Tackling Global Health Threats through Low - Cost Interventions, Focusing on Water Borne Diseases in India

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Abstract: *70% of the earth is water, but only 0.1% is available for human use. Water-borne diseases are caused by pathogenic microorganisms that enter the human body through contaminated water and pose a significant threat to global public health, particularly in developing nations like India. These deadly waterborne diseases, such as typhoid, cholera, and dysentery, have high mortality rates and detract from the overall welfare of society by taxing the healthcare system, causing severe economic losses from decreased productivity and increased healthcare costs. In India, the problems are worsened by overpopulation, leading to overcrowded living conditions, inadequate sanitation, and insufficient clean water supply, thereby creating an environment where waterborne disease can easily spread. Vulnerable populations such as the children and the elderly are especially at risk which leads to a cycle of poverty and poor health. The current primary treatments for waterborne diseases include antibiotics and advanced medical care which are often costly and inaccessible for many people in low-income regions. Additionally, excessive use of antibiotics can lead to resistance which complicates the treatment process. A significant part of the population in India lives in poverty and lacks access to clean water and good healthcare. Thus, low-cost interventions are important as they can offer solutions that can be applied over a large scale, thereby helping to prevent the spread of these diseases and improve public health. Some low-cost methods to combat water diseases include the distribution of affordable water purification systems like chlorine tablets and ceramic filters, the installation of rain harvesting systems, and public education on safe water practices. These strategies are cost-effective and easy to implement in different areas. Our study is based on comprehensive surveys conducted across different regions and aims to assess the current state of water quality and public awareness. Surveys are crucial as they provide detailed insight into the awareness levels across different regions and also help identify gaps in knowledge which allows for targeted solutions. This approach helps ensure that the solutions proposed are relevant and effective for various communities. This project will empower families, especially those of low income, with the knowledge of protecting themselves from waterborne diseases through prevention and breaking the vicious cycle of poverty and ill health. By using low-cost solutions, we can help improve overall public health, reduce healthcare costs, and enhance the quality of life for millions of people all across India.*

Keywords: Water borne diseases, low cost, boiling, healthcare, public health, cholera, typhoid, dysentery, survey

1. Introduction

1.1 Importance of healthy drinking water

Scientists have emphasised the importance of water in sustaining human life, along with the need for healthy, safe drinking water and the risks of consuming contaminated water for a long time. Water affects general health and its importance in fundamental bodily functions including digestion, skin health, waste removal, as well as blood pressure and body temperature management is unimaginable. Drinking water is an important resource for humans. Given the limited availability of freshwater, conserving it is essential. Any contamination to this water supply poses health hazards by the presence of pathogens, heavy metals, pesticides, pharmaceuticals, and radioactive waste in drinking water.

The Indian government has worked actively to provide safe and drinking water through various programs, showing improvements in health outcomes after these initiatives. These initiatives explore the economic and health burdens imposed by the lack of access to safe drinking water in developing countries, stressing the critical need for better water purification methods, including the innovative use of nanoparticles, to ensure the health and well-being of populations which are vulnerable to waterborne diseases. The drawbacks of traditional water chlorination suggest using nanoparticles as a more effective water treatment option. Seawater, which is available in excess, can be purified and converted into distilled water easily. However the process of distillation is costly and the water produced lacks essential minerals for the body. Groundwater, another source of drinking water, has to be preserved too. Despite India's numerous rivers, a significant water crisis affects nearly one-third of the population. During the summer, water scarcity forces many rural communities to rely on contaminated sources, leading to serious health issues. Additionally, even treated water can contain harmful substances, highlighting the importance of thoroughly checking water quality before it reaches households.[1] [2].

1.2 Waterborne diseases and their impact

Studies examine how, in spite of significant efforts to improve access to drinking water, waterborne diseases still remain a problem in India, covering 85% of India's population. This is particularly a major issue among children under five who face around 400,000 to 500,000 deaths annually due to diarrhoea. According to a report from India's Planning Commission, numerous cases go unnoticed due to inadequate disease tracking systems and poor hygiene practices. Additionally, it says that the actual number for illnesses such as viral hepatitis could be far higher than what is currently reported.

Public health improvements are hindered by inadequate sanitation, leading to frequent skin and eye infections among

children. Furthermore, the report criticises the quality of drinking water, pointing out that a large amount of wastewater is still untreated and is polluting water bodies. The presence of fluoride in drinking water is also a serious health risk, with over 25 million people in 17 states exposed to harmful levels of fluoride [3].It has been found that the prevalence and determinants of waterborne diseases among senior citizens in India using data from the 2017–18 Longitudinal Ageing Study in India (LASI). It shows that these diseases are experienced more commonly in rural areas at 22.5% as compared to urban areas, mainly because of the usage of unimproved water sources. The prevalence of these diseases is greatly influenced by a number of factors, including sex, education level, body mass index, kind of toilet facilities, and water supply.

A comprehensive socio-demographic and economic profile of the elderly is also provided by the study, which highlights the importance that age, religion, and socioeconomic level have in disease susceptibility. The study highlights the urgent need of implementing public health interventions to protect this susceptible population and suggests promoting hygiene, access to safe water, and increasing awareness of the risks of waterborne diseases among elderly people. Additionally, it demonstrates the crucial impact that environmental factors have in the occurrence of waterborne illnesses and offers insightful information to public health policymakers to improve the health of senior citizens in India [4].

Scientists have highlighted the significance of water and the impact of water-borne diseases, particularly in light of World Water Day. They delve into the historical and religious significance of water and categorise water-related diseases into those caused by microorganisms and chemicals, vector-related diseases, drowning, and aerosol-carried diseases. Hatami's methods involve a comprehensive review of historical texts, religious scriptures, and contemporary reports from health organisations to illustrate the longstanding reverence for water and the ongoing challenges posed by water-related diseases. Key data points include that diarrheal diseases due to unsafe water, sanitation, and hygiene result in 2 million deaths annually, and cholera, highlighted by the Haiti outbreak following the 2010 earthquake, exemplifies the severe impact of inadequate water and sanitation infrastructure. The results emphasise the critical burden of poor water quality, which accounts for 4.1% of the global disease burden, predominantly affecting children in developing countries. Hatami stresses the need for improved access to safe water, sanitation, and hygiene to prevent these diseases. The key findings underscore the urgent requirement for better water management practices to mitigate the impact of water-borne diseases, highlighting the significant potential health benefits of such improvements [4].

Other studies aim to examine the health status, occurrence of water-borne diseases, and the economic impact of illness due to unsafe drinking water in a rural community in Lahore, Pakistan. It also explores residents' willingness to pay for improved water and sanitation facilities. The research design included a quantitative survey of 50 randomly selected households, gathering data on socio-economic status, water quality perception, illness costs, and willingness to pay. Findings revealed high levels of illiteracy and low awareness of water-borne pathogens and diseases, with a significant portion of the population suffering from diarrhoea, dysentery, and typhoid. The cost of illness was calculated considering both direct medical expenses and indirect costs due to lost working days. The study found that the willingness to pay for improved water services was low, highlighting the need for effective community education and involvement in water and sanitation projects. The results underscore the critical need for policy interventions to improve water quality and access, which could significantly reduce health risks and associated economic burdens in rural Pakistan [5].

Meanwhile a study shows the water distribution system in a non-notified slum in Mumbai, India, and its implication on public health and social equity. The study's objective was to assess the effectiveness of the informal water system through health and social indicators and to determine predictors of bacterial contamination in drinking water. Data were collected using two instruments: a Baseline Needs Assessment (BNA) survey from 959 households in 2008 and a Seasonal Water Assessment (SWA) in 2011, testing 229 water samples over three seasons. The study suggested that the poor slum-dwelling households were paying prohibitive water prices and consuming far below the 50 liters per capita per day recommended by WHO. The proportion is worse during monsoons when 50% of the water sources show dangerous contamination levels. Most contamination occurred during storage; E. coli and coliform bacteria were present in drinking water throughout the year. The results thus demonstrate that the failures in water quality, quantity, and dependability are so profound that household storage and treatment could be expected to ameliorate water quality substantially. The study notes that access to municipal water supplies that are affordable and reliable is the only genuinely satisfactory measure for meeting the primary failings of high cost and low supply while also creating a solution to formalised policy for formally unrecognised slums [14].

In another study in the United States which was conducted to estimate the burden and direct healthcare costs of infectious waterborne diseases researchers found significant discrepancies compared to a previous study by S.A. Collier et al., with DeFlorio-Barker et al. estimating approximately 90 million cases of recreational waterborne illnesses in untreated water, compared to Collier et al.'s 7.1 million total waterborne illnesses. Additionally, the economic burden was assessed at $2.9 billion for recreational waterborne illnesses alone, while Collier et al. estimated $3.3 billion for all waterborne diseases. The differences stem from the methodologies used; DeFlorio-Barker et al. incorporated both direct and indirect costs and relied on data from large cohort studies and outbreak data, while Collier et al. focused on healthcare costs associated with 17 pathogens, heavily relying on expert judgement.

Such research is crucial for developing effective, low-cost interventions to combat these diseases, particularly in regions facing similar health challenges due to limited resources. This study shows the need for comprehensive data collection on waterborne diseases to accurately estimate

their economic impact and highlights the potential underestimation of such illnesses when only specific pathogens are considered [16].

1.3 Role of Public Health in water borne diseases

Multiple strategies have to be in place and are presently being applied effectively around the world in reference to water borne diseases. Work done by a group of researchers investigates the economic impacts and health risks associated with using unsafe drinking water, considering socio-economic factors. Employing a multidisciplinary approach, including cost of illness (COI) analysis, regression techniques, and irrigation water efficiency methods, data were collected from 210 peri-urban and urban households. Findings revealed that the average COI was higher in peri-urban areas ($10.79 USD), while urban residents demonstrated a higher willingness to pay for quality water. Factors such as social status, income, and family size were positively correlated with COI, whereas education, groundwater use, and awareness about safe drinking water were negatively correlated.

Urban residents showed greater efficiency in water use and conveyance. This research uniquely applies irrigation water efficiency methods to assess drinking water efficiency, offering significant practical and social implications. Policy recommendations include enhancing family planning programs and installing filtration plants through public-private partnerships to improve water quality and accessibility. These findings are crucial for guiding policy frameworks to ensure safe drinking water access and mitigate health risks in urban and peri-urban areas.

Work has examined the law's critical role in improving public health and increasing global health equity. It emphasises the importance of legal frameworks in affecting health outcomes through their influence on major socioeconomic factors such as education, housing, and income. The study, which emphasises the underutilization of law as a vehicle for public health development, identifies four critical legal determinants of health that can both assist and impede growth. The report calls for stronger legal frameworks to ensure health equity and protect public health, emphasising the importance of smart legal changes and initiatives. These reforms aim to improve health systems worldwide by promoting more cooperation and understanding between legal and health experts, supporting the development of sustainable health. The purpose is to achieve justice and equity in health through strengthened legal capacities, providing a persuasive argument for incorporating strong legal tactics within the global health agenda [6] [7].

1.4 Ways to treat waterborne diseases and their impacts

Treatment of waterborne diseases is of utmost importance for individuals and economies all over the world. Many simpler methods adopted on time can help prevent the spread of these in both developed and developing countries. A study evaluates bioaugmentation's effectiveness in treating water borne pathogen contamination, emphasising its role in pollutant degradation and pathogen removal. This approach involves introducing specific microorganisms or enzymes into contaminated environments, such as water systems impacted by highly toxic, poorly soluble, and stable pollutants.

By incorporating pregrown microbial cocultures and engineered microbes into native microbial populations, the study explores a strategic enhancement of natural biodegradation processes. The results indicate that bioaugmentation significantly reduces the levels of challenging pollutants and pathogens, confirming its potential as a viable, cost-effective, and environmentally friendly treatment method. This research underscores the importance of bioaugmentation in improving water quality, particularly in regions plagued by frequent contamination issues. The findings suggest that adapting bioaugmentation techniques could revolutionise water treatment practices, offering a sustainable solution to global water contamination challenges [8].

Another study aims to determine what promotes or hinders community involvement and the building of health systems in countries where cholera is reported. Using a scoping review strategy, the study sifts through existing literature to identify critical characteristics influencing cholera prevention efforts. It emphasises how vital strong collaboration between communities and health systems is to effectively combat cholera. Building trust, ensuring effective governance, and encouraging collaboration within health systems are viewed as critical.

The research emphasises the significance of focused interventions in health systems and proactive community involvement, particularly in areas where cholera outbreaks frequently occur. The goal is to assist policymakers at the global and local levels with insights into how to strengthen long-term cholera prevention and control measures. The ultimate goal is to significantly reduce cholera incidence and deaths by 2030 [9].

Economic impacts of using a quick diagnostic test, known as the immunoglobulin M lateral flow assay (IgMFA), versus traditional clinical diagnosis for detecting typhoid fever in children in Cambodia, an area with limited resources have been found by various research groups. Quick and accurate diagnosis of typhoid is a challenge here because fast diagnostic tools are often not available, leading doctors to rely on recognizing symptoms to start treatment. The researchers built a decision tree model for a group of 1,000 children to analyse cost-effectiveness from the healthcare providers' point of view, comparing the IgMFA test with clinical diagnosis.

The researchers found that while IgMFA results in a higher number of true positives and treatment successes compared to clinical diagnosis, it also incurs significantly higher costs. The incremental cost-effectiveness ratio (ICER) they calculated shows that the IgMFA test is pricier but more effective in diagnosing and treating typhoid fever, which raises questions about whether it should be used more widely, depending on the healthcare budgets and priorities in similar environments [10].

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Several low-cost interventions for combating cholera, particularly in vulnerable regions have been proposed by multiple research groups. Key solutions include the deployment of oral cholera vaccines to provide immediate protection in high-risk areas and the implementation of comprehensive WASH (water, sanitation, and hygiene) practices. This includes ensuring access to clean water, constructing adequate sanitation facilities, and promoting hygiene practices such as regular handwashing and safe food preparation. The paper also stresses the importance of community education to improve hygiene behaviours and the necessity of international collaboration to implement these measures effectively.

Sustainable practices and targeted investments are said to be crucial for achieving a 90% reduction in cholera incidence by 2030. These interventions aim to interrupt the transmission cycle of cholera and other waterborne diseases, ultimately improving public health outcomes in affected regions. The research paper examines global health threats posed by waterborne diseases, specifically cholera, and evaluates low-cost interventions recommended by international guidelines for water, sanitation, and hygiene (WASH). Cholera, prevalent in regions with inadequate WASH services, spreads through faecal-oral routes. The study reviews guidelines from organisations such as UNICEF, WHO, and Médecins Sans Frontières, identifying 95 unique recommendations.

These guidelines emphasise improving water quality, access to sanitation, and promoting hygiene practices at both household and community levels. Despite the variety of recommendations, the paper notes inconsistencies and a need for more evidence-based, context-specific strategies. Effective low-cost interventions include household water treatment, safe storage, and hygiene education. The study advocates for better coordination among guidelines, focusing on both within-household and community-level transmission, to enhance the efficiency and impact of interventions. This approach aims to reduce the global burden of cholera and other waterborne diseases by ensuring clear, actionable, and resource-efficient recommendations [11][12].

The research paper from the ICMR-National Institute of Cholera and Enteric Diseases (NICED) addresses the prevention and treatment of waterborne diseases, particularly cholera, in India. Established in 1962, NICED has conducted extensive research on diarrheal diseases, emphasising sanitation and hygiene. The paper highlights key interventions such as promoting Oral Rehydration Therapy, integrating rotavirus vaccines into immunisation programs, and using chlorinated water and safe storage practices to prevent disease transmission. Additionally, the research underscores the benefits of zinc and Vitamin A supplementation in reducing childhood diarrhoea. They also investigate environmental factors contributing to disease outbreaks and develop rapid diagnostics and effective vaccines for enteric diseases. The paper aligns NICED's efforts with the Swachh Bharat Mission, demonstrating significant reductions in diarrheal disease burden and improvements in public health [13].

Another study evaluates three methods to improve drinking water quality. The aim was to assess the effectiveness and acceptability of using chlorine, Moringa oleifera seeds, and closed containers to reduce bacterial contamination. Conducted over six months in a South Indian village, the randomised controlled trial included 126 families. Water samples were tested for thermotolerant coliforms at baseline and several intervals during the study. Chlorination effectively reduced coliform counts to potable levels but was less acceptable due to taste and odour issues. Neither M. oleifera seeds nor closed containers significantly reduced contamination in household water samples, though both had high compliance rates among participants. The study suggests that while chlorine is effective, its acceptability needs to be improved, and further research is required to optimise M. oleifera's efficacy in real-world conditions [15].

The paper reviews primary preventive interventions against waterborne diseases in areas with inadequate safe drinking water. It highlights that waterborne diseases cause significant mortality and morbidity, especially in children in low-income regions. This study finds 8 main interventions: personal hygiene practices (handwashing and prophylactic supplements), household measures (water treatment, safe water storage, cleanliness, and waste management), and community efforts (infrastructure development and educational campaigns). It says that the most effective treatment is when interventions like water treatment and safe storage at the household level are combined. Interventions like regular handwashing and maintaining household cleanliness are also effective but require adequate resources.

However, it notes significant research gaps, such as the need for more evidence on alternative interventions in resource-poor settings and the lack of standardised definitions among studies. The study concludes that addressing these gaps through continued research and policy support is crucial for developing sustainable strategies to combat these diseases and improve public health outcomes [17].

2. Method

Our research involved conducting a survey with more than 100 individuals to understand people's awareness about waterborne diseases. This involved a category of questions targeting treatments of water borne diseases and how much are individuals aware of low cost interventions associated with water borne diseases. This involved designing a google form and circulating among people in India. The form addressed basic questions related to the disease. The data was then interpreted according to the responses to derive a conclusion.

3. Results and Discussions

In our study we aimed to understand the existence of waterborne diseases throughout the world.

Our study dominantly dealt with individuals from the age group of 25 to 60 as shown in Fig 1. Post literature review we had found that these were the most vulnerable age groups in India due to their exposure to contaminated water and

food easily. Younger ones are usually under the supervision of adults.

being the most prevalent one followed by Jaundice and Cholera. This is shown in Figure 2 and 3.
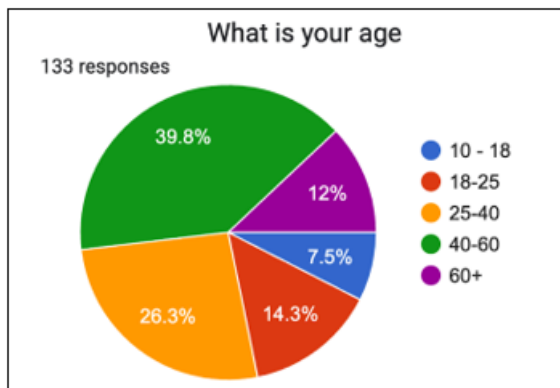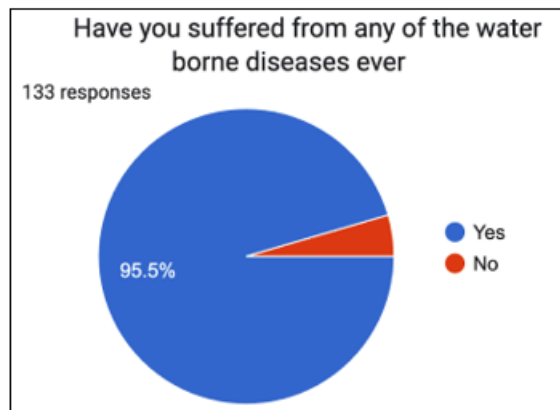

Figure 1

Figure 2

We found that most individuals had suffered from waterborne diseases once in their lifetime with Typhoid
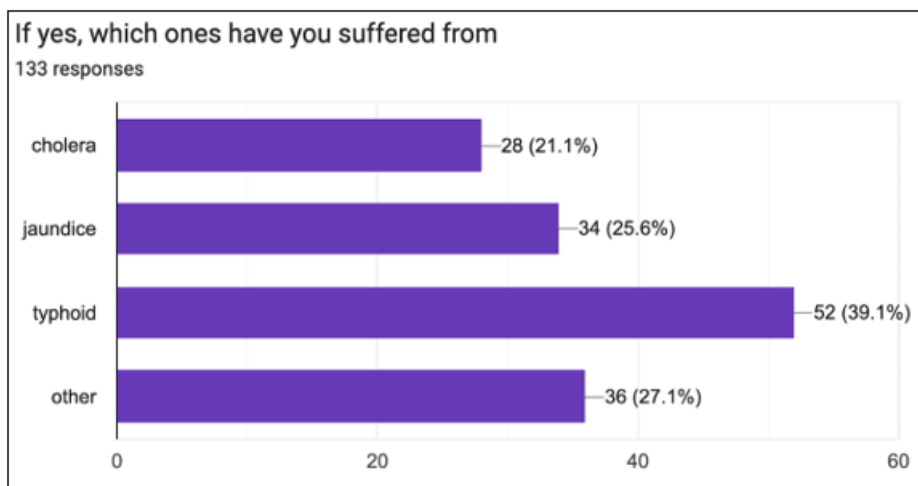

Figure 3

Post waterborne diseases most individuals preferred the use of antibiotics as a cure rather than adopting other ways. Also It appeared that many were unaware of the other alternative methods mentioned by research groups. This is shown in Figure 4
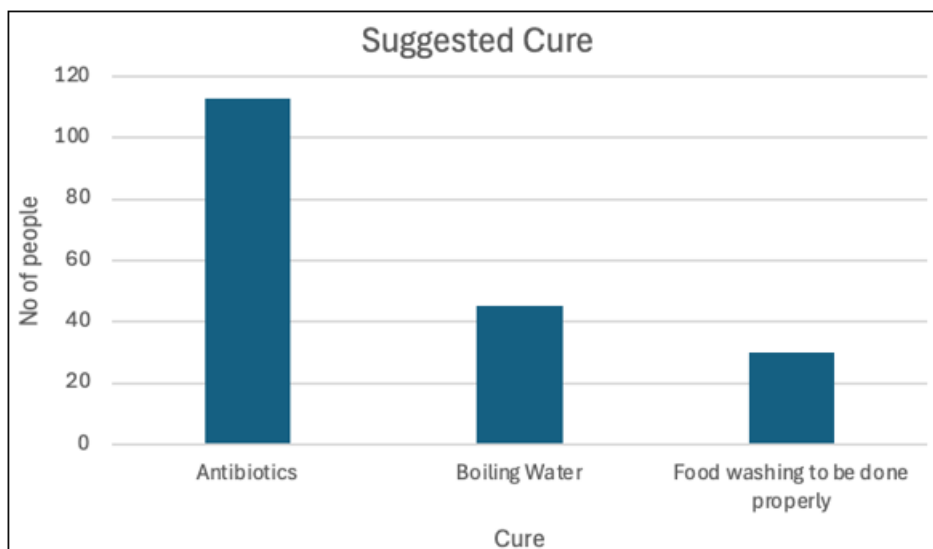

Figure 4

People were aware of the low cost methods easily available at home but were unaware of ones suggested by the research groups around the world. Methods such as Boiling chosen by most of them followed by filtration and vaccines (Figure 5)
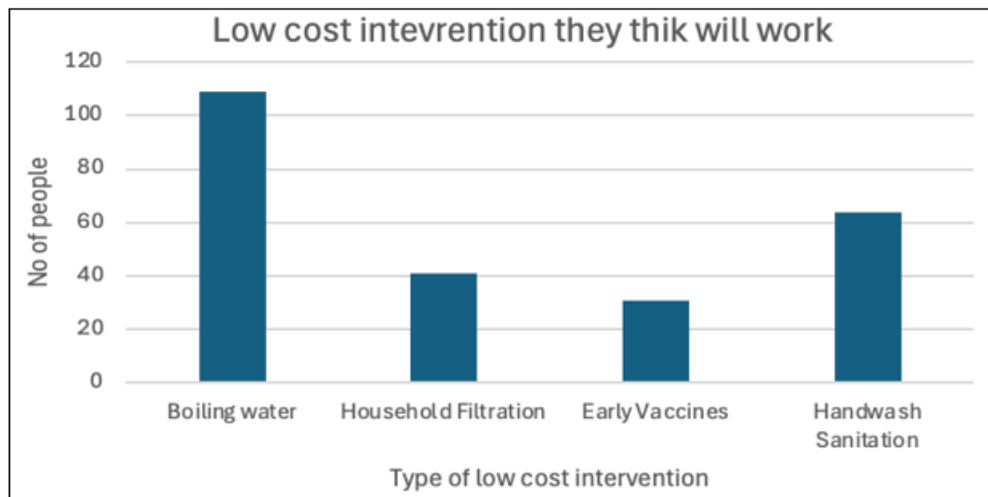
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Figure 5

4. Conclusion

From our studies it is clearly evident that water borne diseases are one of the most common but dreaded diseases. They afflict hundreds of individuals around the world, be it developed or developing countries. Even though the nature of these diseases is bacteria and the most predicted cure is antibiotics, hundreds of deaths occur every year. However there is hope for the future and curing these diseases or preventing the onset is quite easy. Simple methods such as boiling and maintaining sanitation techniques are one of the basic approaches to reduce spread of these diseases.

Multiple low cost interventions such as Bioaugmentation methods, development of health systems, encouraging community involvement. Quick diagnostic test and kits will help to detect these diseases in early stages and will help reduce the numbers world over. Other methods include deployment of oral cholera vaccines to provide immediate protection in high-risk areas and the implementation of comprehensive WASH (water, sanitation, and hygiene) practices. Some of these techniques just involve changes that can be incorporated in our daily lives. Awareness campaigns will help spread the word as much as possible to people in rural areas. Additionally zinc and Vitamin A supplementation in reducing childhood diarrhoea is quite effective, so incorporating these supplements during early developmental years will help control the disease among children.

With the right practices in place eliminating waterborne diseases will not be difficult and low cost interventions are the key to this as they are not only cheaper but easily accessible to people around the world.

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