrated that targeted WASH interventions can improve public health outcomes. The reduction of waterborne disease and the economic benefits of WASH interventions underscore the cost-effectiveness of WASH interventions.

#### Key Insights:

Community participation was essential to the successful implementation of the project, ensuring culturally sensitive interventions and sustainability.

Local agency collaborations facilitated access to resources and made the project effective.

### *Evaluation*

**Strengths:** The project successfully met its objectives of enhancing WASH and decreasing the incidence of waterborne illness. Community engagement and partnerships were key to its success.

**Challenges:** Limited funding delayed the completion of some infrastructure projects. At the start, cultural barriers first limited the adoption of novel hygiene behaviour.

### *Recommendations*

- **Scale Up Interventions:** Extending WASH programs to adjacent communities to maximize their coverage.
- **Increase Funding:** Propose the need for increased investment in water, sanitation, and hygiene (WASH) infrastructure at the country and international levels.
- **Strengthen Monitoring:** Install long-term monitoring systems to evaluate the feasibility of WASH interventions.
- **Promote Behaviour Change:** Initiate community-based approaches to circumvent cross-cultural barriers and promote hygiene practices.

## **Challenges and Barriers to WASH Implementation**

### **Infrastructure and Funding Constraints**

A large proportion of low- and middle-income countries lack the facilities and financial resources to design and implement WASH systems.

Water and sanitation project investments can be characterized by shortages, resulting in service delivery gaps.

### **Climate Change and Environmental Factors**

Water availability is affected by climate change, leading to drought and precipitation deficits in many regions around the globe.

Floods and natural hazards may contaminate water sources and endanger sanitation systems.

### **Behavioural and Cultural Barriers**

In such communities, cultural practices and traditional beliefs influence hygienic behaviour, making it challenging to effect change.

Community engagement and education are also needed to sustain WASH practices.

#### Political and Governance Issues

Ineffective governance, corruption, and a lack of political will hinder the effective provision of WASH programs.

Accountability and transparency for WASH programmes should be consistently ensured for long-term effectiveness.

#### **Materials Delivered**

This section outlines the materials and resources provided during the project, including hygiene kits, educational materials, water purification systems, and sanitation equipment. It also includes entries for training sessions and community workshops carried out within the framework of the project.

Infrastructure: Water purification systems, household and school toilets.

Educational Materials: Posters, pamphlets, and training manuals on hygiene practices.

Data Reports: Surveys at baseline and post-intervention, chemical water quality test results, and healthcare outcomes.

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