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Dam Construction and Schistosomiasis

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ABSTRACT

Schistosomiasis is a neglected tropical disease (NTD) that leads to poor health outcomes and negative socioeconomic impacts. It is estimated to have a burden of 1.9 million disability-adjusted life years globally. Prevalent in tropical and subtropical regions, it is caused by a parasitic worm that penetrates the skin through water transmission. Chronic and reinfections can lead to lifelong complications, such as liver damage, stunting of growth and development, and an increased risk for bladder cancer. There are several risk factors for schistosomiasis, including poor sanitation, access to clean water sources, living and working near freshwater rivers, and knowledge about the disease. Developmental water projects, such as the creation of dams, can also become a significant risk factor. Dams increase breeding grounds for freshwater snails, which serve as the parasite's intermediate hosts, and stop the migration of prawns that prey on these snails into rivers. These factors then increase the chances of exposure to the parasite, thus leading to higher cases of human infection. An integrated collaborative approach through ongoing environmental and disease surveillance, coupled with enhanced sanitation and hygiene provision and health education, is vital to reduce the negative consequences that dams can pose on the prevalence of schistosomiasis.

Keywords: Dam construction, Schistosomiasis, Tropical disease, Communicable diseases, Disease prevention

1. INTRODUCTION

Recognized by the World Health Organization (WHO) as a neglected tropical disease (NTD), schistosomiasis, also known as Bilharzia, second only to Malaria in regards to socioeconomic impact poses a severe global health challenge [1]. It is estimated that over 700 million people are at risk for infection worldwide, with at least 237 million people requiring preventive treatment in endemic areas [2-3].

Schistosomiasis is caused by a parasitic worm of the genus Schistosoma, and transmission occurs when individuals come into contact with cercaria, the larval

form of the parasite that infests bodies of freshwater [3]. Populations most at risk include children, women, agricultural workers and fishermen [4]. Symptoms are caused by the body's reaction to the worm's eggs and are characterized by a rash or itchy skin, which can progress to a fever, headache and diarrhea [5]. Treatment consists of taking Praziquantel for 1-2 days to kill the worms [5]. If treatment is not acquired, chronic infection occurs, resulting in blood in stool or urine, damage to the liver, increased risk of bladder cancer, malnutrition and anemia in children [5]. However, reinfections are common, and since individuals often do not present symptoms immediately or remain asymptomatic, prevention and control efforts are critical [5].

Environmental changes resulting from water scheme developments such as dam construction and irrigation systems can lead to changes in disease distribution and transmission. It is hypothesized that dam construction increases human schistosomiasis transmission. It is essential to investigate this relationship, as schistosomiasis is taking a toll on the poor; evidently, it has significantly reduced labor productivity in countries such as Egypt, Sudan and Tanzania [4]. Thus, the following paper will examine various studies related to the link between dam construction and its impact on schistosomiasis transmission in endemic regions.

2. METHOD AND MATERIALS

A literature review was conducted by first identifying relevant articles through the PubMed database by searching the phrase “schisto* AND dam” (n = 284). Schistosomiasis as a whole term was not used to ensure that articles using the words schistosoma, schisto and schistosome within their title were not excluded. The following filters to narrow down the literature were applied: free-full text, published within the last ten years, humans as the subjects and written in the English language (n = 68). Sex or age restrictions were not applied. Books, clinical trials, and randomized controlled trials were excluded; thus, the articles further examined consisted of journal articles, meta-analyses and systematic reviews (n = 67). The results were then sorted by checking that the titles and abstracts fit the inclusion criteria. The inclusion criteria included emphasis on quantitative data, data on transmission rates of schistosomiasis before and after dam construction, distribution of intermediate hosts after dam construction, observational or monitoring studies implemented after the construction of dams, field research and qualitative data to determine risk factors for schistosomiasis (n = 20). The articles were then fully read, and those that did not meet the inclusion criteria were excluded; in total, 16 articles were finalized to be used for this research paper. Through a grounded theory approach, it will analyze the identified literature sources to determine whether my hypothesis that dam construction leads to increased transmission of schistosomiasis can be accepted.

3. DISCUSSION

Dams are useful for generating power, stabilizing water availability and facilitating crop production and thus have the potential to provide significant benefits to society [6]. In regions susceptible to long periods of drought, dams are often developed to solve the shortage of food and water [7]. In 1979, commitments to the construction of the Diama and Manantali dams along the Senegal River were established [8].

This project was proposed as poor weather conditions and salt-water intrusion made nearby land unfitting for agricultural purposes, leading to a food shortage crisis [8]. However, within a couple of years after completion, adverse effects on the local ecosystem and on the health

of the nearby communities were observed [8-9]. Notably, cases of both urogenital and intestinal schistosomiasis infections increased [10]. It is estimated that of the approximately 700 million people at risk from schistosomiasis, 100 million, 13.6% of all of the at-risk population, live close to dam systems [8, 11]. The degree to which this disease is distributed depends on the concentration of freshwater snails, which serve as intermediate hosts for trematode worms [12]. The creation of dams seems to expand favorable habits for these snails, in effect spreading new transmission sites for schistosomiasis [11]. Another notable hypothesis to explain this trend argues that dams block the migration of native river prawns, Macrobrachium vollenhovenii, that prey on snails [13]. In this way, the parasite larvae are able to continue reproducing and maturing within the snails, leading to increased chances that a worm will penetrate human skin and infect them with schistosomiasis. As an effort to reduce schistosomiasis in these impacted regions, officials reintroduced the river prawns into an intervention site of the Senegal River [9]. The results showed that, in comparison to the control site, “the prevalence of snail species and schistosomiasis transmission substantially decreased in the intervention site” [9]. This finding strongly indicates that the dams are associated with the increase in schistosomiasis transmission.

Similar trends have also been observed with the Tono irrigation scheme in Ghana, the Aswan Dam in Egypt, and several dams across many countries in Africa [13-14]. The Tono dam, one of the largest agricultural dams in West Africa, is located in the Kassena-Nankana district in Ghana. It first became operational in 1977 and has provided communities with a year-round water supply for crop use [1]. However, it was observed that the water contact of nearby communities was very high, with 71.4% of children indicating that they swim in the canal frequently [1]. It was again observed that these individuals, in this case, children, who engaged in frequent activities in this river had higher rates of infection. Furthermore, in the 1930s, the completion of the Aswan Low Dam led to a rapid increase in schistosomiasis, with some areas rising from 20% prevalence to a 75% prevalence rate [13]. A review of these several articles supports the hypothesis that dams increase schistosomiasis transmission.

When the Three Gorges Dam (TGD) began its construction in 1994 in China, there were many concerns that it would create the same problems observed within Africa [15]. Now known as the world's largest dam, it was completed in 2009 and is situated along the Yangtze River [16]. It serves as a method of flood adjustment and year-round water storage [15]. Flooding of the lower and middle regions of the river has been associated with the spread of freshwater snails [15]. However, the TGD runs on a ‘land-summer and water-winter’ cycle, which contradicts the reproduction cycle of snails and thus decreases the snail population. [15]. A longitudinal observational study from 2004-2016 conducted in Hubai concluded that the prevalence of schistosomiasis cases decreased by 96.97% in 2016 compared to 2004 [15]. In this way, the dam is able to reduce contact with infected water by decreasing flooding and is able to reduce snail density in marshlands, thus decreasing the transmission of schistosomiasis. The TGD should be further investigated, and ongoing surveillance and monitoring should be conducted, as other endemic countries can learn from their success and implement similar strategies.

Schistosomiasis can be considered a disease of poverty, as it mainly impacts low-income and middle-income countries; in fact, approximately 85% of the world's cases are concentrated in Africa, leading to a substantial loss of income due to morbidity and mortality [12].

Since schistosomiasis is transmitted through infected water, engaging in activities such as fishing, farming, washing clothes, bathing and swimming around bodies of freshwater increases the probability of infection [7]. In a survey, over 60% of farmers reported suffering from schistosomiasis at least once in their life [4]. This indicates that communities most affected will be composed of lower-class individuals, as they rely on the rivers in which the dams are built to provide them with water for daily use and for income. Since many of the communities cannot limit their contact with infected water, dam construction must be improved such that it does not increase the risk of infection and leads to poor socioeconomic and health outcomes.

4. CONCLUSION

Several articles reporting on dams in Africa have provided significant evidence that schistosomiasis cases increased within communities situated near newly constructed dams. However, investigation of the TGD in China reveals that dams could reduce schistosomiasis transmission. The literature concludes that since the TGD eliminates snail breeding grounds, human exposure to the parasite is reduced as larvae are left with no intermediate host [16]. Furthermore, implementing an integrated control program near the Yangtze River, consisting of agricultural development, fencing bovines and drug treatment for infected hosts, likely contributed to this project's success [16]. This indicates that through multi-sector collaboration, dams can be effective in preventing and controlling schistosomiasis.

Key recommendations build on this existing research with an emphasis on interdisciplinary efforts. The first recommendation is conducting ongoing surveillance through environmental monitoring of dams, such that changes in disease distribution and transmission can be tracked and consequences can be appropriately and timely mitigated. Furthermore, due to increased travel and migration in this globalized world, incorporating mandatory reporting of schistosomiasis is essential to track and monitor the disease's distribution. Additionally, investing in sanitation and hygiene is critical for good health outcomes. This can be done by providing a safe and cheap water supply to communities near dams and establishing sanitation infrastructure such as toilets, such that human contact with infected water can be reduced. Implementing toilets near lakes or establishing safe and efficient portable toilet systems is particularly important for fishermen, as they find themselves urinating and defecating in the rivers as they have no other options. Since schistosomiasis is transmitted to humans via contact with water and human waste can reintroduce the parasite eggs back into the water, this strategy will break the transmission cycle and reduce mortality and morbidity from this disease. Furthermore, it was noted in a qualitative study that health literacy led to behavioral changes for those living near dam reservoirs. By providing comprehensive and community-relevant information on schistosomiasis, coupled with enhanced water and sanitation systems, individuals will be able to practice health-protective behaviors. This would require the support of health officials, volunteers and community leaders. Overall, the recommendations require significant collaboration across all institutions of society, such that a safe environment and community mobilization can be achieved to decrease the risk of increased schistosomiasis transmission due to dam construction.

There are still many research gaps; notably, many of the studies indicated gender differences, in which males had increased rates of infection even though women had higher-water contact patterns. Thus, further investigation looking at why these gender differences

exist is crucial to develop targeted prevention strategies. In conclusion, this paper revealed the importance of investigating the link between dam construction and schistosomiasis, such that enhanced prevention and control methods can be developed. Although my hypothesis that dams lead to increased transmission of schistosomiasis cannot be entirely accepted as accurate, as there are exceptions, it is clear that a correlation does exist. Thus, global priorities need to be shifted toward investigating this relationship in more depth.

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6. CONFLICT OF INTEREST

The authors have declared that there is no conflict of interest.

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