Floods: An Increasing Threat to Schistosomiasis Control in Nigeria

Hafizu Muhammed
Department of Biological Sciences, Federal University Dutse, Nigeria

Corresponding Author
Hafizu Muhammed
Email:
Hapheezmuhammad@gmail.com
Mobile:
+2348068222667

Received:1/9/2023
Revised:1/9/2023
Accepted:16/10/2023
Published: 3/11/2023
Keywords:
Schistosomiasis; Transmission; Flooding; Snails; Control

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 disease eradication 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 increase the dispersal of *Bulinus* and *Biomphalaria* snails, which are the intermediate hosts 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 the 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 for *Schistosoma* hybrids from neighboring Niger River Basin (NRB) countries to be established in Nigeria due to floods. Monitoring the dispersal patterns and/or the modeling of water snails (*Bulinus* and *Biomphalaria*) in endemic countries like Nigeria and 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 were an estimated 240 million people with Schistosomiasis infection in the world, with 700 million 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 24000 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 are *Schistosoma bovis*, *Schistosoma curation*, and *Schistosoma mature* **[7]**.

Sub-Saharan Africa has the highest burden of the infection globally, with a 90% prevalence **[8]**. *S. haematobium* and *S. mansoni*, which are the causative agents 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]**. it is endemic in 35 of Nigeria's 36 states **[10]**, with a severe transmission rate **[4]** and there is an increase in the transmission of the disease in Nigeria **[11]**.

The parasite's life cycle alternates between two hosts. The intermediate hosts are snails, and the definitive hosts are mammals. Asexual amplification occurs in the intermediate host, snails **[5]**. It occurs with the development of miracidia into sporocysts; the sporocysts multiply and develop into the infective stage called the cercaria

[5]. In the mammalian host, the male and female parasites fuse, mature, and produce eggs. The definitive hosts (mammals) excrete eggs in urine or feces into water bodies. In water, the worm eggs hatch and release miracidia that penetrate aquatic snails **[5]**. The common snails, which are the intermediate hosts in Africa, are of the genera, *Biomphalaria* and *Bulinus, which* are responsible for the transmission of *S. mansoni* and *S. haematobium,* respectively **[12]**. People get infected with schistosomiasis when they come into contact with infested water that harbors the infective larval stage of the parasite, the cercaria when it penetrates their skin. Upon penetration, the cercaria lost its tail and became schistosomulae. The schistosomulae migrate through the circulatory system, 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 disasters in the world is flooding **[13]**. Flooding occurs when excess water flows into a dryland or when too much rainfall exceeds the 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, which affected 2.3 billion people worldwide and constituted 47% of natural disasters recorded **[15]**. Of all natural disasters, flooding is the most deadly; in 2019, it caused 43.5% of deaths as a result of natural disasters with more than three-quarters of the deaths in low-income countries **[16]**.

In developing countries, flooding results from blocking waterways **[17]**, too much rainfall **[18]**, climate change, a rise in sea level, population growth, the operation of dams **[19,20],** and a lack of adequate preparation **[21]**. In the last ten years, the most frequent natural hazard in Africa was flooding **[22]**. Flooding in Nigeria occurs annually, but the most recent devastating floods were in 2012, 2018, and 2022 **[23, 24]**. Because of anthropogenic activities and climate change, there is no 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 causes 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 the potential threat of flooding to schistosomiasis control in Nigeria.

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

The control of snails, especially those of the genera, *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 for 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 floods, 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 modeling of snail dispersal patterns after flooding in Nigeria, due to the incessant floods that Nigeria is experiencing, there is a high possibility for 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 infrastructure leading to the contamination of water from sewage and chemicals, damage to health facilities, disruption of hospital accessibility, damage to school infrastructure and residential areas **[34],** and the spread of diseases such as cholera and typhoid among the displaced flood victims **[16]**.

Nigeria is considered to be at an extremely high risk of the impact of climate change, according to UNICEF's Children's 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 2000 residential areas were damaged **[24]**. The displacement of people and the lack of sanitary facilities would increase water contact activities thereby increasing the risk of communicable and non-communicable diseases, including schistosomiasis infection.

Flooding leads to the destruction of lavatories that harbor *Schistosoma* eggs, this increases the chances of the flood victims to have contact with cercaria-infested water **[35]**. Water contact increased the frequency of schistosomiasis transmission; for example, in China, the number of acute cases of schistosomiasis at the Yangtze River was 2.8% higher in years with floods when compared to years without floods **[29]**. In Nigeria, a significantly higher prevalence of schistosomiasis was recorded in flood-displaced persons when compared to the population not affected by floods 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 hosts 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 matthei*, and *Schistosoma curation* in small ruminants were prevalent and were known to cause mortality and morbidity in livestock. Primates and rodents were known reservoir hosts of *Schistosoma mansoni*, a causative agent of human intestinal schistosomiasis **[38]**. Heavy rainfall, which causes flooding, gives rise to lush vegetation, which attracts livestock for grazing. The flooded vegetation may harbor infective washed-away snails, increasing the risk of infection with 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 1997 **[40]**.

Flooding also causes the migration of wild animal populations, such as rodents, to live close to human settlements. The potentially infective wild animals will transmit eggs to areas without the infection or non-endemic areas, thus increasing schistosomiasis transmission **[39]**. Although not much study was conducted on livestock and wildlife schistosomiasis in Nigeria, there is a need for 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 for exposure to different species of *Schistosoma* that infect both humans and animals, thereby increasing the establishment of hybrid schistosomes **[42]**. There were concerns that the *Schistosoma* hybrids pose 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 hybrid schistosome epidemiology in Nigeria was sparse, there were reports on hybrid Schistosomes based on egg morphology **[46]** and *S. haematobium* with *S. bovis* hybrid infections in some parts of Nigeria **[47]**.

Research in several West African States neighboring Nigeria has 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 the 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 traverses the territory of ten countries, including Nigeria. There is a high chance that the hybrid schistosomes that are not present in Nigeria will 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.

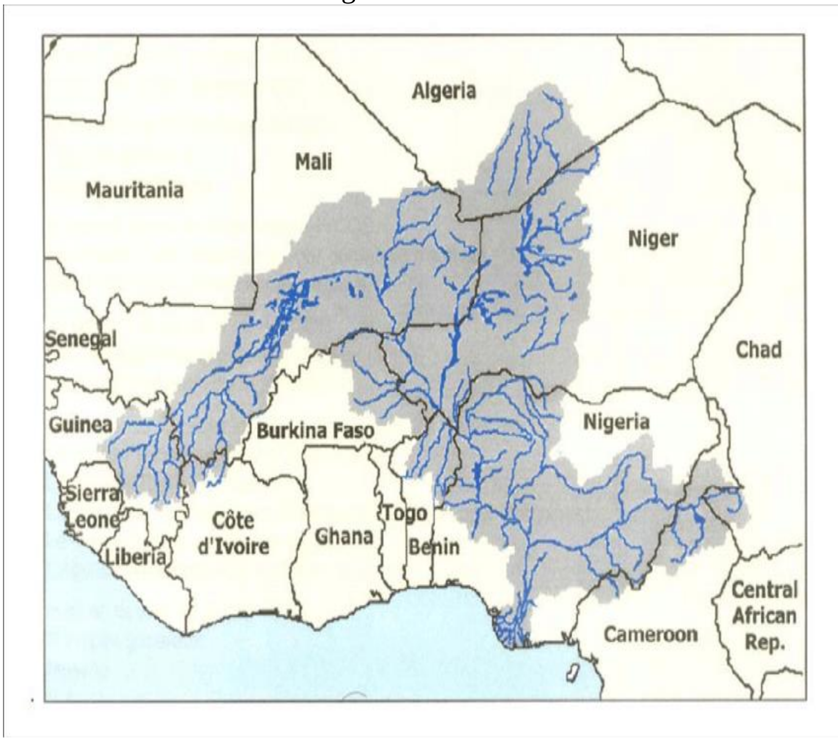

Figure 1: Map of Niger River Basin showing traversed countries and tributaries **[41]**.

4. Conclusion

In this article, I gave an overview of the possible impact of flooding on schistosomiasis transmission in Nigeria, which may hinder its control. The World Health Organisation (WHO) set a target to eliminate schistosomiasis and disrupt its transmission around 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 cause 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 and modeling of snails (*Biomphalaria* and *Bulinus*) spread after flooding and 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

Funding: None. Author funded

Conflict interest: None.

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 increase the odds of the diffusion of hybrid schistomes from NRB countries into Nigeria.

REFERENCES

1. World Health Organization. *Schistosomiasis (Bilharzia)* (2023a). Available at: https://www.who.int/health-topics/schistosomiasis# tab=tab_1 (Accessed: 25 July 2023).
2. World Health Organization. The social context of schistosomiasis and its control: an introduction and annotated bibliography. World Health Organization; 2008.
3. Hotez PJ, Alvarado M, Basáñez MG, Bolliger I, Bourne R, Boussinesq M, Brooker SJ, et al. The global burden of disease study 2010: interpretation and implications for the neglected tropical diseases. *PLoS Trop Dis Negl* 2014 ;8(7):e2865.
4. World Health Organization. Ending the neglect to attain the Sustainable Development Goals: a road map for neglected tropical diseases 2021–2030. (2020).
5. Nelwan ML. Schistosomiasis: life cycle, diagnosis, and control. *Curr Ther Res* 2019;91:5-9.
6. World Health Organization. *Schistosomiasis* (2023b). Available at: https://www.who.int/news-room/fact-sheets/detail/schistosomiasis (Accessed: 25 July 2023).
7. Stothard JR, Kayuni SA, Al-Harbi MH, Musaya J, Webster BL. Future schistosome hybridizations: Will all Schistosoma haematobium hybrids please stand-up? *PLoS Negl Trop Dis* 2020;14(7):e0008201.
8. Hotez PJ, Kamath A. Neglected tropical diseases in sub-Saharan Africa: review of their prevalence, distribution, and disease burden. *PLoS Negl Trop Dis* 2009;3(8):e412.
9. Aula OP, McManus DP, Jones MK, Gordon CA. Schistosomiasis with a Focus on Africa. *Trop Med and Infec Dis* 2021;6(3):109.
10. Ekpo UF, Hürlimann E, Schur N, Oluwole AS, Abe EM, Mafe MA et al. Mapping and prediction of schistosomiasis in Nigeria using compiled survey data and Bayesian geospatial modelling. *Geospat Health* 2013;7(2):355-66.
11. Okon OE, Udoutun MF, Oku EE, Nta AI, Etim SE, Abraham JT et al . Prevalence of urinary schistosomiasis in Abini community, Biase local government area, Cross River state, Nigeria. *Niger J Parasitol* 2007;28(1):28-31.
12. Coulibaly JT, N'gbesso YK, N'guessan NA, Winkler MS, Utzinger J, N'goran EK. Epidemiology of schistosomiasis in two high-risk communities of south Côte d'Ivoire with particular emphasis on pre-school–aged children. *Am J Trop Med Hyg* 2013;89(1):32.
13. World Health Organization. *Floods* (2023). Available at: https://www.who.int/health-topics/floods#tab=tab_1 (Accessed: 25 July 2023).
14. Umar N, Gray A. Flooding in Nigeria: a review of its occurrence and impacts and approaches to modelling flood data. *Int J Environ Stud* 2023;80(3):540-61.
15. Centre for Research on the Epidemiology of Disasters, United Nations Office for Disaster Risk Reduction, Emergency Events Database. The human cost of weather-related disasters: 1995-2015. Brussels; 2015. https://reliefweb.int/report/world/human-cost-weather-related-disas ters-1995-2015.
16. Suhr F, Steinert JI. Epidemiology of floods in sub-Saharan Africa: a systematic review of health outcomes. *BMC Public Health* 2022;22(1):268.
17. Olajuyigbe AE, Rotowa OO, Durojaye E. An assessment of flood hazard in Nigeria: The case of mile 12, Lagos. *Mediterr J Soc Sci* 2012;3(2):367-75.
18. Tarhule A. Damaging rainfall and flooding: the other Sahel hazards. *Clim Change* 2005;72(3):355-77.
19. Rahman M, Ningsheng C, Mahmud GI, Islam MM, Pourghasemi HR, Ahmad H et al. Flooding and its relationship with land cover change, population growth, and road density. *Geosci Front* 2021;12(6):101224.
20. Swain DL, Wing OE, Bates PD, Done JM, Johnson KA, Cameron DR. Increased flood exposure due to climate change and population growth in the United States. *Earth's Future* 2020;8(11):e2020EF001778.
21. Onwuemele A. Public perception of flood risks and disaster preparedness in lagos megacity, Nigeria. *Acad J Interdiscip Stud* 2018;7(3):179.

22- Lumbroso D. Flood risk management in Africa. *J. Flood Risk Manag* 2020;13(3).

23- Nigeria Hydrological Services Agency, 2020, 2020 annual flood outlook. Available online at: https://nihsa.gov.ng/wp-content/uploads/2020/06/2020-NIHSA-Annual-

Flood-Outlook- AFO-5-2.pdf (accessed 05 August 2023).

24. UNICEF (2022).*More than 1.5 million children at risk as devastating floods hit Nigeria*. Available at: https://www.unicef.org/press-releases/more-15-million-children-risk-devastating-floods-hit-nigeria (Accessed: 2 August 2023).
25. Parry ML, editor. Climate change 2007-impacts, adaptation, and vulnerability: Working group II contribution to the fourth assessment report of the IPCC. *Cambridge University Press*; 2007.
26. Lv SB, He TT, Hu F, Li YF, Yuan M, Xie JZ, et al. The Impact of Flooding on Snail Spread: The Case of Endemic Schistosomiasis Areas in Jiangxi Province, China. *Trop Med Infect Dis* 2023;8(5):259.
27. King CH, Bertsch D. Historical perspective: snail control to prevent schistosomiasis. *PLoS Negl Trop Dis* 2015;9(4):e0003657.
28. Adekiya TA, Aruleba RT, Oyinloye BE, Okosun KO, Kappo AP. The effect of climate change and the snail-schistosome cycle in transmission and bio-control of schistosomiasis in Sub-Saharan Africa. *Int J Environ Res Public Health* 2020;17(1):181.
29. Wu XH, Zhang SQ, Xu XJ, Huang YX, Steinmann P, Utzinger J et al. Effect of floods on the transmission of schistosomiasis in the Yangtze River valley, People's Republic of China. *Parasitol Int* 2008 Sep 1;57(3):271-6..
30. Ntonifor HN, Ajayi JA. Studies on the ecology and distribution of some medically important freshwater snail species in Bauchi State, Nigeria. *Int J Biol Chem Sci* 2007;1(2):121-7.
31. Ikpeze OO, Obikwelu ME. Factors affecting seasonal abundance of gastropods of public health importance found at Agulu Lake shorelines in Nigeria. *Int J Pure App Biosci* 2016;4(2):91-102.
32. Alhassan AB, Abidemi A, Gadzama IM, Sha'aba RI, Wada YA, Kelassanthodi R. Distribution and diversity of freshwater snails of public health importance in Kubanni reservoir and weir/sediment trap, Zaria, Nigeria. *J Environ Occup Sci* 2020;10(1):1-9.
33. Oladejo SO, Ofoezie IE. Unabated schistosomiasis transmission in Erinle River Dam, Osun State, Nigeria: evidence of neglect of environmental effects of development projects. *Trop Med Int Health* 2006 Jun;11(6):843-50.
33. Wizor CH, Week DA. Impact of the 2012 Nigeria flood on emergent cities of Nigeria: The case of Yenagoa, Bayelsa State. *Civ Environ Res* 2014;6(5):31-40.
34. UNICEF (2021) *The climate crisis is a child rights crisis*, *UNICEF*. Available at: https://www.unicef.org/reports/climate-crisis-child-rights-crisis (Accessed: 2 August 2023).
35. Shokri A, Sabzevari S, Hashemi SA. Impacts of flood on health of Iranian population: Infectious diseases with an emphasis on parasitic infections. *Parasite Epidemiol Control* 2020;9:e00144.
36. Ito EE, Egwunyenga AO. Schistosomiasis: the aftermath of 2012 floods in delta state, southern Nigeria. *Int Medical J* 2015;22(4):218-23.
37. Rudge JW, Webster JP, Lu DB, Wang TP, Fang GR, Basáñez MG. Identifying host species driving transmission of schistosomiasis japonica, a multihost parasite system, in China. *Proc Natl Acad Sci* 2013;110(28):11457-62.
38. Gower CM, Vince L, Webster JP. Should we be treating animal schistosomiasis in Africa? The need for a One Health economic evaluation of schistosomiasis control in people and their livestock. *Trans R Soc Trop Med Hyg* 2017 ;111(6):244-7.
39. Guo SY, Li L, Zhang LJ, Li YL, Li SZ, Xu J. From the one health perspective: Schistosomiasis japonica and flooding. *Pathogens* 2021;10(12):1538.
40. Chen W, Yang X, Huang X, Zhang Y, Cai S, Liu J, Fu Y, Li S. Influence of flood in 1998 on schistosomiasis epidemic. *Chin J Schistosomiasis Control* 2000;12(4):202-5.
41. Anwar Al-Gamal S, Sokona Y, Dodo AK. Climatic changes and groundwater resources in Africa. *Int J Clim Chang Strateg Manag* 2009;1(2):133-45.
42. Léger E, Garba A, Hamidou AA, Webster BL, Pennance T, Rollinson D et al. Introgressed animal schistosomes Schistosoma curassoni and S. bovis naturally infecting humans. *Emerg Infect Dis*;22(12):2212.
43. Mogaji HO, Omitola OO, Bayegun AA, Ekpo UF, Taylor-Robinson AW. Livestock Reservoir Hosts: An Obscured Threat to Control of Human Schistosomiasis in Nigeria. *Zoonotic Dis* 2023;3(1):52-67.
44. Moné H, Minguez S, Ibikounlé M, Allienne JF, Massougbodji A, Mouahid G. Natural Interactions between S. haematobium and S. guineensis in the Republic of Benin. *Sci World J* 2012;2012.
45. Webster JP, Molyneux DH, Hotez PJ, Fenwick A. The contribution of mass drug administration to global health: past, present and future. *Philos Trans R Soc Lond B Biol Sci* 2014;369(1645):20130434.

46. Bayegun AA, Omitola OO, Umunnakwe CU, Akande FA, Akinwale OP, Mogaji HO et al. Morphometric analysis of schistosome eggs recovered from human urines in communities along the shoreline of Oyan River Dam in Ogun State, Nigeria. *J Helminthol* 2022;96:e89.

47. Onyekwere AM, Rey O, Allienne JF, Nwanchor MC, Alo M, Uwa C, Boissier J. Population genetic structure and hybridization of Schistosoma haematobium in Nigeria. *Pathogens* 2022;11(4):425.

48. Webster BL, Tchuenté LT, Jourdane J, Southgate VR. The interaction of Schistosoma haematobium and S. guineensis in Cameroon. *J. Helminthol* 2005;79(3):193-7.

49. Huyse T, Webster BL, Geldof S, Stothard JR, Diaw OT, Polman K et al. Bidirectional introgressive hybridization between a cattle and human schistosome species. *PLoS Pathog* 2009; 5(9):e1000571.

50. Webster BL, Diaw OT, Seye MM, Webster JP, Rollinson D. Introgressive hybridization of Schistosoma haematobium group species in Senegal: species barrier break down between ruminant and human schistosomes. *PLoS Negl Trop Dis* 2013;7(4):e2110.

51. Soentjens P, Cnops L, Huyse T, Yansouni C, De Vos D, Bottieau E et al. Diagnosis and clinical management of Schistosoma haematobium–Schistosoma bovis hybrid infection in a cluster of travelers returning from Mali. *Clin Infect Dis* 2016:ciw493.

52. Aich V, Liersch S, Vetter T, Fournet S, Andersson JC, Calmanti S et al. Flood projections within the Niger River Basin under future land use and climate change. *Sci Total Environ* 2016;562:666-77.

Cite as: Muhammed, H. Floods: An Increasing Threat to Schistosomiasis Control in Nigeria. *Afro-Egyptian Journal of Infectious and Endemic Diseases,* December 2023; 13(4): 280-286. doi: 10.21608/aeji.2023.324459