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Research Article

Spatio-Temporal Impact of Contaminated Water on Human Health in South-Asian Countries

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Abstract

Drinking water is one of the basic human necessities and rights. Availability of clean drinking water is the primary requirement for a human to stay healthy. The consumption of unsafe or contaminated drinking water causes various waterborne infectious diseases, which are deadly to humans and animals alike. One such disease caused due to the consumption of unsafe drinking water is diarrhoea, which is the most fatal disease globally, infecting humans and preferably children below the age of five years. The present study deals with the assessment of the spread of diarrhoea in countries where the death toll is maximum in Diarrhoeal deaths. The study analysed the mortality rate of diarrhoea for both children with age less than five years and other people of both sexes in Afghanistan, Bangladesh, China, India, Nepal, Pakistan, and Sri Lanka. The study can be proved very beneficial in making policies for diarrhoea prevention and control in both adults and child

Key Words: Diarrhoea, Global status, Status of diarrhoea, Prevention, Control, waterborne diseases

Introduction:

Water is said to be the driving agent of life on this earth. From trees and plants to animals and humans, every living organism depends on water for survival. However, the availability of fresh water is critically scarce. Of the total water present on the Earth, only 2.5% is fresh water, and just 0.3% of that exists in a liquid state accessible to humans (Jury and Vaux, 2007).

According to the World Bank, India hosts 18% of the total global pollution but has access to only 4% of the world's freshwater resources, which makes it one of the most

water-stressed countries in the world (Salehi, 2022). Similar is the case of some neighbouring countries of India, such as China, having only 6% of the global water resources available for roughly 18% of the global population residing in the country, Nepal, Afghanistan, Sri Lanka, Pakistan, and Bangladesh (Wang et al., 2021). All the countries are facing high explosions of population growth along with the rapid exploitation of water resources due to climate change, as well as over-increased human interference. This is one of the most crucial problems that needs to be addressed and resolved quickly for the stability of the economy in a country.

Another problem holding an equal level of concern in a country's economy is contamination of drinking water. There are major health impacts that can impose a serious threat to human health as well as the environment due to the consumption of contaminated drinking water (Fida et al., 2023; Lin et al., 2022). The government enacts various laws and acts in this regard, but still, the graph of health-impacting cases due to contaminated water is rising. There are various sources through which the contamination can be introduced to the water that is being utilized by humans as well as animals. This contaminated water is not only posing deadly health impacts to humans but is also affecting the animals and the environment gradually (Van Vliet et al., 2021). The present study is carried out in some South-Asian countries, namely India, Afghanistan, China, Nepal, Bangladesh, Pakistan, and Sri Lanka to emphasize the deadly impact of the waterborne diseases spread due to the polluted drinking water. The objective of the study is to assess and highlight the mortality rate in some of the highly affected South-Asian countries; and to assess the effect of Diarrhoeal disease on different age groups of population.

Contamination Present in Drinking Water :

The quality of drinking water can be hampered by a number of microbial and chemical contaminants responsible for spreading numerous diseases, as well as epidemics in some serious situations. Sources of these contaminants, although discrete, may include point sources such as wastewater treatment plants, leaking septic tanks, and industries, as well as non-point sources such as agricultural runoff, urban runoff, construction site runoff, and atmospheric deposition. These sources can magnify the harmful as well as non-harmful pathogens introduced in the drinking water

sources, which majorly affects the surface water sources when compared to groundwater sources (Wang et al., 2021). The various polluting contaminants introduced in the drinking water sources as thoroughly discussed below:

- **Microbial Contaminants**

One of the major problems in the quality of drinking water is the contamination of water due to faecal matter and all the pathogens arising from human faecal waste. This is one of the major sources of the spread of Diarrhoeal disease in humans. It can sometimes also become the cause of an epidemic outbreak of waterborne diseases, such as in the case of Europe and North America in the 19th century. Drinking water containing these pathogens is extremely dangerous for human health and can cause diarrhoea, cholera, and other harmful diseases, and in some cases, self-limiting Diarrhoeal disease, which, as of now, is incurable (Pieper et al., 2021). The majority of pathogens caused due to this faecal discharge as well as the pipelines and taps, are listed in Table 1. The detection of pathogens present in drinking water is very difficult to access and thus Escherichia coli and faecal streptococci as used as indicators of pathogens involvement in drinking water (Kristanti et al., 2022). Mostly, the pathogens in large numbers are not harmful, but some, such as the case of *Pseudomonas aeruginosa* and *Aeromonas* spp. are deadly and can get manifold at particular temperature conditions.

- **Chemical Contaminants**

Chemical contaminants are the toxic substances introduced naturally or manually into the drinking water whose presence over a permissible limit can impose various deadly diseases on humans and animals and significant harm to the environment. The chemical contaminants can be organic or inorganic and can originate from a variety of natural sources such as living organisms like plants, fungi, bacteria, and algae, and artificially originates from various sources such as industries including mining practices, tannery activities, plastics manufacturing, waste management, and the fuel/energy generation; agricultural waste such as pesticides, herbicides or fertilizer discharge; and other human activities such as petroleum, automobile, pharmaceutical or electrical waste (Levin et al., 2024; Valbonesi et al., 2021). A compilation of

various harmful chemicals presents in drinking water and their possible harmful impacts on human health, incorporating the studies concerning the case, is shown in Table 2.

1. Effect of Diarrhoea on Human Health

The condition of dehydration generated due to three or more loose liquid or watery bowel movements in a day is known as diarrhoea. This condition generally arises due to the consumption of contaminated food and water. About 1.7 to 5 billion cases of diarrhoea emerge per year and make diarrhoea one of the most fatal waterborne diseases (Kolstad and Johansson, 2011). People of any age group can get affected by diarrhoea, but the disease is prevailing in children below the age of 5 (Farthing, 2000). According to the study by Curtis et al. (2000), approximately 2.9 million deaths were caused by diarrhoea globally in 1990, which was reduced to 1.53 million in 2019, which is still an immense figure to go on with. In 2012, diarrhoea was the second most common cause of death in children below the age of 5 years (de Vrese and Offick, 2010).

The most common cause of diarrhoea is the consumption of drinking water contaminated with feces, which ultimately leads to the infection of the intestine through a parasite. Diarrhoeal disease can be broadly classified into three categories, namely watery Diarrhoea, Bloody Diarrhoea, and persistent Diarrhoea (Petri et al., 2008). Acute watery diarrhoea is a condition when the human body suffers a quick loss of water and electrolytes, leading to intense dehydration and vascular collapse in infants and young children. Enterotoxigenic *E.coli* and *Vibrio cholerae* are the agents causing diarrhoea, and rotavirus and enteric adenovirus are the agents leading an infant to suffer diarrhoeal disease (Weirzba and Muhib, 2018). Bloody Diarrhoea also known as dysentery, is a condition the human body suffers from loose watery stool mixed with blood. It is usually caused by enteropathogens such as *Shigella* spp., *Salmonella* spp., and *Campylobacter jejuni*. In adults as well as infants, the major carrier of bloody diarrhoea is Enterohaemorrhagic *E.coli,* causing infection in the distal ileum and colon (Kelly and Hodges, 2024). The condition of persistent diarrhoea occurs when the body suffers from loose watery stools for more than two weeks. It can be caused by any of the organisms sited above but in children, enteropathogenic and enteroaggregative

E.coli also plays a significant role in causing persistent diarrhoea (Kotloff, 2022).

The best ways to keep ourselves safe from Diarrhoea are sanitation, consuming clean drinking water, and washing hands frequently at regular intervals. Eating healthy food or consuming zinc tablets are a few ways to resist the intestinal infection caused by Diarrhoea in adults. For infant, continuous breastfeeding and oral rehydration solutions can be recommended to safeguard them against the fatal diarrhoeal disease (Guerrant et al., 2002).

Material & Method:

For the present study, mortality data from around the world were analysed from the online data repository of the World Health Organization. Based on that data, seven countries across the world were selected, which were India, Afghanistan, Bangladesh, China, Nepal, Pakistan, and Sri Lanka. Also, the deaths due to diarrhoea were recorded from the repository of the World Health Organization from the year 2000 to 2021 for these selected countries. The population of these selected counties, according to the latest census count, is represented in Table 3. Among all the waterborne diseases, diarrhoea was selected for the study because it is one of the most fatal and easily spread waterborne diseases, which has contributed high rate of deaths due to the consumption of contaminated drinking water. Among different age groups and genders of the people living in those selected countries, the major affected selected age group was observed to be the children below the age of five years. The present study tries to enlighten the impact of diarrhoea on children below the age of five from 2000 to 2021. Figure 1 below shows the parameters being taken for the selected countries to analyse the seriousness of the situation arising due to the contaminated drinking water.

Result and Discussion:

The present study focused on analysing the harmful effects caused by contaminated water on human health, and it was found that the most widespread and fatal disease originating from the contaminated drinking water was diarrhoea. Diarrhoea, being a waterborne disease, caused the greatest number of deaths globally, targeting children below the age of five years on a primarily basis. The study tried to show mortality rate in all the seven countries by considering the totals deaths and deaths due to diarrhoea in all the seven countries. Figure 2 below indicates the global death rate due to diarrhoea from 2000 to 2021 in

the selected countries, and Figure 3 represents graphically the status of the death rate due to diarrhoea in India, Afghanistan, Bangladesh, China, Nepal, Pakistan, and Sri Lanka.

Most cases of diarrhoea were observed in the children of India, where India leads in the maximum mortality rates. The mortality rate due to diarrhoea is led by India, followed by Pakistan, Bangladesh, and so on. Moreover, the number of mortality cases in children below the age of five years was much higher than that of adults of both sexes. Figure 4 (a), (b), (c), (d), (e), (f), (g) illustrate the deaths caused by Diarrhoeal disease in all the selected seven countries for both the genre of the population i.e., children below the age of five years and all the other population including both the genders. The present study also tried to determine the per annum switch in the mortality cases due to diarrhoea in the selected seven counties and observed a decreasing trend in the deaths due to diarrhoeal disease, as shown in Figure 5. The reasons for such a reduction in the cases included awareness of the ill impacts of unsafe drinking water, access to clean drinking water, improvements in sanitation, hygiene promotions,

Conclusion:

The present study was conducted to carry out an analysis of Diarrhoeal death cases in Afghanistan, Bangladesh, China, India, Nepal, Pakistan, and Sri Lanka for both adults of both sexes and children below the age of five years. The study carried out a comparative graphical analysis of deaths of adults of both sexes and children below the age of five years as depicted in the Figure. The graphs indicated that India topped in the number of cases of diarrhoeal deaths per year. The results from the graph can also be drawn that in Afghanistan, the deaths of children less than 5 years are much more than the other people of both sexes, while in the rest of the countries, the number of deaths in children less than five years is less than the adults of both genders. Also, after India, the highest number of cases of diarrhoea were observed in Bangladesh, whereas Sri Lanka is the country among all the seven countries regarded for this study that has the least number of deaths due to diarrhoea. It is evident from the fig. that India ranks top in annual death count, followed by Pakistan and Bangladesh. It can be concluded from the study that though the number of cases drops each year, but still there is a significant figure of deaths in both adults and children standing and needs to be dragged down for which

availability of clean drinking water needs to be assured to all classes of people living in the country as well as proper policies addressing the solution for this huge number of cases.

Table 1: Harmful microbial pathogens in drinking water

S.no.	Pathogen	Activity	Citation
1	*Pseudomonas aeruginosa*	Causes acute or chronic infection	Klockgether and Tümmler, 2017
2	*Aeromonas* Spp.	Wound infections, cellulitis, septicemia, and urinary tract infections in both humans and animals	Altwegg et al., 1989
3	*Cryptosporidium parvum*	Persistent Diarrhoea and gastroenteritis in humans and animals	DuPont et al., 1995
4	*Giardia*	Infecting the upper intestinal tract of humans as well as domestic and wild animals	Dixon, 2021
5	*Salmonella typhi*	Causes typhoid fever in humans by invading the gastrointestinal tract, the intestine, and the bloodstream	Zhang et al., 2008
6	*Campylobacter*	Bacterial Diarrhoea, abdominal pain, fever, nausea, and Guillain-Barré syndrome in some cases	Saint-Cyr et al., 2016
7	*E. coli* 0157	Intestinal mucosa and releasing Shiga toxin	Mead and Griffin, 1998

Source: Researcher Data collection

Table 2: Harmful chemical contaminants in drinking water

S. No.	Contaminant	Diseases spread	Study
1	Nitrogen	Methemoglobinemia; certain cancers; reproductive problems; and thyroid issues.	Wolfe and Patz, 2002
2	Bleach	Irritation in the eyes, nose, and throat; stomach discomfort; nausea; vomiting; or abdominal cramps.	Rutala and Weber, 1997
3	Salts	High blood pressure; increased risk of heart disease; kidney problems; and gastrointestinal issues.	Hunter et al., 2022
4	Pesticides	Reduce body immunity; hormonal imbalance; reproductive-related issues; and cancer.	Syafrudin et al., 2021

5	Metals	Acute to chronic illnesses; damage to the liver, kidneys, and nervous system; cancer; diabetes; and reproductive problems.	Mohod and Dhote, 2013
6	Toxins produced by bacteria	Gastrointestinal issues; diarrhoea; vomiting; cramps; fever; hepatitis; and typhoid fever.	Falconer, 1996
7	Human or animal drugs	Typhoid fever; cholera; hepatitis A and F; polio; diarrhoea; dysentery; and giardiasis.	Bruce et al., 2010

Source: Researcher own collection

Table 3: Population of selected developing nations

S. No.	Country	Population
1	Afghanistan	43.8 million
2	Bangladesh	0.169 billion
3	China	1.41 billion
4	India	1.21 billion
5	Nepal	29.16 million
6	Pakistan	0.24 billion
7	Sri Lanka	21.76 million

Source: Researcher own collection

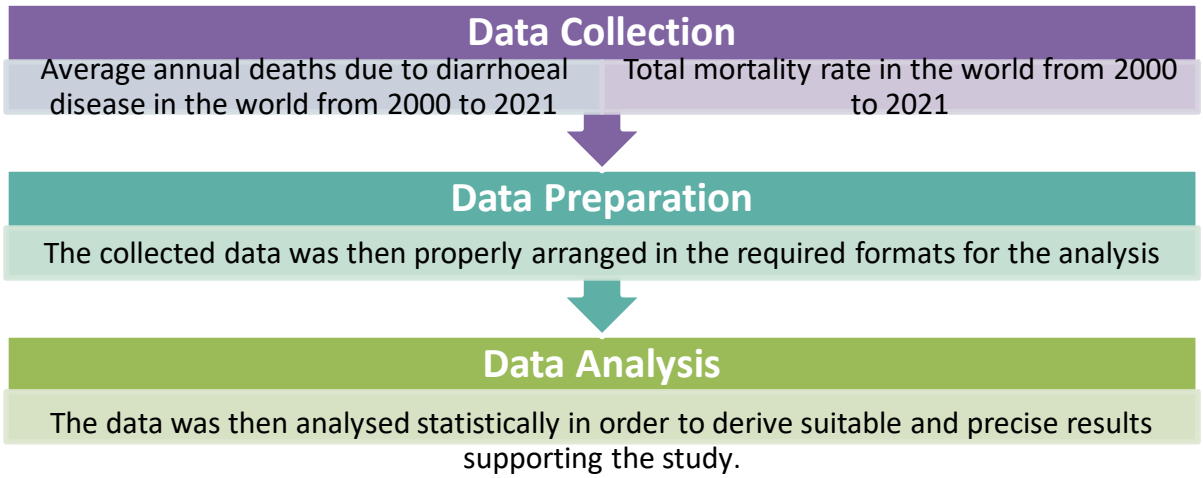

Figure 1: Methodology adopted in the stud

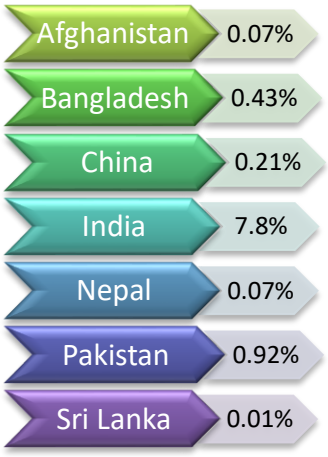

Figure 2: Mortality rate for the selected countries

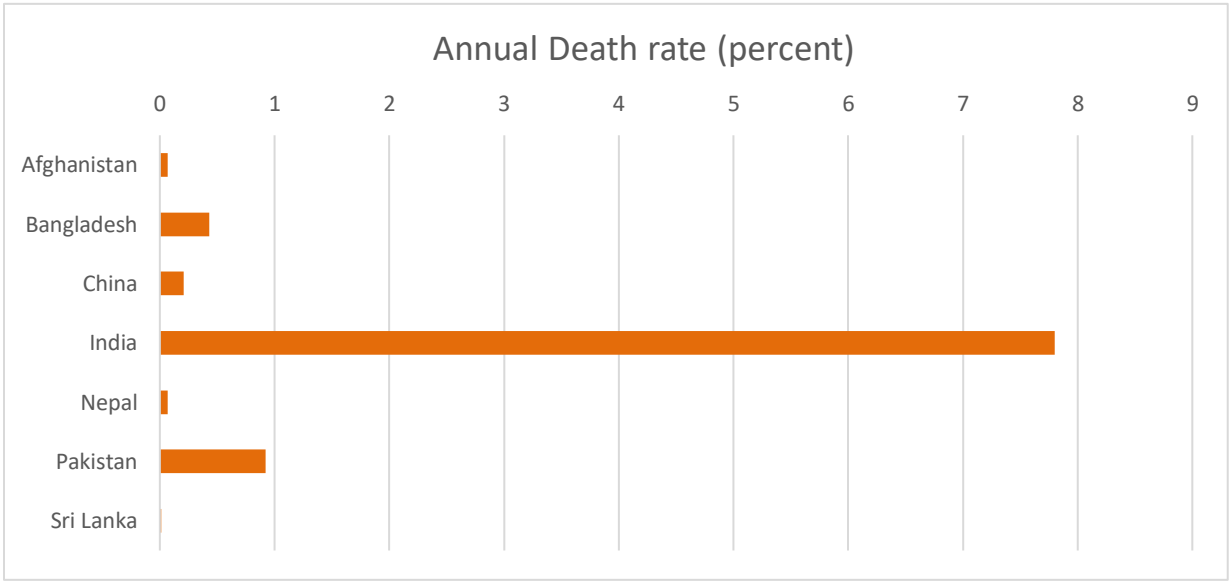

Figure 3: Graphical representation of the mortality rate of the selected countries

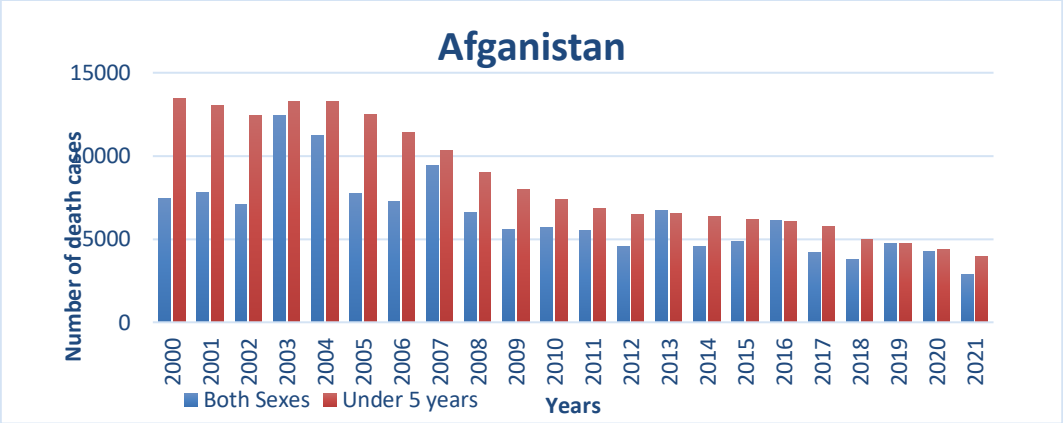

Figure 4 (a): Diarrhoeal death cases in Afghanistan from 2000 to 2021

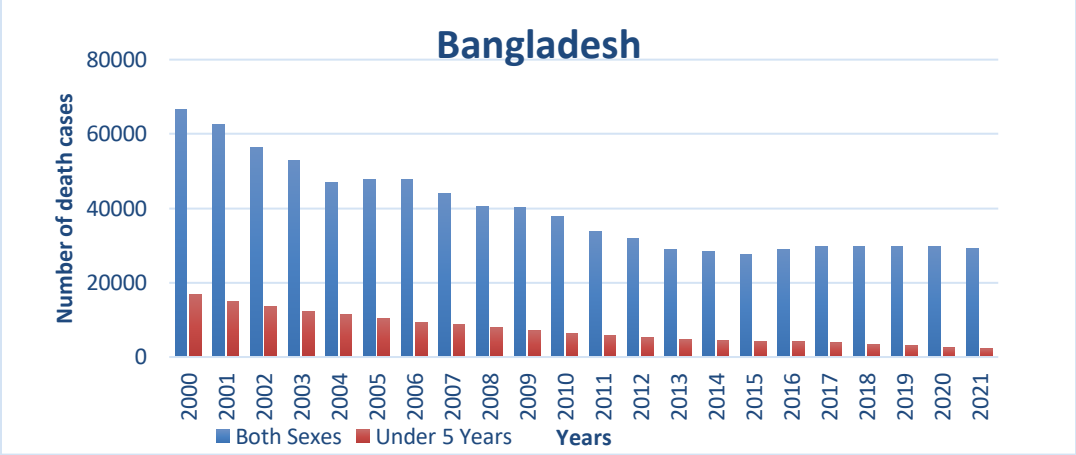

Figure 4 (b): Diarrhoeal death cases in Bangladesh from 2000 to 2021

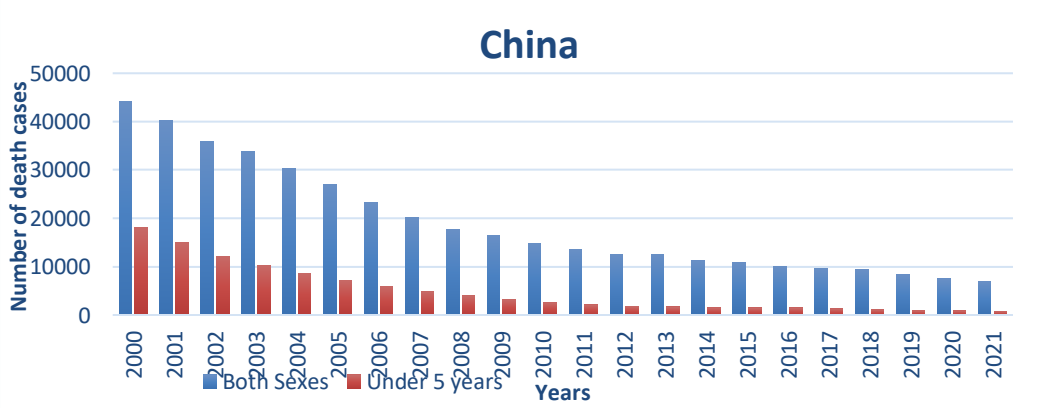

Figure 4 (c): Diarrhoeal death cases in China from 2000 to 2021

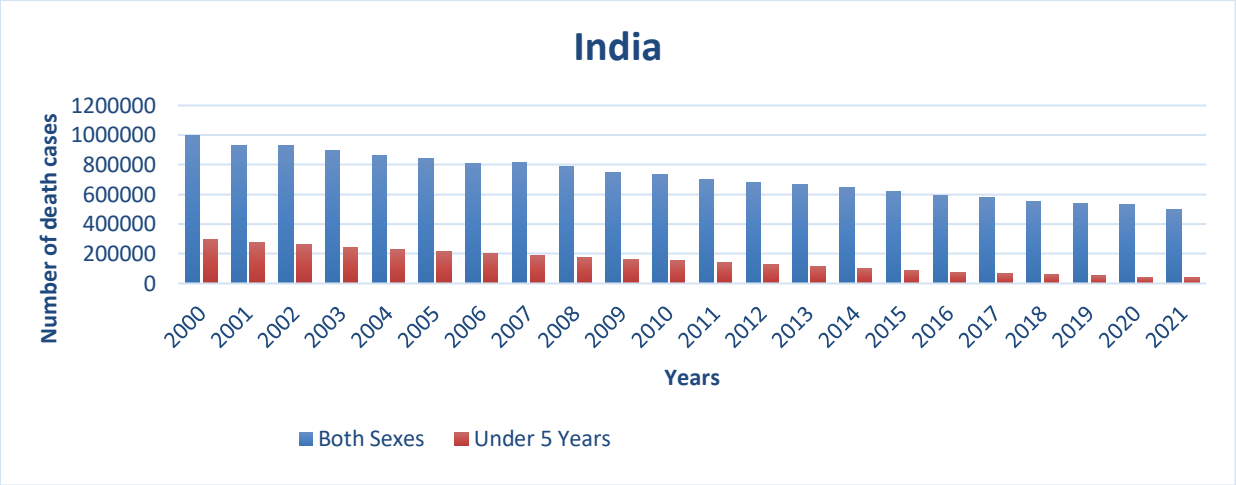

Figure 4 (d): Diarrhoeal death cases in India from 2000 to 2021

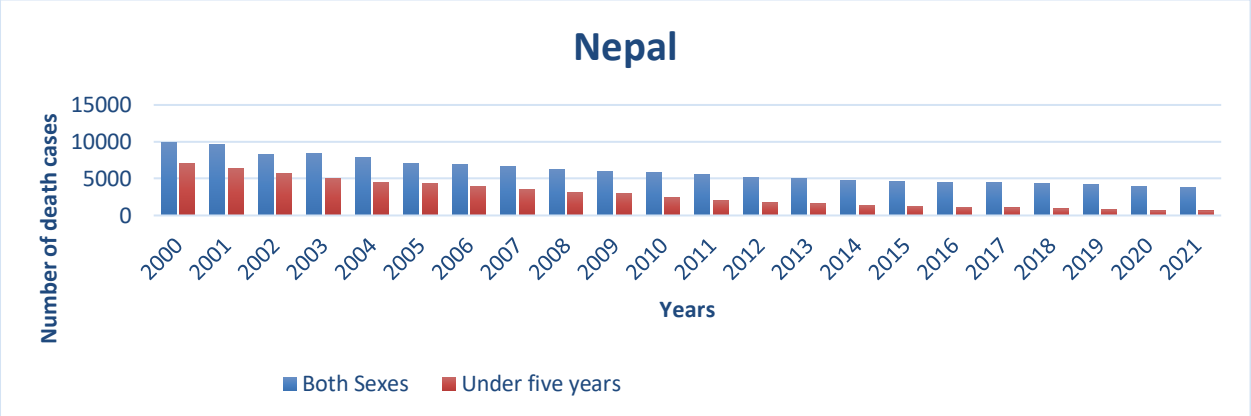

Figure 4 (e): Diarrhoeal death cases in Nepal from 2000 to 2021

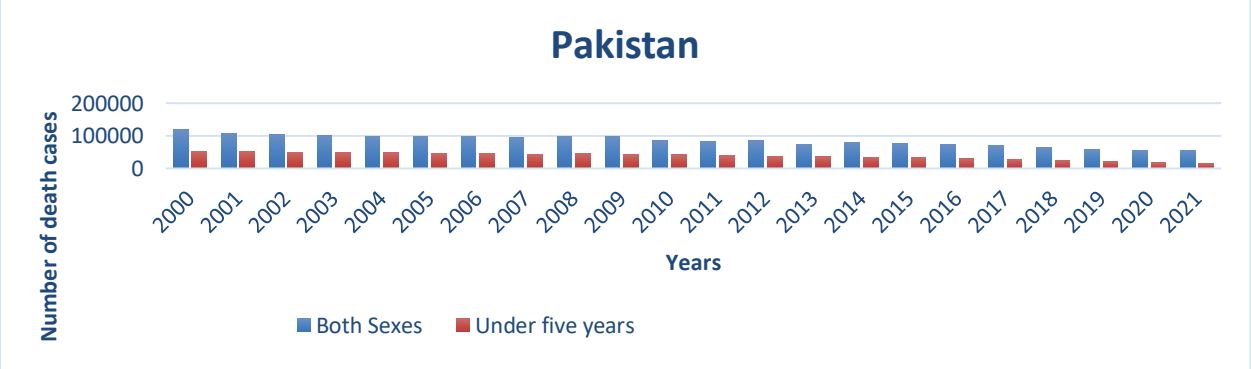

Figure 4 (f): Diarrhoeal death cases in Pakistan from 2000 to 2021

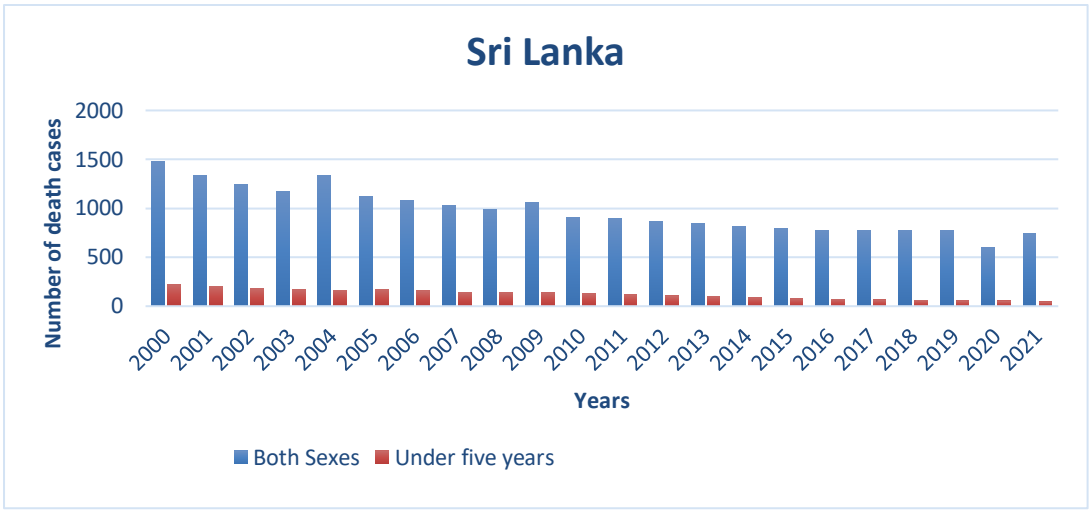

Figure 4 (g): Diarrhoeal death cases in Sri Lanka from 2000 to 2021

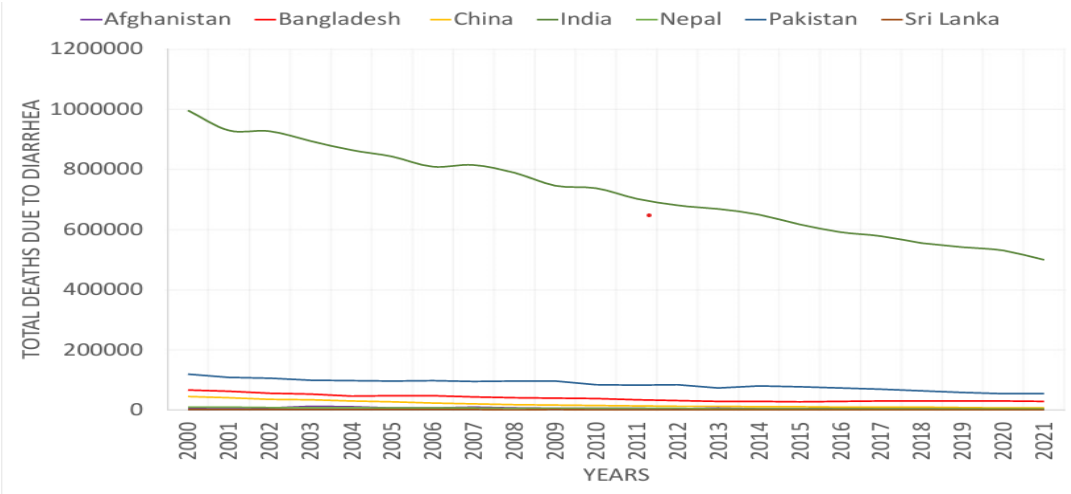

Figure 5: Total diarrhoeal death cases in all seven selected countries from 2000 to 2021

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