Floods: An Increasing Threat to Schistosomiasis Control in Nigeria

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Schistosomiasis is an endemic neglected tropical disease in Africa. Nigeria has the highest prevalence and intensity of the infection with a severe transmission rate. The World Health Organisation (WHO) targeted the interruption of transmission and the elimination of the disease by 2030. However, an increasing climate change consequence, flooding, may foster a challenge in the control of the infection. This article provided an overview of the potentiality of flooding in increasing the spread of schistosomiasis transmission in Nigeria, thus hindering its control. Floods increases the dispersal of Bulinus and Biomphalaria snails which are the intermediate host of schistosomiasis, from active transmission areas to areas without the infection, thereby causing an increase in the transmission of schistosomiasis in humans and animals (especially livestock). The destruction of sanitary facilities in schistosomiasis infested areas and the displacement of people and animals by flooding, increase water contact activity of the displaced victims (humans and animals) and the dispersal of Schistosoma eggs that amplify schistosomiasis transmission. There was also the tendency of Schistosoma hybrids from neighboring Niger River Basin (NRB) countries to be established in Nigeria due to floods. Monitoring the dispersal patterns and or the modelling of water snails (Bulinus and Biomphalaria) in endemic countries like Nigeria, the prevalence of livestock, wildlife, and hybrid schistosomes before and after flooding is strongly recommended in Nigeria for effective control interventions.

1. Introduction

Schistosomiasis or bilharziasis is a neglected tropical disease (NTD), caused by the trematode worms of the Schistosoma genus. There was an estimated 240 million people with Schistosomiasis infection in the world with 700 million people living in endemic areas [1]. Schistosomiasis is the most prevalent NTD in tropical and subtropical countries [2] and has the highest morbidity after malaria in Africa [3]. In 2019, about 24 000 deaths and 2.5 million disability-adjusted life-years were recorded due to the disease with about 236 million people requiring mass drug administration [4]. The species that were known to infect humans include Schistosoma haematobium, Schistosoma mansoni, Schistosoma intercalatum, Schistosoma mekongi, Schistosoma guineensis and Schistosoma japonicum [5, 6]. The common species that infect livestock and wildlife were Schistosoma bovis, Schistosoma curassoni and Schistosoma matheei [7].

Sub-Saharan Africa has the highest burden of the infection globally, with 90% prevalence [8]. S. haematobium and S. mansoni which are the causative agent of urogenital schistosomiasis and intestinal schistosomiasis respectively are the major species infecting humans in sub-Saharan Africa [9]. Nigeria has the highest burden of schistosomiasis in Africa [9], its endemic in 35 of Nigeria’s 36 states [10] with a severe transmission rate [4] and there is evidently increase in the transmission of the disease in Nigeria [11].

The parasite life cycle alternates between two hosts. The intermediate hosts, snails and the definitive hosts, mammals. Asexual amplification occurs in the intermediate host, snails [5]. It occurs with the development of miracidia into sporocyst, the sporocyst multiply and develop in to the infective stage called the cercaria.
In the mammalian host the male and female parasite fuse, mature and produce eggs. The definitive hosts (mammals) excrete eggs in urine or faeces into waterbodies. In water, the worm eggs hatch and released miracidia that penetrate aquatic snails [5]. The common snails which are the intermediate hosts in Africa are of the genus, *Biomphalaria* and *Bulinus* which are responsible for the transmission of *S. mansoni* and *S. haematobium* respectively [12]. People got infected with schistosomiasis when they have a contact with an infested water that harbour the infective larval stage of the parasite, the cercaria, when it penetrates their skin. Upon penetration the cercaria lost its tail and become schistosomulae, the schistosomulae migrate through the circulatory system and mature in the mesenteric veins or venous plexuses of the bladder in terms of *S. haematobium* infection or the rectal venules in terms of *S. mansoni* infection and produce eggs [5].

One of the most devastating and common natural disaster in the world is flooding [13]. Flooding occurs when excess water flows into a dryland or when too much rainfall exceeds absorption capacity of the soil which in turn causes great environmental consequences [14]. The most occurring natural disaster in the last 20 years was flooding, it affected 2.3 billion people worldwide and constituted 47% of all natural disasters recorded [15]. Of all natural disasters, flooding is the most deadly, in 2019, it caused 43.5% of all death as a result of natural disasters with more than three quarter of the death in low income countries [16].

In developing countries, flooding results as a result of blocking water ways [17], too much rainfall [18], climate change, rise in sea-level, population growth, operations of dams [19,20] and lack of adequate preparation [21]. In the last ten years, the most frequent natural hazard in Africa was flooding [22]. Flooding in Nigeria occurred annually, but the most recent devastating floods were in the year 2012, 2018 and 2022 [23, 24]. Because of anthropogenic activities and climate change it is without doubt that the intensity and occurrence of extreme weather conditions such as excessive rainfall, storms, floods, and high temperatures among others will increase globally [25].

Flooding is one of the major cause of the spread of snails that aid schistosomiasis transmission in areas without the infection causing a shift in transmission dynamics [26]. In Nigeria studies on monitoring the spread of infective; snails, livestock, wildlife and humans after flooding were inadequate. This review highlights on the potential threat of flooding to schistosomiasis control in Nigeria.

### 2. Effect of flooding on the spread *Biomphalaria* and *Bulinus* Snails

The control of snails especially of the genus, *Biomphalaria* and *Bulinus* is pivotal for schistosomiasis control especially in Africa [27]. Although the number of snails could decrease due to intense flooding and heavy rainfall at transmission sites, there is an increased possibility of the snails to establish new colonies in areas where schistosomiasis is eliminated or in places without schistosomiasis transmission [28]. In china, a retrospective analysis that was conducted to determine the dispersal of the snail intermediate host *Onchomelania hupensi*, found an increased spread of *O. hupensi* snails as a result of flooding, the habitats of the snails were 2.6-2.7 times bigger than in years without floods, although there was a decrease in the density and infection rate of the snails two years after the flood, there was, however, a significant increase in the third year [29].

Studies in Nigeria have shown a decrease in the number of *Biomphalaria* and *Bulinus* snails in the rainy season and an increase in the dry season in infested water bodies [30,31,32,33]. Although, there was little available study on the dispersal of snails especially *Biomphalaria* and *Bulinus* or the modelling of the snail dispersal patterns after flooding in Nigeria. Due to the incessant floods that Nigeria is experiencing there is a high possibility of the infective snails (intermediate hosts) to reach areas that are without prior schistosomiasis transmission. This is important in determining the extent of the spread and in marking possible transmission areas for effective control interventions.

### 3. Effect of flooding on Schistosomiasis Transmission

#### 3.1 Effect of flooding on the transmission of schistosomiasis in Humans and Animals

Floods destroyed sanitary facilities and infrastructures leading to the contamination of...
water from sewage and chemicals, damage health facilities, disrupt hospital accessibility, damage schools infrastructure/residential areas [34] and the spread of diseases such as cholera and typhoid among the displaced flood victims [16].

Nigeria is considered at an extremely high risk of the impact of climate change according to UNICEFs children climate risk index [34]. In the recent 2022 flood in Nigeria more than 1.3 million people were displaced, about 600 people lost their lives and more than 2,000 residential areas were damaged [24]. The displacement of people and the lack of sanitary facilities would increase water contact activities there by increasing the risk of communicable and non-communicable diseases including schistosomiasis infection.

Flooding leads to the destruction of lavatories that harbor schistosoma eggs, this increase the chances of the flood victims to have contact with cercaria infested water [35]. The water contact increased the frequency of schistosomiasis transmission, for example in china, the number of acute cases of schistosomiasis at Yangtze River was 2.8% higher in years with floods when compared to years without floods [29]. In Nigeria a significant higher prevalence of schistosomiasis were recorded in flood displaced persons when compared to the population not affected by flood in Delta state, after the devastating 2012 flood [36]. Additionally, the migration of people from flooded areas to non-flooded areas will increase the risk of schistosomiasis transmission from endemic areas to non-endemic areas.

Moreover, there were more than 40 mammalian reservoir host of schistosomiasis [37]. There was an increasing recognition of the prevalence and morbidity of animal schistosomiasis in both wild and domestic animals in Africa [38]. In sub-Saharan Africa infections due to *Schistosoma bovis* in Cattle, *Schistosoma mattheei* and *Schistosoma curassoni* in small ruminants were prevalent and were known to cause mortality and morbidity in livestock. Primates and rodents were known reservoir host of *Schistosoma mansoni*, a causative agent of human intestinal schistosomiasis [38]. Heavy rainfall which causes flooding give rise to lush vegetation which attract livestock for grazing, the flooded vegetation may harbor infective washed away snails there by increasing the risk of infection of schistosomiasis in livestock [39]. For instance, after the devastating flood in 1998 in China, there was a 1.68 fold higher increase in the prevalence of schistosomiasis in cattle in Hubei province than in the year 1997 [40].

Flooding also causes the migration of wild animal populations such as rodents, to live in close proximity with human settlements, the potentially infective wild animals will transmit eggs to areas without the infection or to non-endemic areas thus increasing schistosomiasis transmission [39]. Although not much study was conductive on livestock and wildlife schistosomiasis in Nigeria, there is a need for a research to determine the prevalence of wildlife and livestock schistosomiasis in Nigeria and the extent of animal schistosomiasis spread after flooding.

3.2 Effect of Flooding on the spread of hybrid Schistosomes

The sharing of water bodies by humans and animals (especially livestock) increases the tendency of exposure to different species of *Schistosoma* that infects both humans and animals, thereby increasing the establishment of hybrid schistosomes [42]. There were concerns that the *Schistosoma* hybrids poster a major challenge in the control of schistosomiasis because of their genetic diversity, adaptability, greater infectivity, wide reservoir hosts [44, 43] and the ability to lower the potency of praziquantel [45, 43]. Although information about hybrids schistosomes epidemiology in Nigeria were sparse, there were reports on hybrid *Schistosoma* based on eggs morphology [46] and *S. haematobium* with *S. bovis* hybrids infections in some part of Nigeria [47].

Research in several West African States neighboring Nigeria have recorded human infections with several *Schistosoma* hybrids, including; *S. haematobium* with *S. guineensis* in Cameroon [48] and Benin [44], *S. haematobium* with *S. bovis* and *S. haematobium* with *S. curassoni* in Senegal [49, 50] and Mali [51] and *S. bovis* with *S. curassoni* in Niger republic [42]. Moreover, all these countries share the Niger River Basin (Figure 1).

There were floods in the Niger River Basin countries and there was a projected increase in flooding in the NRB countries because of climate change and land use changes [52]. The basin traverse over the territory of ten countries
including Nigeria. There is a high chance of the hybrid schistosomes that are not present in Nigeria to be established. This is because, the hybrid schistosome infective snails, livestock, wildlife and humans may disperse into Nigeria from the neighboring infected countries as a result of flooding. Research is therefore needed in Nigeria to know the status of hybrid schistosomes in animals and humans. This is important for effective control intervention.

Figure 1: Map of Niger River Basin showing traversed countries and tributaries [41].

4. Conclusion

In this article I gave an overview of the possible impact of flooding to schistosomiasis transmission in Nigeria which may hinder its control. The World Health Organisation (WHO) road mapped a target to eliminating schistosomiasis and disrupting its transmission in the world by 2030 [4]. There is more at stake in schistosomiasis endemic countries like Nigeria because of an increasing climate change consequence, flooding. Flooding causes the dispersal of infective intermediate hosts (snails) from areas of active schistosomiasis transmission to areas without the infection. The destruction of sanitary facilities and the spreading of infested water bodies by floods causes the migration of humans, livestock and wildlife which in turn increases the odds of contact with the cercaria infested water bodies, thereby increasing schistosomiasis transmission. There was also the probable diffusion of hybrid schistomes from NRB countries into Nigeria. Research is therefore needed to know; the extent/modelling of snails (Biomphalaria and Bulinus) spread after flooding, the status of livestock, wildlife and hybrid schistosomes before and after flooding in Nigeria. This would help in providing effective intervention for the successful elimination of schistosomiasis by 2030.

Abbreviations :
WHO- World Health Organisation
NRB- Niger River Basin
NTD- Neglected Tropical Diseases
UNICEF- United Nations Children’s Fund
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HIGHLIGHTS
- Flooding causes the dispersal of infective intermediate hosts (snails) from areas of active schistosomiasis transmission to areas without the infection
- Flooding leads to the migration of humans, livestock and wildlife which increases contact with cercaria infested water bodies, thereby increasing schistosomiasis transmission
• Floods increases the odds of diffusion of hybrid schistomes from NRB countries into Nigeria

• Floods are an impediment to schistosomiasis control

REFERENCES


Muhammed, H., Afro-Egypt J Infect Endem Dis 2023;13(4):xxx
https://aeji.journals.ekb.eg/