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Spatial Distribution of Schistosomiasis and Soil-Transmitted Helminthiasis (STH) in Plateau State, Nigeria

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ABSTRACT

Schistosomiasis and soil-transmitted helminthiases (STH) remain significant public health challenges in Plateau State, Nigeria. This study synthesizes current evidence and integrates geospatial analyses to describe spatial distribution patterns of both diseases across the 17 Local Government Areas. Secondary data obtained from published works were geocoded and plots in ArcGIS pro software for spatial distribution of the diseases. Findings show geographically heterogeneous disease clustering, with schistosomiasis concentrated in southeastern LGAs and STH in southern rural regions. Environmental determinants such as elevation, soil moisture, rainfall, and land use strongly influenced transmission patterns. Targeted interventions based on spatial risk stratification are essential to accelerate disease control and progress toward elimination.

Keywords

Schistosomiasis, Soil-transmitted helminthiases, Spatial distribution, GIS, Plateau State, Epidemiology.

Introduction

Schistosomiasis and soil-transmitted helminthiasis (STH) are among the most significant neglected tropical diseases (NTDs), primarily affecting impoverished populations in tropical and subtropical regions [1]. These infections are strongly associated with inadequate access to safe water, sanitation, hygiene, and health services, making them diseases of poverty and underdevelopment [2]. These infections are characterized by chronic morbidity, frequent reinfection and long-term impacts on nutritional status, physical growth, cognitive development and productivity, particularly among school-aged children and vulnerable populations [1,3].

The global burden of schistosomiasis is particularly significant in sub-Saharan Africa, where the majority of infections occur [4]. The disease is associated with severe morbidity including haematuria, anaemia, bladder pathology, liver damage, and impaired physical and cognitive development in children [5]. Similarly, soil-transmitted helminth infections contribute significantly to malnutrition, growth retardation, and reduced educational performance among school-aged children [6]. Studies conducted in parts of Plateau State have reported the presence of both schistosomiasis and soil-transmitted helminthiasis among local populations. Long-term intervention programmes involving mass administration of praziquantel and albendazole have been implemented in some endemic communities; however, evidence suggests that low-level transmission continues to occur in certain areas [7]. The heterogeneous environmental landscape of Plateau State including variations in altitude, vegetation, water bodies, and land use patterns may influence the spatial distribution of these infections. Understanding how these environmental factors interact with human behaviour and socio-economic conditions is essential for identifying high-risk areas and designing effective disease control strategies [8].

Despite ongoing mass drug administration (MDA) programs, spatial heterogeneity in disease prevalence persists. Understanding these spatial patterns is necessary for informing localized interventions and policy decisions. Thus, the integration of geospatial technologies with epidemiological data offers an effective approach for monitoring disease dynamics and predicting areas at risk of infection [8]. This approach can contribute significantly to the development of evidence-based strategies aimed at reducing the burden of parasitic diseases in endemic regions. This can be done with GIS which enables the integration, visualization and spatial analysis of epidemiological, environmental and socio demographic data, facilitating the identification of disease clusters and spatial relationships [9]. A comprehensive spatial analysis of these infections is therefore necessary to identify transmission hotspots and understand the environmental factors influencing disease distribution. Such information is essential for guiding targeted interventions, improving disease surveillance, and supporting the implementation of integrated control programmes.

Materials and Methods

This study synthesizes published epidemiological data to assess spatial patterns with Geographic Information System (GIS) tool (ArcGIS pro) as shown in (Table 1). Table 2 and Table 3 shows all published work done in Plateau State on schistosomiasis and soil transmitted helminthiasis.

Table 1: Data collection and sources.

S/N	Data	Format	Sources	Relevance
1	Administrative Boundary	Shapefile	OSGOF	To define spatial boundary
2	All published articles for Schistosomiasis and STH		Online	Prevalence of Schistosomiasis and STH

Study Area

This study was conducted in Plateau State, located in North-Central Nigeria between latitudes approximately 8°30′–10°30′N and longitudes 8°20′–10°30′E. Plateau State covers an estimated land area of about 30,913 km² and is characterized by undulating highlands, plains and river valleys. The state shares boundaries with Kaduna, Bauchi, Gombe, Taraba, Nasarawa and Benue States. Plateau State, is characterized by diverse ecological zones, numerous freshwater bodies, and agricultural activities that create favourable conditions for the transmission of parasitic diseases. Communities located near rivers, streams, dams, and irrigation schemes often experience higher risks of schistosomiasis due to increased human-water contact activities such as fishing, farming, bathing, and domestic water use.

Table 2: Publications on Schistosomiasis and STH in Plateau State (by Year).

Year	Author(s) / Source	Location (LGA / Community)	Disease Focus	Key Findings
1990s	Akufongwe et al.	Multiple LGAs	Urinary Schistosomiasis	Prevalence ~47.8%; snail infection correlated with human infection.
1999–2004	Okpala (PhD Thesis, Univ. of Jos, 2010)	Jos South LGA	Urinary & Intestinal Schistosomiasis	Very low prevalence (0.13% urinary, 0.20% stool); 7.9% infected snails.
2011	Nanvyat, Dakul & Mwansat	Ndinjor, Langtang North LGA	Urinary & Intestinal Schistosomiasis	Prevalence 55.7%, highest in males and 10–29 yrs.
2012	Akilah (MSc Thesis, UNILAG)	Shendam LGA	Urinary Schistosomiasis	Prevalence 23.6%; higher in boys and ages 9–11; river contact significant.
2014	Njoku (PhD Thesis, Univ. of Jos)	Jos (general)	Urogenital Schistosomiasis & HIV	Prevalence ~26.3%; evaluated cytokines and HIV co-infection.
2016	Karshima et al.	Plateau State (multiple schools)	STH (environmental)	35.4% soil contamination with STH; Trichuris, Strongyloides, Ascaris found.
2018	Dahal et al.	Kangang (Dadin Kowa), Jos South	STH	42.6% prevalence in pupils; A. lumbricoides (25.7%) most common.
2019	Obeta & Asiya	Jos Township Primary School	STH	Prevalence 24.0%; Ascaris (10%), Hookworm (7%), Trichuris (4.5%).
2020	Am J Trop Med Hyg (MDA study 2013–2018)	Barkin Ladi, Langtang North, Mangu LGAs	SCH & STH	Significant SCH reduction; STH mixed results (some LGAs increased).
2022	Ezeanyagu et al.	Kisayhip, Bassa LGA	Urinary Schistosomiasis	Prevalence between 4–8%, below WHO threshold.
2022	Ladan et al. (Nigerian Med Journal)	Jos Metropolis (markets)	STH on Vegetables	38.3% vegetable contamination; Strongyloides and Hookworm most common.
2023	Binshak et al. (InfoNTD)	Gille & Wulmi, Pankshin LGA	SCH & STH (post-MDA)	SCH = 0%; STH = 2.29% after 10 years of treatment.

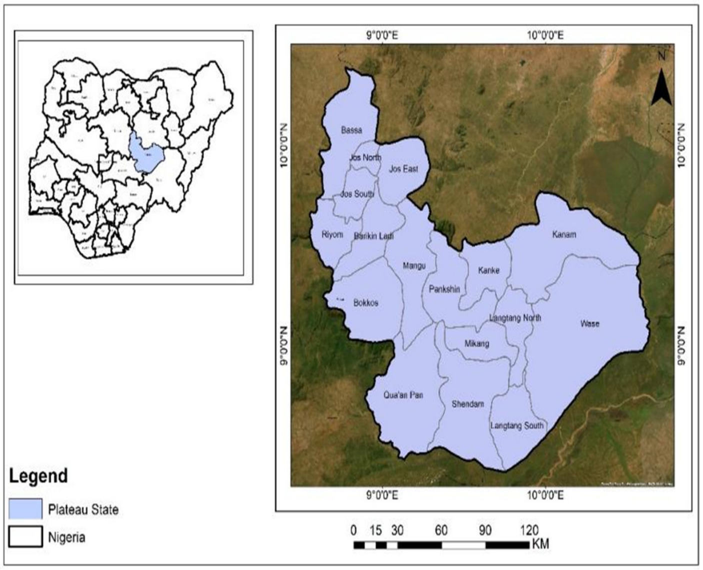

Figure 1: Map of Plateau State. Source: Author(s) Analysis, 2026.

Methodology

Published works on Schistosomiasis and STH were searched online, geocode (linking it with their coordinates), plots in GIS background using ArcGIS pro and plotted for spatial distribution of the diseases as shown in (Figure 2) flow chart below.

Results and Discussion

Schistosomiasis hot spot

Schistosomiasis hotspots were identified primarily in southeastern LGAs: Pankshin, Langtang North, Mikang, and Wase. STH hotspots were concentrated in the southern belt, including Langtang South, Shendam, and Qua'an Pan. Highland LGAs surrounding Jos reported consistently low prevalence levels (Table 4).

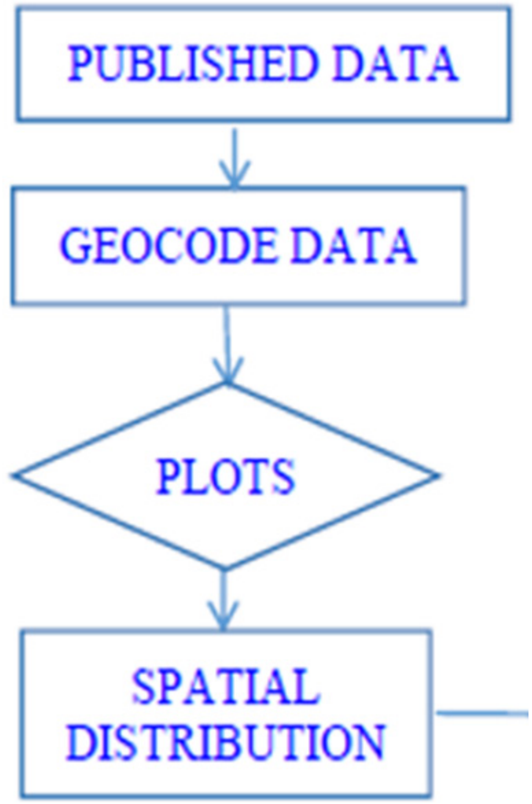

Figure 2: Flow chart showing Methodology.

Table 3: Published work in Plateau State.

Study ID	Year	Authors	Source	Location	Disease Focus
1	2023	Ezra Jatau / ResearchGate entry	ResearchGate (Jos North study).	Jos North	Schistosomiasis
2	2012	Authors (Gwong & Kabong study)	ResearchGate entry	Gwong & Kabong, Jos North	Schistosomiasis
3	2023	Study authors (IJPR)	International Journal of Pharmacy Research (IJPR)	Jos (various schools)	Schistosomiasis
4	2019	Obeta MU et al.	London Journal of Medical & Health Research	Township Primary School, Jos	STH
5	2019	Dahal AS et al.	PMC / PubMed	Dadin Kowa, Jos	STH
6	2022	Barnabas FO et al.	Nigerian Journal of Medicine	Jos	STH (food contamination)
7	2022	E Obiora et al.	SARJNHC (2022)	Jos North	Schistosomiasis
8	2019	Dawet et al	GSC Online Publications	PilganI, Langtang North	Schistosomiasis
9	2017	Irrigation farmers study authors	RROIJ open access article	Jos South	Schistosomiasis
10	2021	Authors (antenatal study)	EAS Publisher (2021)	Jos (Plateau State Specialist Hospital)	Schistosomiasis
11	2025	WG Damar et al.	medRxiv preprint (2025)	Qua'an-Pan; Apata & Laranto, Jos	Schistosomiasis
12	2025	Jamilu MA et al.	IJIABR (2025)	Pankshin	STH
13	2025	CC Onyeka et al.	PNAS (local journal)	Jos North	STH

Table 4: Schistosomiasis prevalence from published articles.

LGA	Prevalence reported by year (%)			
LGA	**(1990-1999)**	**2000-2009**	**2010-2019**	**2020-2025**
BASSA			49.9, 49.9	
RIYOM			50.0,9.9	
JOS NORTH			23.6, 9.9,49.9	
JOS SOUTH		0.3	49.9, 9.9	
JOS EAST			9.9,9.9	
BARKIN LADI			9.9,0.9	
BOKKOS			9.9, 9.9	
MANGU			9.9, 9.9	
PANKSHIN	62.4		49.9, 9.9	0.0
KANKE			9.9, 9.9	
KANAM			49.9, 49.9	
WASE	50.0		49.9, 49.9	
LANGTANG NORTH	58.8		55.7,49.9,49.9	
LANGTANG SOUTH	45.4		9.9, 9.9	
MIKANG			49.9, 9.9	
SHENDAM	40.2		26.3, 49.9, 9.9	
QUAANPAN	22.9		9.9, 9.9	

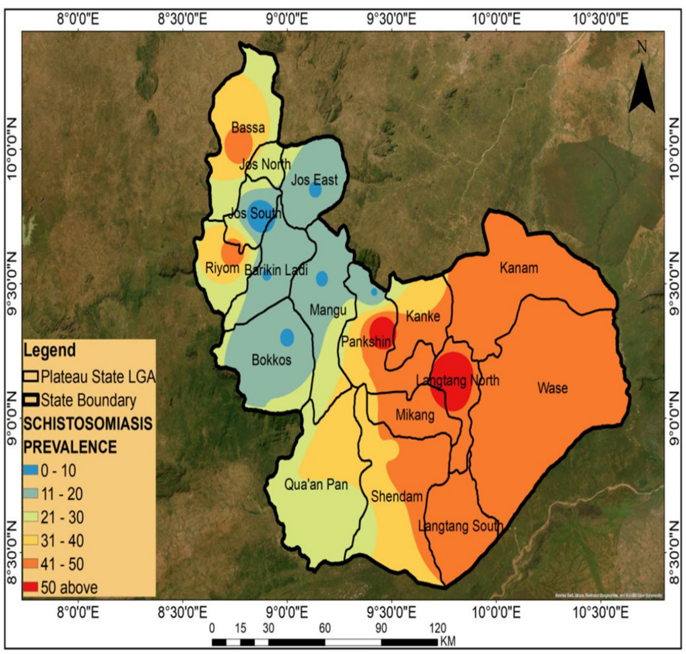

Figure 3: Spatial distribution of Schistosomiasis prevalence across Plateau State LGAs.

The spatial distribution map of schistosomiasis prevalence across the Local Government Areas (LGAs) of Plateau State (Figure 3) reveals marked spatial heterogeneity in the occurrence of the disease. The distribution pattern indicates that schistosomiasis is unevenly distributed across the state, with certain LGAs exhibiting higher prevalence than others. Such spatial clustering reflects the influence of environmental, ecological, and socio-economic determinants that shape the transmission dynamics of the parasite. The observed spatial variability in the distribution of schistosomiasis in Plateau State is consistent with findings from previous epidemiological studies conducted in Nigeria. For instance, a nationwide geospatial modelling study reported that schistosomiasis is endemic in most Nigerian states, with prevalence varying widely across locations due to environmental and climatic factors such as rainfall, temperature, and soil characteristics. The study demonstrated that ecological conditions strongly influence the survival of intermediate snail hosts and therefore determine the spatial patterns of infection.

In Plateau State specifically, earlier parasitological surveys have reported high levels of urinary schistosomiasis in several LGAs. A malacological and epidemiological survey conducted in rural communities across LGAs such as Pankshin, Shendam, Qua'an-Pan, Langtang North, Langtang South, and Wase recorded prevalence rates ranging from approximately 22.9% to 62.4% among examined individuals [10]. These findings correspond with the spatial patterns observed in the current study, where some LGAs appear to act as transmission hotspots. The clustering of high-prevalence areas may largely be attributed to the presence of suitable freshwater habitats that support the breeding of *Bulinus* snails, which serve as intermediate hosts for *Schistosoma haematobium*. Communities located near rivers, dams, ponds, and irrigation systems often experience increased human-water contact activities such as fishing, irrigation farming, swimming, and domestic water use. These behaviours significantly increase the risk of exposure to cercariae, the infective stage of the parasite.

The relationship between environmental factors and schistosomiasis distribution has also been documented in other parts of Nigeria. For example, spatial mapping studies in Cross River State demonstrated that the distribution of schistosomiasis varied across LGAs and was closely associated with water-related activities and proximity to natural water bodies [11]. Similarly, research examining the epidemiology of schistosomiasis in Plateau State reported that infection prevalence was strongly influenced by environmental exposure and human behavioural practices in endemic communities. Environmental conditions such as rainfall patterns, temperature, and vegetation also contribute to the persistence of schistosomiasis transmission. Areas with moderate temperatures and stable freshwater bodies create favourable ecological niches for snail intermediate hosts. According to geospatial predictive modelling studies, climatic variables such as mean temperature and annual precipitation are significant predictors of schistosomiasis distribution across Nigeria. Socio-economic conditions and sanitation infrastructure further influence the spatial distribution of the disease. Communities with limited access to safe drinking water and adequate sanitation facilities often rely on natural water sources for domestic activities. In such settings, contamination of water bodies with parasite eggs through urination or defecation perpetuates the transmission cycle. This pattern has been widely reported in endemic regions where poverty and inadequate public health infrastructure facilitate the persistence of schistosomiasis [12]. The spatial heterogeneity observed in the map may also reflect variations in the implementation and coverage of control interventions. Over the past decade, mass drug administration (MDA) programmes using praziquantel have been implemented across many endemic communities in Nigeria. However, inconsistent treatment coverage and reinfection following treatment often sustain transmission in high-risk areas. Consequently, LGAs with limited intervention coverage or higher environmental exposure may continue to exhibit elevated prevalence rates.

Another important factor influencing the spatial pattern of infection is population behaviour and occupational exposure. Rural populations engaged in activities such as irrigation farming, fishing, and livestock watering often have prolonged contact with contaminated water bodies. Such behavioural risk factors have been widely reported in schistosomiasis-endemic communities across Africa. Furthermore, the integration of environmental datasets such as land use patterns, vegetation indices, elevation, rainfall, and proximity to water bodies into spatial models can enhance the prediction of schistosomiasis risk areas. Such predictive models allow public health authorities to anticipate potential outbreaks and allocate resources more efficiently.

Overall, the spatial distribution of schistosomiasis observed in Plateau State reflects the complex interaction between ecological factors, environmental conditions, human behaviour, and socio-economic circumstances. The identification of high-risk LGAs highlights the need for targeted interventions including sustained mass drug administration, improved sanitation infrastructure, provision of safe water supplies, and community-based health education programmes. Understanding these spatial patterns is critical for developing effective control strategies aimed at reducing the burden of schistosomiasis and improving public health outcomes in endemic regions.

STH Hot spot

Table 5 presents the distribution of Soil-Transmitted Helminth (STH) prevalence across the LGAs of Plateau State. The data show moderate to high prevalence levels in earlier periods, followed by progressive but uneven decline in recent years, with some LGAs still exhibiting persistent or even increasing prevalence.

The spatial distribution of Soil-Transmitted Helminth (STH) infections across the Local Government Areas (LGAs) of Plateau State (Figure 4) reveals clear geographical variation in prevalence. The distribution pattern indicates that STH infections are not uniformly distributed across the state but rather exhibit distinct spatial clustering in certain LGAs. This heterogeneous pattern of infection reflects the influence of environmental conditions, sanitation practices, socio-economic factors, and behavioural patterns that affect the transmission dynamics of these intestinal parasites. Soil-transmitted helminths, including *Ascaris lumbricoides, Trichuris trichiura,* and hookworms *(Ancylostoma duodenale* and *Necator americanus)*, are transmitted through contact with soil contaminated with infective parasite eggs or larvae [13]. Their distribution is therefore closely linked to environmental conditions that support egg survival and larval development. Warm temperatures, adequate soil moisture, and poor sanitation systems provide favourable ecological conditions for the persistence of these parasites in the environment.

Table 5: Soil Transmitted Helminths Prevalence from published Articles.

LGA	Prevalence reported by year (%)			
LGA	1990-1999	2000-2009	2010-2019	2020-2025
BASSA			35.4, 9.9, 9.9	
RIYOM			35.4, 9.9, 9.9	
JOS NORTH			35.4,9.9,1.9,24.0	38.3
JOS SOUTH			35.4,9.9,1.9,42.6	
JOS EAST			35.4, 9.9, 1.9	
BARKIN LADI			35.4, 9.9, 1.9	
BOKKOS			35.4, 9.9, 9.9	
MANGU			35.4, 9.9, 1.9	
PANKSHIN			35.4, 9.9, 9.9	2.29
KANKE			35.4, 9.9, 9.9	
KANAM			35.4, 9.9, 19.9	
WASE			35.4, 19.9, 49.9	
LANGTANG NORTH			35.4, 9.9, 19.9	
LANGTANG SOUTH			35.4, 19.9, 19.9	
MIKANG			35.4, 19.9, 19.9	
SHENDAM			35.4, 19.9, 19.9	
QUAANPAN			35.4, 19.9, 19.9	

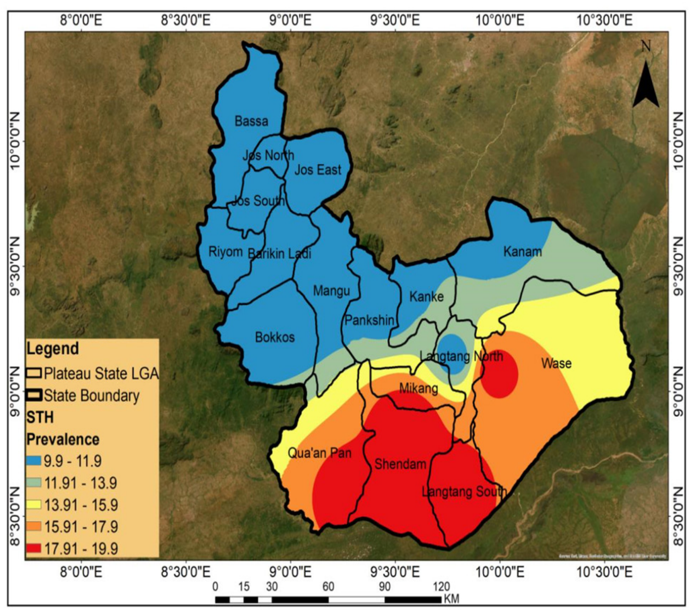

Figure 4: Spatial distribution of Soil-Transmitted Helminth (STH) prevalence across Plateau State LGAs.

The spatial pattern observed in Plateau State suggests that LGAs with higher prevalence of STH infections are likely associated with poor sanitation infrastructure, high population density, and limited access to clean water. In many rural communities, open defecation remains a common practice due to inadequate sanitation facilities. This behaviour contributes significantly to the contamination of soil with parasite eggs, thereby sustaining transmission cycles within affected communities. Similar observations were reported by [14], who noted that poor sanitation and inadequate hygiene practices are major determinants of STH transmission in endemic regions. The spatial clustering observed in this study is consistent with findings from other epidemiological investigations conducted in Nigeria. For instance, a nationwide mapping study of soil-transmitted helminthiasis reported significant geographical variation in infection prevalence across different states, with higher infection rates occurring in areas characterized by poor sanitation and limited access to safe water [15]. The authors emphasized that environmental contamination with human faeces remains one of the most important factors driving the persistence of STH infections in many developing countries. Environmental conditions such as rainfall patterns, soil composition, and temperature also play important roles in determining the survival and transmission of soil-transmitted helminths. Parasite eggs require moist soil conditions to develop into infective stages, and therefore areas with moderate rainfall and suitable soil types tend to exhibit higher infection prevalence. [16] demonstrated that climatic variables such as precipitation, temperature, and humidity strongly influence the geographical distribution of STH infections across Africa. These environmental factors create favourable conditions for the survival of parasite eggs in soil, thereby facilitating transmission among exposed populations.

The results of this study also align with earlier investigations conducted in Plateau State that reported persistent STH infections among rural populations despite the implementation of mass drug administration programmes [8]. Also, [17] reported that soil-transmitted helminth infections remained prevalent in several communities in the state even after prolonged intervention efforts, highlighting the role of environmental and behavioural factors in sustaining transmission. This finding suggests that chemotherapy alone may not be sufficient to eliminate STH infections unless it is accompanied by improvements in sanitation, hygiene practices, and access to clean water. Human behaviour also contributes significantly to the spatial distribution of STH infections observed in the study area. Children are particularly vulnerable because they frequently play in contaminated soil and may ingest parasite eggs through poor hygiene practices such as eating without washing hands. Studies conducted in other parts of Nigeria have reported similar patterns of infection among school-aged children, with prevalence rates often exceeding those observed in adult populations [18]. These findings highlight the importance of school-based deworming programmes as part of integrated control strategies.

The spatial distribution pattern observed in this study also reflects variations in socio-economic development across the LGAs of Plateau State. Communities with better sanitation infrastructure, improved housing conditions, and higher levels of public health awareness tend to exhibit lower prevalence of STH infections. Conversely, areas characterized by poverty and inadequate infrastructure often experience higher levels of environmental contamination and disease transmission.

Comparison of the findings of this study with similar spatial analyses conducted in other endemic regions further highlights the importance of environmental and socio-economic factors in shaping disease distribution. [3] conducted a global analysis of STH distribution using geospatial modelling techniques and reported that infection risk is strongly associated with climatic variables, sanitation coverage, and population density. Their findings emphasized that STH infections tend to cluster in areas where environmental conditions favour parasite survival and where sanitation infrastructure is inadequate. The application of geospatial technologies such as Geographic Information Systems (GIS) in this study has provided valuable insights into the spatial epidemiology of STH infections in Plateau State. Spatial mapping allows for the identification of high-risk LGAs where targeted intervention strategies can be implemented. Such information is essential for optimizing the allocation of resources and improving the effectiveness of control programmes aimed at reducing the burden of intestinal parasitic infections.

In Plateau State, Nigeria, the spatial distribution of schistosomiasis and soil-transmitted helminths reflects the complex interactions between environmental suitability, human behaviour, sanitation infrastructure, and access to water resources. Both diseases share certain risk factors such as poor sanitation and poverty; however, their transmission dynamics differ due to variations in their life cycles and ecological requirements [13]. While STH infections are transmitted through contact with contaminated soil, schistosomiasis transmission depends on freshwater bodies that serve as habitats for intermediate snail hosts. Consequently, the spatial patterns of these infections often differ across geographical locations.

Comparative Analysis of Schistosomiasis and STH Distribution

Although schistosomiasis and soil-transmitted helminthiasis are both classified as neglected tropical diseases, their spatial distributions differ due to variations in transmission ecology. Schistosomiasis transmission is strongly associated with freshwater environments that support intermediate snail hosts, whereas STH transmission is primarily linked to soil contamination resulting from poor sanitation practices. The spatial analysis conducted in this study indicates that schistosomiasis tends to cluster around water bodies, while STH infections are more widely distributed in areas characterized by inadequate sanitation and poor hygiene conditions. This observation is consistent with the findings of [3], who reported that environmental suitability and sanitation coverage are key determinants of helminth infection patterns globally.

Despite these differences, co-endemicity of schistosomiasis and STH infections has been reported in many regions of sub-Saharan Africa. Communities lacking adequate sanitation facilities often rely on natural water bodies for domestic activities, thereby creating favourable conditions for the transmission of both diseases simultaneously [2]. Such co-endemic areas represent important targets for integrated control strategies.

Implications for Disease Control and Public Health

Understanding the spatial distribution of schistosomiasis and STH infections is essential for designing effective control programmes. Spatial mapping enables public health authorities to identify high-risk communities and prioritize interventions such as mass drug administration, improved sanitation infrastructure, and health education campaigns. Integrated control strategies are particularly important in areas where both infections occur simultaneously. The World Health Organization recommends combined interventions that include preventive chemotherapy, improved access to safe water, sanitation improvements, and behavioural change initiatives [1]. In Plateau State, MDA has been done in the whole state which bring down the high prevalences reported in the 1990s as shown in table 6 and table 7 significantly reducing the burden of these infections. The use of geospatial technologies can also support the development of predictive models that identify emerging transmission hotspots, thereby enhancing surveillance and early intervention efforts.

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