



Effect of Contaminated Water on Human Health: A Literature Review

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Abstract

The purpose of this research work was to provide an epidemiological explanation in Pakistani society and shed light on the etiology by concentrating on polluted and unclean water. The World Health Organization claims that waterborne infections are the top cause of death globally. An extremely hot problem that leads to water-borne infections is the outbreak of human diseases transmitted by epidemic microorganisms, such as bacteria, viruses, and protozoa. A qualitative research technique was used, and a literature review was conducted. Thirty research articles and project reports were analyzed through a secondary data analysis technique. The findings revealed that pathogenic bacteria in polluted water are responsible for a quarter of all fatalities globally. The fact that Pakistan's inadequate sanitation infrastructure is a major vector for the spread of infectious diseases drives home the point of this article. The recommendation is put forward to the policymakers that hygiene education and water purification systems in every village are critical for human beings' secure health in developing nations like Pakistan.

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Introduction

Water pollution is one of the major problems in the field of worldwide public health. The ground and surface water used in urban activities are sources of chemicals that are utilized in soaps, medicines, detergents, fuel, and other products. Biological and synthetic chemicals, in addition to those found in nature, are therefore considered pollutants of water (Robson, 2015). The availability of clean water for human consumption and bathing is critical, especially for the well-being of young children. Some of the things that pollute water and cause water-borne illnesses include chemical compounds, harmful bacteria, and viruses. These substances are immediately conveyed to humans via the water that is used for drinking, leisure, and other household activities. An epidemic of a water-borne disease happens when two or more individuals have the same kind of sickness, and the epidemiological data points to water as the probable cause (Beaudeau et al., 2008). Furthermore, such epidemics are affecting both poor and rich nations (Health Protection Agency, 2008).

Studying water is like being a scientist in a perpetual state of flux since both water quality and pollution are subject to constant change. The right to clean water and sanitation was proclaimed a universal human right in 2010 by the United Nations General Assembly. Water and sanitation are essential for the attainment of other development objectives, such as ending poverty, reducing gender inequality, and providing enough food for everybody. The contamination of water reserves by chemical, natural, and radiologic contaminants occurs annually, affecting billions of people worldwide (Meinhardt, 2015). Also, according to the Environmental Protection Agency (2008), American public water systems are among the safest in the world. In addition, the World Health Organization and the United Nations Children's Fund have established a joint assessment program for water supply and sanitation that tracks progress toward the Sustainable Development Goals (SDGs) and has classified drinking water supplies into three distinct types. A home's or yard's water supply falls within the first group. The other two categories include both improved (from sources like hand pumps and public taps) and unimproved (from sources like unprotected water that is susceptible to pollution) sources (JMP, 2010). Even still, the treated water is inaccessible to 663

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million people. According to the World Health Organization (2015), half of these individuals call sub-Saharan Africa home, although around 20% call Southern Asia home.

Study Objectives

- To analyze the present situation of water pollution in Pakistani context.
- To explore the water borne diseases problems in Pakistan.
- To explore the water infrastructure and epidemiological scrutiny of water pollution in global context.

Literature Review

Epidemiological Scrutiny of the Global Village

Despite being avoidable with access to clean water and adequate sewage treatment, the cholera pandemic is wreaking havoc on a global scale (Griffith, Kelly-Hope, & Miller, 2006). In 2008, there were 100,000 cases and around 4,000 fatalities during the epidemic in Zimbabwe. According to Harris et al. (2010), it was considered the most extreme eruption in the last decade. Nevertheless, in 2010, cholera broke out for the first time in Haiti (CDC, 2010). It was so deadly that it continued for almost a century (Faucher & Piarroux, 2011). New Mexico was also the site of a previous norovirus epidemic. There were 119 cases of gastrointestinal disease among the juvenile campers who drank from the polluted spring-fed water supply. The fact that it happened again after the first epidemic in that area showed that the problems were not being adequately addressed (CDC, 2015). The European Union (EU) had 354 outbreaks between 2000 and 2007, affecting nations such as Belgium, Croatia, Finland, Greece, Hungary, Italy, Lithuania, Norway, Slovakia, Spain, Sweden, England, and Wales. The quantity of breakouts in a given area is a good measure of the water quality there (Miettinen, 2009).

Furthermore, cholera, malaria, and dengue fever are all interconnected disorders. Their connection to water is that very connection. The bacterial disease known as cholera may be acquired by consuming water that has been polluted. Without access to clean water for drinking and washing hands, caregivers are also at risk of contracting the disease caused by that bacterium. In times of calamity, that pandemic tends to spread more rapidly. Locations inhabited by the world's poorest population tend to have higher rates of these illnesses (Lewis, 2016). Malaria is often considered to be the leading cause of death in tropical regions (Falco & Smith, 2010).

Additionally, climate is strongly correlated with water-borne infectious illnesses. Because there is not enough water to go around, sanitation suffers during droughts. The majority of people living here might drink polluted water. For example, a severe drought in Northern Kenya gave rise to the cholera pandemic (Emily & Shuman, 2010).

Likewise, as a result of SDG's attainment of the global aim to provide clean drinking water to the public, 147 nations in this globe utilize the upgraded sources of drinking water. Oceania, sub-Saharan Africa, Northern Africa, the Caucasus, and Central Asia were among the regions that fell short of the drinking water objective. Eight out of 10 rural residents still do not have access to better sources, compared to urban residents, according to JMP statistics. The World Health Organization (2015) estimates that arsenic-contaminated water affects around 137 million people. Most of the common illnesses in underdeveloped nations disproportionately affect children. One in five fatalities in children less than five years old is caused by diarrhea. According to the World Bank (2008), there is a strong relationship between infant mortality and the percentage of the population that does not have access to clean water, as well as the GDP of that nation.

Educators, parents, and community members throughout Europe recognized the need to ensure their children had access to safe drinking water, proper toilet facilities, and other WASH services in order to promote student wellness. Achieving healthy school settings in the area was the primary focus of the Parma Declaration on Environment and Health in 2010. All of the governments at the time had pledged to restore cleanliness standards and offer access to clean water and sanitation by 2020 in order to reach that goal. Nutrition, health, and education are all aspects of

WASH that are complementary to one another and have strong associations. Equal and widespread distribution of clean water, sanitation, and hygiene (WASH) services is another goal of the Agenda for Sustainable Development, which also aims to provide safe learning settings (Maanen et al., 2016).

Water Infrastructure of Pakistan

From an initial 85% in 1990, Pakistan's water resources increased to a maximum of 92% in 2010. This in no way indicates that more access to water will result in better potable water. Separate from the question of whether or not the water is safe to drink is the question of how to ensure that the water delivery system does not modify the water's characteristics in a way that makes it unfit for human use. Consequently, the cleanliness of grass roots is determined by enhancements to water sanitation systems via initiatives such as the "Joint Monitoring Program for Water Supply and Sanitation" (Bridges & Asian Development Bank, 2007). As a prime instance of creative thinking in these projects, consider the "Project" in Karachi (Katherina, 2008) and sanitation in rural regions. Sanitation also saw an increase from 27% to 48% between 1990 and 2010.

Nevertheless, we cannot claim that this part fixes water supply problems and makes clean water. Urban regions with poor wastewater treatment facilities have led to the spread of water-borne illnesses in cities like Peshawar, Faisalabad, Karachi, and Lahore (Bridges & Asian Development Bank, 2007). According to a study, nearly three million individuals contracted such illnesses in 2006 (World Bank, 2005). Sanitation systems and initiatives in cities are called into question because of the conditions in metropolitan areas. In addition, in 2006 and 2009, the ministries of ecology and the leadership of Pakistan introduced the "National Sanitation Policy" and the "National Drinking Water Policy," respectively. According to Bridges and the Asian Development Bank (2007), the assistance provider was dependent on official and international financing under these policies. However, the projected investment fell short of meeting the community's demands and requirements. Importantly, these initiatives' promises of better water quality have not materialized.

A small percentage of industrial and household wastewater underwent treatment, according to the deplorable data provided by the Ministry of Water and Power. According to the water situational study, Islamabad is home to three purification centers. However, only one of them is operational. Two of Karachi's sanitation facilities are pitiful and ineffective, adding insult to injury. Faisalabad also has a treatment facility. Regardless, it only handles 7% of the city's wastewater. Lahore also has operational grit removal and screening systems.

In contrast, there are zero wastewater treatment facilities in the cities of Rawalpindi, Gujranwala, Bahawalpur, and Gujarat. Also, surface water quality is at risk, and there is no treatment facility in rural regions. Pathogenic infections occur as a result of dirty water and eventually make their way into groundwater. It is possible to prevent a wide variety of transmitted and not transmittable illnesses by treating water. Particulate matter in the water supply is responsible for 80% of global pandemic illnesses. Due to the fact that water-related illnesses claim the lives of about 1.2 million Pakistanis per year and cost the country billions of pounds in medical expenses, this poses a significant risk to public health in the country.

Pakistan's Social and Living Standard Survey, 2010 to 2018

When it comes to meeting the fundamental needs of society on a daily basis, the provision of potable water is a vital task. In essence, drinking water is comprised of 32% of the water from the tap, 28% of the water from hand pumps, 27% of the water from motor pumps, and 4% of the water from wells and other sources. Most of the time, additional sources of water supply are not safe for health and sanitation, which may raise the likelihood of germs combining, which will be detrimental to the community and society as a whole. Based on the findings of the hygiene survey that was carried out in 2015, it was found that the water sources have been improved by as much as 91%. Furthermore, the research highlighted that 66% of the locations have a toilet that flushes, 15% need a toilet that does not flush, and 18% do not have any toilets at all. According to the Pakistan Bureau of Statistics (2012), this demonstrated that the cleanliness infrastructure is not as advanced as its water supply and is also considered to be at an earlier stage.

Quality of Water for Drinking

A well-known aphorism states that where there is water, there is life. However, in our modern day, this statement has taken on a new meaning, namely, where there is clean water, there will be healthy living. According to the Pakistan Research Council of Water Resources (2012), 88% of operable water supply systems are contaminated with microbial infectivity. Furthermore, substantial quantities of arsenic, nitrate, and fluoride contaminants have been found in drinking water throughout Pakistan (Kahlowan, Tahir, & Rasheed, 2007). According to official government certificates, poor water pressure and pipeline leaks are the two most common causes of water pollution.

Furthermore, the parameters of drinking water are not universally defined; they are controlled based on regional conditions. Safe water, as in industrialized nations, is regulated by the 'European Drinking Water Directive,' while in the United States, the 'United States Environmental Protection Agency' created the criteria for clean drinking water. Furthermore, the cleanliness of water is regulated based on the country's context since water varies in terms of pollutants. Water flows from rivers and dams in certain locations before being filtered through several layers of soil and rocks in the ground. Other compounds are consumed in the water; the majority of them are safe up to some point, but others may be harmful to human health.

Scourge of Water-borne Diseases in Pakistan

Pakistan's health system is coping with both transmissible and noncommunicable illnesses at the same time. Tuberculosis, measles, pneumonia, acute respiratory infection, diarrhea, malaria, gastrointestinal infection, viral hepatitis, and acquired immune deficiency syndrome (HIV-AIDS) are among the communicable illnesses that transmit infection. There are mainly two types of water-borne illnesses. The 'water contact illnesses' are transmitted by freshwater, pools, lakes, streams, rivers, and contaminated surface water. People get unwell after using water for bathing, drinking, and washing, as well as preparing or consuming food, and therefore being contaminated. Among the numerous types of illnesses, diarrheal disease is most common in underdeveloped nations, particularly among youngsters. According to an endemic estimated study, about 250,000 children under the age of five died as a result of the common cause of diarrhea, which was disseminated via the use of contaminated water. Once we consider that 630 children die each day from diarrhoea-related reasons in Pakistan, the statistic becomes even more concerning. According to a World Health Organization estimate, the worldwide burden of these illnesses is 4.1% every day, resulting in 1.8 million people deaths per year. Another survey released in Pakistan indicated that 85% of water-borne illnesses are caused by drinking unsanitary water, resulting in 25 million deaths annually. Toxic chemicals have no taste or flavor and enter drinking water in large quantities, potentially causing abnormalities in newborns during delivery and other health concerns. Microbes produce water-borne illnesses; they are found in water and the environment and have been shown to be hazardous to human life, playing a significant influence on mortality. Especially in the contemporary period, problems persist in water filtering and sanitation methods.

Table 1
Cases Reported for Viral Pathogens in Pakistan

| Type of Virus | Reported Area | References |
|---------------|--------------------------|----------------------|
| Hepatitis E | Rawalpindi and Islamabad | (Ahmad et al., 2010) |
| Hepatitis C | Hafizabad | (Bari et al., 2001) |

| | | |
|-------------------|------------|-----------------------|
| Hepatitis C | Faisalabad | (Ahmad et al., 2007) |
| Hepatitis A and E | Faisalabad | (Baryan et al., 2002) |

Additionally, there is another group known as vector-borne illnesses. In this case, the germs are injected by insects that deposit their eggs in the contaminated water rather than entering the human body physically. Using their septic bites, arthropod species such as mosquitoes, ticks, bugs, black flies, and sand flies spread illness. Malaria accounts for 90% of vector-borne illness cases in Sub-Saharan Africa. That illness is the primary cause of the estimated 1.5–2.5 million fatalities that occur each year. Five percent of cases linked to urban environments have resulted in mortality from dengue fever, another virus spread by mosquitoes. The virus that causes chikungunya is very common in urban areas, much like dengue illness. Additionally, yellow fever and Japanese encephalitis are common in Asia's rural regions, where they have a 30% death rate. According to the Central Intelligence Agency (2016), both kinds of water-borne illnesses are similar to harmful microbes that are spread by contaminated water.

Methods

This study aims to analyze the current state of water pollution in Pakistan, examine waterborne disease issues, and assess the state of water infrastructure to conduct a global epidemiological evaluation of water pollution. A systematic literature review (SLR) procedure has been employed, facilitating a thorough, impartial, and reproducible synthesis of existing literature. Adherence to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines ensure academic rigor and accountability. A systematic search was conducted across key academic databases, including Google Scholar, Web of Science, Scopus, Academia.edu, PubMed, ScienceDirect, and SpringerLink, encompassing publications from January 2001 to May 2025.

The keywords employed in the literature search were mixtures of phrases like as “*water pollution in Pakistan*”, “*waterborne diseases Pakistan*”, “*water infrastructure*”, “*epidemiology of water pollution*”, “*water sanitation Pakistan*”, and “*global water quality issues*”. Boolean operators (AND, OR) have been employed to augment the precision of the search. Studies were first screened based on titles and abstracts and then underwent full-text screening. The inclusion criteria were peer-reviewed journal articles, book chapters, conference papers, and governmental or institutional reports published in English that addressed one or more of the specified goals. Research emphasizing the Pakistani context or providing comparative worldwide perspectives on water infrastructure and epidemiological assessments was prioritized. Only publications with explicitly specified techniques and review-based results were approved.

The exclusion criteria were works published before 2001, non-English publications, research irrelevant to water pollution or health effects, opinion pieces, duplicate studies, and unreviewed grey literature. Papers and literature that did not pertain to the fundamental objectives, including those only addressing marine pollution or associated environmental matters, were eliminated. From the first search, more than 4,000 publications and reports were evaluated, resulting in around 120 papers selected for comprehensive review. Ultimately, 30 articles and reputed published reports were selected that met the inclusion criteria, ensuring a fair and thorough synthesis of local and global perspectives on water contamination, associated diseases, and infrastructure-related epidemiological factors.

Conclusion and Recommendations

High-income nations continue to have difficulties in the spread of water-borne infections; even sanitary sanitation, first-rate logistics, and clean architecture are at risk from the spread of harmful

microorganisms. According to a recent U.S. estimate, 19.5 million instances of water-borne illnesses are documented annually. Drinking water is one of the primary causes of the 60,000 instances of cryptosporidiosis sickness that are recorded in the United Kingdom each year. Another problem in industrialized nations is the 150 million people who utilize single-use water sources, many of whom reside in rural locations where strict regulations and inadequate monitoring raise the danger of harmful water-borne illnesses. A thorough analysis of worldwide surveillance on contaminated water and parasitic protozoa outbreaks between January 2004 and December 2010 is presented. In this case, the Australian mainland accounted for 46.7% of the recorded outbreaks, followed by North America (30.6%) and Europe (16.5%). Amongst them, outbreaks in Europe and America account for 60.3%.

Similarly, people with water-borne illnesses, especially in underdeveloped nations, occupy half of hospital beds worldwide. Furthermore, the worst hygiene conditions and contaminated water are associated with 80% of the infections. Water-borne illnesses account for one out of every five fatalities globally. According to a separate assessment by the United Nations panel, the use of contaminated water is causing the deaths of 4,000 children. According to the research, water-borne illnesses account for four out of ten deaths worldwide, especially in Asia and Africa. Both Asia and Africa are home to a large percentage of the world's population, meaning that half of them suffer from these illnesses as a result of unsanitary conditions and tainted water. Approximately two million people die from diarrhea, while four billion people are affected by it in poorer nations (Berman, 2009).

According to a World Health Organization estimate, 100 million children under five get diarrhea annually in underdeveloped nations. Unsafe and contaminated drinking water is the only cause of the enormous number of sick individuals. In addition, the Council of Scientific and Industrial Research Laboratories Complex in Pakistan said that water-borne diseases account for 40% of fatalities and 80% of hospitalizations. Additionally, cholera, typhoid, hepatitis A and E, and diarrhea are among the most common water-borne illnesses in the nation. This danger is not limited to rural regions; metropolitan areas are also now victims of this concerning circumstance (Zia, 2013).

Along with the aforementioned, it is advised that the business sector and non-governmental organizations (NGOs) take a leading role in educating schools, colleges, and universities about the effectiveness of enhanced sanitation and a sanitary atmosphere in reducing the incidence of communicable illnesses in Pakistan. Young people, in particular, may make a big contribution to aware about water born disease. When it comes to water sanitation and infectious diseases, everyone has a role to play; the well-known phrase "health for all" is not just the duty of government agencies or the wider community health.

Author Contributions:

The Conception and design: Hafiz Farhan Gohar. Collection and refined data: Literature Review Analysis and interpretation of the results: Drafting and Critical revision of the article for important intellectual content:

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