Received: 2025-08-19
Accepted: 2025-12-02
Published Online: 2025-12-30
DOI: 10.70454/IJMRE.2025.50406

International Journal of Multidisciplinary Research and Explorer (IJMRE)
E-ISSN: 2833-7298, P-ISSN: 2833-7301

Overview of Intestinal Helminthiasis In Nigeria: Regional Patterns, Contributing Factors, And The Paradox Of Prolonged Wash Interventions

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Abstract: This study reviewed the current report helminthiasis in Nigeria. This study revealed that prevalence of intestinal helminth in the country has not declined since the1970s. Ascarislumbricoides was the most prevalent helminth in the Southwestern and South-southern parts of Nigeria. Hookworm was the most prevalent helminth infection in the Southeastern while multiple infections were highly prevalent in Northern Nigeria. Nigeria has benefited from the Water, Sanitation and Hygiene (WASH) programme for over thirty years in the aspects of enhanced capacity building for applying personal hygiene and sanitation, improved water sources and provision of sanitation facilities and the National Emergency Group for coordination of emergency preparedness and response for WASH-related diseases. Despite the prevalence of helminth infections in Nigeria is still very high and alarming. The factors identified for the high prevalence include socio-economic status, culture and ignorance; attitudes and behaviours toward hygiene and sanitation are also critical.

Keywords: Intestinal Helminthiasis, WASH, Interventions

1. Introduction

Helminth is a general term for parasitic worms; the most common are nematodes, trematodes and cestodes. Infection with these parasites is generally termed helminthiasis. Helminthic diseases, whether soil-transmitted, vector-borne or resulting from particular social habits, cause some of the great public health problems to humans (Laughlin, 2014). Helminths cause human infection through contact with parasite eggs or larvae. Thelife-cycles of *Ascaris*, *Trichuris* and hookworm follow a general pattern. The adult parasite stages inhabit the intestinal tract (Ascaris and hookworm in the small intestine and *Trichuris* in the colon), reproduce sexually, and produces eggs, whichare passed out in human faeces and deposited in the external environment(Stephenson *et al*., 2013).

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Helminthiasis has low detectability due to perhaps confusion of the symptoms associated with the infection. Most often, investigations only consider the possibility of helminth infections after other likely conditions have been ruled out. At such times, effective detection methods must be employed if fatalities are to be reduced or prevented (Anonymous, 2010).Generally, helminth infections are acquired by children through consumption of fruits, vegetable and water contaminated with faucal matter; they may also acquire infection through ingestion of contaminated soil. Environmental pollution or improper sanitation practices, to a large extent, account for a high prevalence of helminth infections. Indiscriminate disposal of human and animal faces play an important role in this respect. The danger is evident since parasite cysts and eggs from such sources can be passed directly to the mouth or through contaminated hands or food (Nock and Tanko, 2015).

In Nigeria, infections caused by intestinal parasites are of public health concern. Poor socioeconomic environment is a major factor facilitating the spread of the disease (WHO, 2015). The prevalence rate of intestinal parasites varies considerably in different parts of Nigeria. Studies had shown *Ascarislumbricoides* as the most prevalent helminth followed by hookworms, *Trichuristrichiura* and *Strongloidesstercoralis* (Asaolu and Ofoezie, 2013; Sam-Wobo and Mafiana, 2015). For instance, the study of Taiwo and Agbolade (2013) showed *A. lumbricoides*as the most prevalent parasite (66%) among school children in Oru, Ogun State. On the contrary, published work in some parts of Nigeria had revealed hookworm as the most prevalent helminth (Suswan*et al*., 2012; Anosike*et al*., 2013). Furthermore, *T. trichiura* was reported as the most prevalent in parts of Lagos and Oyo (Ogbe and Adu, 2010).

According to Olaniyi*et al*. (2016), unhygienic practices of people dumping excrement or defecating indiscriminately at dumpsites, nearby bushes, traffic highways, river banks and open fields in the 1980s had not changed till date. Little success has been achieved in the introduction of latrines to rural communities in Nigeria (Holland and Asaolu, 2013; Ekundayo*et al*., 2014). It was observed that helminth infections are a disease of poverty, with a strong correlation found between parental socio-economic status and intestinal parasitosis in children (Nock and Tanko, 2015). Infection by intestinal helminths thrives and persists in communities lacking better housing, clean water, good sanitation, improved access to health care, education and increased personal income (Crompton, 2014). Sam-Wobo*et al*. (2015) concluded in their study that, the unwillingness to pay for helminth treatment was a factor of ignorance and low economic profile of the community member. These are typical characteristics of many rural communities and urban slums in Nigeria. Also, children raised in these communities are expected to be infected soon after weaning and to be re-infected constantly throughout their life span (Awasthi*et al*., 2013). Therefore, this study seeks to reviews current reports on helminthiasis in Nigeria.

2. Intestinal Parasitic Infestation And Nutritional Status

Parasites that infest the GIT are not only pathogenic but also result in the loss of a wide range of nutrients, and this predisposesto poor nutritional status in both children and adults. In fectionswith *Giardia lamblia* damages the intestinal mucosa and results in malabsorption of nutrients, particularly fat. It seems to be commonly seen in children with undernutrition and results in impaired growth and weight loss in children. *E. histolytica* infections occur mostly in adults, although they are seen in children. Since the parasite infects the large intestine, severe infection

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E-ISSN: 2833-7298, P-ISSN: 2833-7301

result in serious loss of blood and also may cause systemic problem such as liver abscesses due to infection of the liver by the parasites, amoebiasis can cause nutrient loss and canlower the levels of circulating proteins, this sometimes leads toundernutrition.

Infection with *S. mansoni* is associated with severe weightloss and lowered serum proteins levels. Chronic infections canresult in impaired growth and the children are typically both thinand short (Nock and Tanko, 2015).Nwaneri and Omuemu (2013) in their study on Intestinal helminthiasis and nutritional status of children living in orphanages in Benin City, Nigeria.reported that prevalence of intestinal helminthiasis was 20.7% and was observed highest in children aged 12-17 years. *Ascaris*lumbricoides and *Trichuristrichiura* were the intestinal helminths isolated. Nearly all infected subjects had significant stunted growth (P = 0.014) and another one-quarter were significantly under-weight (P = 0.021) when compared with noninfected subjects.

3. Co-Infection Of Intestinal Parasites

Gastro-intestinal parasites are predominantlyprotozoans and helminths with over 70 speciesthat infect humans and animals throughcontaminated food and water (Omalu*et al*., 2013).They can also be contracted throughcontaminated soil, domestic or wild animalsharbouring the parasites, person to person andauto-infection. These gastro- intestinal parasitesare responsible for numbers of prevalent diseasesin the developing countries. Disease conditionscaused by gastro-intestinal parasites includeanaemia, reduced birth weight, intra-uterinegrowth retardation, poor development andperformance in children (Sackey*et al*., 2013;Rodriguez-Morales *et al*., 2016). It has beenobserved that children exposed to soiltransmittedhelminths performed low in theireducational pursuits (Miguel and Kreme, 2013).

Economic loss due to helminth infections on domestic animals had also been reported (Migueland Kreme, 2013).Hotez*et al*. (2014) reported that hookworms are an important cause of intestinal blood loss that results in iron deficiency and protein malnutrition. Because of the underlying poor iron status inchildren, women of reproductive age, andpregnant women, they are frequently the mostsusceptible to developing hookworm anaemia(Brooker *et al*., 2016). Iron deficiency anaemiaduring pregnancy has been linked to adverse maternal-feotal consequences, including prematurity, low birth weight, and impairedlactation (WHO, 2015). Chronic soil-transmitted helminth (STH) infections can affect physical and mental development in children (WHO, 2015).

According to Atting, *et al*., (2016) in their study on Prevalence of intestinal and malaria parasitic infections among school age children in a rural community (NkwotNko) in AkwaIbom State, Nigeria, reported that for co-infection of malaria and intestinal parasites was 14.2%. Males had the highest prevalence rate of Plasmodium falciparum, 43.9% compared to females, 41.5%. Non-availability of toilet facilities and potable drinking water also contributed to the transmission of parasites. Household water sources such as well (49.2%), pond (22.1%), rain (11.1%), public borehole (33.3%) were potential routes of spread of these parasites.

Their study showed a high prevalence of intestinal and malaria parasites amongpupils in this rural community. This finding calls for greater attention to the effective control of these parasitic infections. This action will thus contain their negative health impact on the school age children.

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4. Current Findings In Nigeria

Hookworm is an important helminth that is most frequently diagnosed after *A. lumbricoides*in the studies reported in Southwestern, Nigeria. Hookworm is usually acquired through skin penetration from contaminated soil when walking barefooted (Ezeagwuna*et al*., 2016). *Trichuriasis* is also a common infection in some parts of theSouthwestern States e.g.*T. trichiura* prevalence value (18.4%) reported by Adeoye*et al*. (2015) was greater than the overall helminth prevalence reported by Okonko*et al*. (2012) and Sam-Wobo*et al*. (2012) in separate studies carried out in Abeokuta, Ogun State. Sex is an epidemiological factor in assessing prevalence and intensity of parasitic diseases. In the studies reported above, there is no clear line of gender prevalence. While some studies had identified higher prevalence among the male participants; some have reported females as the most infected gender. In the studies identified in Table 1, it appeared that gender dominance in helminth infection is closely associated with age. Female subjects appeared to have higher prevalence of intestinal infection in studies involving adults (14 years and above). This might be linked to exposure through fecal clean-up for young children and also a personal hygiene issue.

Generally, discrepancy in gender helminthprevalence might be attributable to factorsincluding the study locations within thegeopolitical zone, people's response duringsample collection, type of occupation, age groups,and personal hygiene. Age prevalence in thesestudies is also not consistent. The study of Adeoye*et al*. (2015) in Lagos has identified age prevalencepeak of 0-2 years, Awolaju and Morenikeji (2014)have observed the prevalence peak to be 14-16years, Banjo *et al*. (2013) reported 21-40 yearswhile Akingbade*et al*. (2013) also reported 4-5years.

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Table 1: Prevalence of Helminth Infections in Southwestern Nigeria (source: Taiwo*et al*., 2016)
Studies on prevalence of helminth infections in South-eastern Nigeria are highlighted in Table 2.

Author (s)	**Study Area**	**Method of Analysis**	**Helminth Prevalence (%)**	**Prevalence by Sex (%)**	**Prevalence among Age Group (%)**	**Cause of Infection (%)**
Akingbade*et al*., 2013	Abeokuta Ogun	Saline, Iodine wet mount, Formol-Ether	*A. lumbricoides* =14.5 Total =14.5 (25.8)	Male = 45.2 Female = 54.8	1-3yrs =32.3 4-5yrs = 67 .7	Sanitation problem and Low body immune system
Simon-Oke et al., 2014	Ifedore, Ondo	Saline	*A.lumbricoides*=22.2 Hookworm = 10.6 *S.stercoralis*= 12.8 Multiple infection=3.3 Total =48.9	Male = 47.7 Female = 52.3	5-9yrs =54.6 10-14yrs =45.4	Poor sewage disposal, Unsafe water source, Poor sanitary conditions, Poor housing and Lack of awareness by parents
Akinsey e*et al*., 2015	Ifedore, Ondo	Formol-Ether	*A. lumbricoides* =21.9 Hookworm = 3.9 *T. Trichiura* = 3.1 Multiple infection=0.8 Total 28.9	Male = 47.7 Female = 52.3	5-9yrs =54.6 10-14yrs =45.4	Playing activities, Poor hygiene and sanitation and Poverty

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The major identified helminths include *A. lumbricoides*, hookworm, *T. trichiura*, *S. stercoralis*, *H. nana* and *Taenia sp*. A glance at the studies from the Southeastern Nigeria revealed hookworm as the most prevalent helminth (Emmy-Egbe, 2013; Kamalu*et al*., 2013; Wosu and Onyeabor, 2014). It was observed from these studies that female subjects were more infected by hookworms compared to their male counterparts (e.g. Kamalu*et al*., 2013). This might be directly linked to farming activities engaged mostly by women in the region (Odurukwe*et al*., 2016).

The study of Emmy-Egbe (2013) contradicted the observation that female subjects were at greater risk of hookworm than male. Emmy-Egbe (2013) argued that men are at the greater risk due to behavioral change, poor sanitation, lack of domestic hygiene and ignorance. The risk factors of hookworm infections in the study of Kamalu*et al*. (2013) were bush defecation, walking barefooted and poor hygiene. The act of geophagy was also common in the Southeastern Nigeria (Izugbara, 2013). This might also be another factor responsible for high prevalence of hookworm in the region. It was observed that some studies carried out in Southeastern Nigeria showed high prevalence of *A. lumbricoides*similar to the helminthic situation in the southwestern Nigeria.

The study of Emeka (2013) on the prevalence of intestinal helminth infections among school children in rural and semi-urban communities in Enugu revealed *A. lumbricoides*as the most prevalent helminth. Ogbuagu*et al*. (2009) and Kalu*et al*. (2013) in separate studies also reported a high prevalence of *A. lumbricoides*infection. They further observedthat men were at greater risks of *A. lumbricoides*than women. (Ezeagwuna*et al*., 2009; Kalu*et al*., 2013; Wosu and Onyeabor, 2014).

Information on some helminths in South-south Nigeria is presented in Table 3. The overall prevalence of helminths was lower than those observed for Southwest and Southeast. The highest prevalence value in these studies was 59% (Usip and David, 2013). Even though, low helminth infection prevalence was generally observed in this region; many risk factors responsible for helminth infections include fecal contamination, poor personal hygiene and environmental sanitation, lack of protective foot wears, low socio-economic status, malnutrition and lack of toilet facilities. In the south-south region, the identified helminths were not different from those reported in the Southwest and Southeast regions. Prevalence of *A. lumbricoides*was clearly observed in most of the published studies. Only the study of Usip*et al*. (2013) from AkwaIbom reported hookworm and *Trichuris* as the dominating helminths. Hookworm (29%) and *T. Trichiura* (17%) were the most prevalent helminths observed in school children within the age bracket 5-13 years. In terms of gender prevalence, males were more exposed than female in most studies.

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Table 2: Prevalence of Helminth Infections in South-Eastern Nigeria (source: Taiwo*et* 2016)

Author (s)	**Study Area**	**Method of Analysis**	**Helminth Prevalence (%)**	**Prevalence by Sex (%)**	**Prevalence among Age Group (%)**	**Cause of Infection (%)**
Kamalu*et al*., 2013	Owerri Imo	Formol-Ether Saline	*A. lumbricoides*=13.4 Hookworm = 16 *T. Trichiura*= 2.8 *Taeniasp* =3.2 H.nana= 1.6 *S. stercoralis* =3.6 Total =43.8	Male = 25 Female = 75	<10yrs =17.2 11-15yrs =15.9 16-20yrs =33.8 21-25yrs =14.6 ≥26yrs =11.3	Level of education, Personal environmental Hygiene and Social habit
Wosu and Onyeabor, 2014	Umuahia Abia	Formol-Ether	*A. lumbricoides*=22.7 Hookworm = 33.7 *T. Trichiura* = 34.5 *S. stercoralis* =3.6 Total =75.7	Male = 38 Female = 62	6-8yrs =3.9 9-11yrs =47 12-14yrs =41.7 15-17yrs =7.4	Poor sewage disposal, Unsafe water source, Poor sanitary conditions, Poor housing and Lack of awareness by parents

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Chioma*et al*., 2015	Uga, Anambra	Formol-Ether	*A. lumbricoides*=19.7 Hookworm = 7.7 *T. Trichiura* = 6.5 *Taeniasp* =10.8 Total =44.7	Male = 46 Female = 54	3-5yrs =40 6-8yrs =30 9-11yrs =20 11-14yrs =10	Ignorance, Poverty, Poor environmental Hygiene, Lack of toilet facilities and Lack of health care

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Table 3: Prevalence of Helminth Infections in South-South, Nigeria (source: Taiwo*et al*., 2016)

Author (s)	Study Area	Method of Analysis	Helminth Prevalence (%)	Prevalence by Sex (%)	Prevalence among Age Group (%)	Cause of Infection (%)
Nwaneri and Omuemu, 2013	AkwaIbom	Saline and Brine floatation	*A. lumbricoides*=12.3 Hookworm = 29 *T. Trichiura*= 16.5 *Taeniasp*=0.4 *S. stercoralis*=0.4 Total =59.1	Male = 43 Female = 57	0-5yrs =46.6 6-11yrs = 30.7 12-17yrs =25.7	Low s ocio-economic status and malnutrition
Usip and David, 2013	Umuahia Abia	Formol-Ether	*A. lumbricoides*=22.7 Hookworm = 33.7 *T. Trichiura* = 34.5 *S. stercoralis* =3.6 Total =75.7	Male = 56 Female = 44	5-7yrs=57.3 8-10yrs=30.8 11-13yrs=11.9	Lack of protecting shoes, playing barefooted
Ogbain-Emovone *t al*. 2014	Benin City, Edo	Formol-Ether	*A. lumbricoides*=6.9 Hookworm = 2.4 *T. Trichiura*= 0.2 Total =9.5	Male = 80.9 Female = 19.1	1-5yrs =51 6-10yrs = 46.8 11-15yrs =18.5	Non-washing of hands after defecation and personal and environmental hygiene

The published literature works on intestinalhelminths in the North-central of Nigeria ispresented in Table 4. A very high prevalencehelminth infection up to 80% was observed in thisregion (Ejima and Ajogun, 2011). The helminthclasses identified in the reported works are *A.lumbricoides*, hookworm, *Taeniasp*, *Schistosomamansoni*, *S. stercoralis*, *E. vermicularis*, *Fasciolasp*, *T.Trichiura* and *Vampirolepisnana*. These helminthclasses were greater than those reported in thesouthern parts of Nigeria. Helminths such as *E.vermicularis*, *Fasciolasp*, *H. nana* and *S. mansoni* werenot often diagnosed in the studies from thesouthern parts of Nigeria.

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Table 4: Prevalence of Helminth Infections in North-Central Nigeria (source: Taiwo*et al*., 2016)

Author (s)	Study Area	Method of Analysis	Helminth Prevalence (%)	Prevalence by Sex (%)	Prevalence among Age Group (%)	Cause of Infection (%)
Babatundeet *al*., 2013	Moro Kwara	Formol-Ether	*A. lumbricoides*=11.3 Hookworm = 15.4 *T. Trichiura* = 8.1 *S. stercoralis*=7.1 Total =41.9	Male = 49.1 Female = 51.9	5-9yrs =44.4 10-12yrs =50.9 13-15yrs =4.7	Poor personal hygiene
Saka *et al*., 2014	Ilorin Kwara	Formol-Ether	*A. lumbricoides*=22 Hookworm = 4.5 *T. Trichiura* = 1.2 *S. stercoralis*=0.4 Multiple infection =1.6 Total =29.7	Male = 39 Female = 63	5-7yrs = 31.5 8-10yrs =48 11-12yrs =20.5	Toilet Facility and Unhygenic behavior
Eke *et al*., 2014	Karu Nasarawa	Direct Saline	Hookworm = 39.6 Total =39.6	Male = 58.8 Female = 41.2	0-10yrs =33.3 11-20yrs = 24.6 21-30yrs =14.9 31-40yrs =9.6 41-50yrs = 7.9 51-60yrs =6.1 61-70yrs =3.5	Fecal contamination and Walking barefoot

Prevalence of helminth infections in Northeastern and Northwestern Nigeria is shown in Table 5. There is no much difference in helminth classes identified in this region with that of north-central except for higher values of*Trichuris* and *Taenia sp*. Also, a very high value of *E.vermicularis* (9%) was also observed in the studyconducted by Inabo and John (2010) in KadunaState; however, *Asacrislumbricoides* (29%) was themost prevalent helminth followed by *T. Trichiura*(14%) and *E. vermicularis* (9%). The studies carriedout in Gwagwada, Kaduna has shown high prevalence values of *Taenia sp*. (Auta*et al*., 2013;2014). A higher prevalence value of *S. mansoni* wasalso observed in the studies reported from theNortheastern and Northwestern Nigeria than anyof the regions. As gender prevalence is concerned,the domination of helminth infections by malesubjects was clearly noted. This may be attributedto the fact that males are more active in terms ofsocio-economic activities than their femalecounterparts in this region.

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Eating with unwashed hands has also beenindicated as one of the most probable risk factorsof helminth contamination in this region(Thomas *et al*., 2014). High consumption of porkand beef had been identified as major factor thatcould increase Taenia infections (Enimien*et al*.,2014).

In terms of individual helminth prevalence, moststudies had reported a slight higher prevalence ofhookworm than *A. lumbricoides.* An elevatedprevalence value of 39.3% was observed by Eke *et al*. (2014) in their studies on the prevalence rate ofhookworm infection in Panda, Nasarawa State.The age group between 1 and 10 years were shownto be at the greatest risk probably due to walkingaround without sandal or shoe. The highest *A. lumbricoides*prevalence value was 22% recorded bySaka *et al*. (2013) in a study carried out in Ilorin.Although, some studies had ascribed highprevalence values to Ascaris (Ejima and Ajogun,2011; Saka *et al*., 2014); but it appeared thathookworm infections were more prevalent.

Table 5: Prevalence of Helminth Infections in Northeastern and Northwestern Nigeria (source: Taiwo*et al*., 2016)

Author (s)	**Study Area**	**Method of Analysis**	**Helminth Prevalence (%)**	**Prevalence by Sex (%)**	**Prevalence among Age Group (%)**	**Cause of Infection (%)**
Auta*et al*., 2014	Gwagwada Kaduna	Formol-Ether	*A. lumbricoides*=40.1 Hookworm = 6.5 *T. Trichiura*= 4.5 *Taeniasp*=17.6 *S. mansoni*= 7.8 Total =76.8	Male = 60.4 Female = 39.6	7-9yrs =31.1 10-12yrs =26.2 13-15yrs =21.3 ≥16yrs =21.3	Poor hygiene and Sanitation
Thomas *et al.* , 2014	Chukum and Kaduna South, Kaduna	Direct wet mount, Formol-Ether	*A. lumbricoides*=8.3 Hookworm = 3.5 *Taeniasp*=3.0 *S. mansoni*=1.0 Total =15.8	Male = 58.1 Female = 41.9	6-7yrs = 8.9 8-9yrs =32 9-11yrs =52.7 12-13yrs =6.5	Poor personal hygiene Eating with unwashed Hands
Enimien*et al.* , 2014	Numan, Adamawa	Formol-Ether and Kato-Katz	*A. lumbricoides*=2.0 Hookworm = 3.4 *Taeniasp* =3.7 Total =9.1	Male = 51.9 Female = 48.1	<20yrs=51.9 21-39yrs =37.0 40-69yrs =11.1 >70yrs=0	Consumption of Pork

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Figure 1 shows the mean summary of published studies on helminth prevalence across the observed regions in Nigeria. The helminth distributions revealed southwest as the region with the highest prevalence of *A. lumbricoides*infection while Southeast showed the highest prevalence for hookworm and *Trichuris*. Multiple infections were highest in the North-central while Northeast and Northwest regions showed highest prevalence with *Taeniasp* and *S. Manson* infections.

The prevalence of helminth in the North-centralwas not as high as those reported in the Southern part of Nigeria; however, cases of multiple/mixed infections were very high in this region and call for public concerns. As high as 54% prevalence valueof multiple/mixed infections were reported byEjima and Ajogun (2011). Omalu*et al*. (2013) also reported a prevalence value of 18% for multiple infections among food vendors in Minna, NigerState. The most affected age group was 41-50years. In the studies from Southwest, Southeastand South-south, the highest prevalence value reported for multiple infections was 7% (Kalu*et al*., 2013).

Generally, studies conducted across the six geopolitical zones in Nigeria had identified the following risk factors for soil-transmitted helminth infections: lack of toilet facilities, poor personal hygiene and environmental sanitation, ignorance, contaminated water, low socioeconomic status and attitude of walking barefoot.

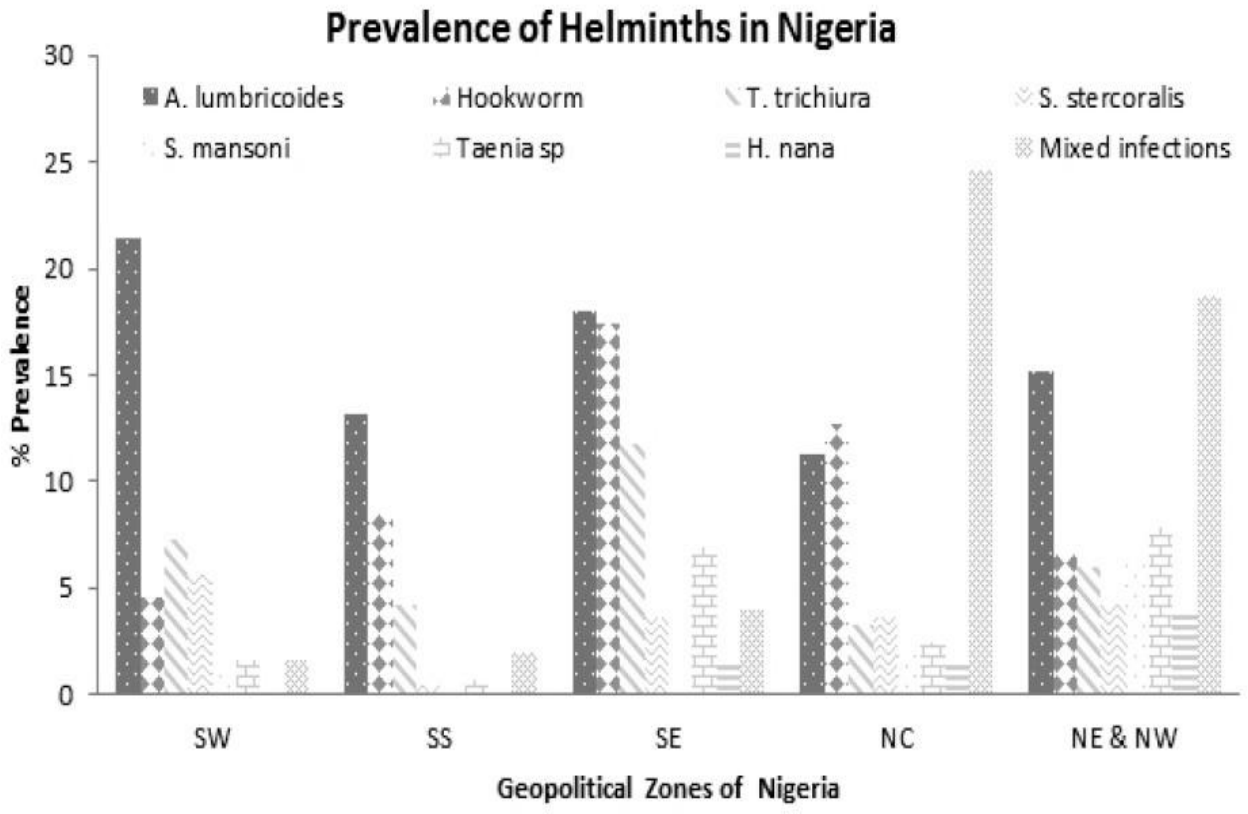

Figure 1: Prevalence of helminths by geopolitical regions in Nigeria (source: Taiwo*et al*., 2016)
Key: SW-Southwest, SS-South-south, SE-Southeast, NC-North-central, NE-Northeast and NW-Northwest

Taiwo*et al*.(2016) in their study on spatial distribution of helminth infections in Nigeria reported that that prevalence of intestinal helminth in the country has not declined since the 1970s.

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Ascarislumbricoides was the most prevalent helminth in the Southwestern (21%) and South-southern (13%) parts of Nigeria. Hookworm was the most prevalent helminth infection in the Southeastern (19%) while multiple infections were highly prevalent in Northern Nigeria (25% in North-central and 19% in the Northeast and Northwest, respectively).

5. Risk Factor For Intestinal Parasitic Infection

Several previous studies have identified numerous risk factors which are associated with intestinal parasitic infection. These include some demographic, socioeconomic, environmental and behavioral factors which form a web of causation for intestinal parasitic infection. The risk factors of intestinal parasitic infection are discussed briefly.

A. Environmental factors

The environmental conditions in the unplanned slums of developing countries are ideal for the persistence of STH infections. Many studies have shown a high prevalence of these infections in children of slums and shanty towns (Crompton and Savioli, 2013).

- **Soil:** Soil is an essential element for the development of STH. The eggs must reach the proper soil where they develop into the infective stages. The most suitable soil should be moist and loamy while clay soils are believed to prevent egg development.
- **Climate and season:** Ascaris eggs do not embryonate at low humidity and with atmospheric saturation less than 80%. Tropical conditions would normally result in high endemicity (Brooker *et al*., 2016).

B. Demographic factors

- **Age:** Several previous studies revealed the age-dependency prevalence of STH infections. Although heavy hookworm infections still occur among children in some tropical areas, the peak prevalence and intensities for hookworm occurs in individuals in middle age, or even over the age of 50.

C. Socioeconomic factors

- **Poverty:** Poverty is the root of almost all neglected tropical diseases including STH infections which are highly prevalent in poor and underprivileged communities. This may be attributed to the inadequate facilities that are essential in STH prevention and control. These include poor sanitation, unavailability of clean and treated drinking water and poor health care facilities.
- **Sanitation:** Sanitation is considered a key factor for the transmission of intestinal parasitic infections. People in the rural areas and poor socioeconomic communities live with absence or inadequate sanitation including the absence of toilets and lack of provision of clean and treated water supply. Such situations cause STH infections to be easily transmitted vertically and horizontally as well.
- **Education and Occupation**: Many previous studies have shown a significant association between parents' educational level and the prevalence of STH infections among their children (Quihui*et al*., 2016). It is believed that educated parents are more aware

Received: 2025-08-19
Accepted: 2025-12-02
Published Online: 2025-12-30
DOI: 10.70454/IJMRE.2025.50406

International Journal of Multidisciplinary Research and Explorer (IJMRE)
E-ISSN: 2833-7298, P-ISSN: 2833-7301

about the health of their children and have better knowledge about the prevention of such infections compared to non-educated parents.

- **Household clustering:** Higher prevalence rates of STH infections have been reported among people who live in houses made of wood and bamboo when compared with their counterparts who live in concrete houses (Holland &Asaolu., 2013). This could indicate the nature of the culture and the presence of soils in the community which favor the transmission of STH infections. It could also be related to the type of floor in these houses, whether tiles/concrete or bamboo or sand.

D. **Behavioral factors:** The association between STH infections and personal hygiene practices is well documented. Hygienic behavior has proven to be a significant contributor to a sustainable control of STH infections, schistosomiasis, diarrhoea, and other fecal-orally transmitted diseases. Unhygienic personal practices such as not washing hands before eating and after playing with soil, walking barefooted, not washing vegetables/fruits before consumption, drinking untreated water and not cutting nails periodically were identified as significant predictors of STH infections.

E. **Immunogenic risk factors:** Predisposition to all three STH species may have either an immunologic, genetic or even a combined immunogenic basis.

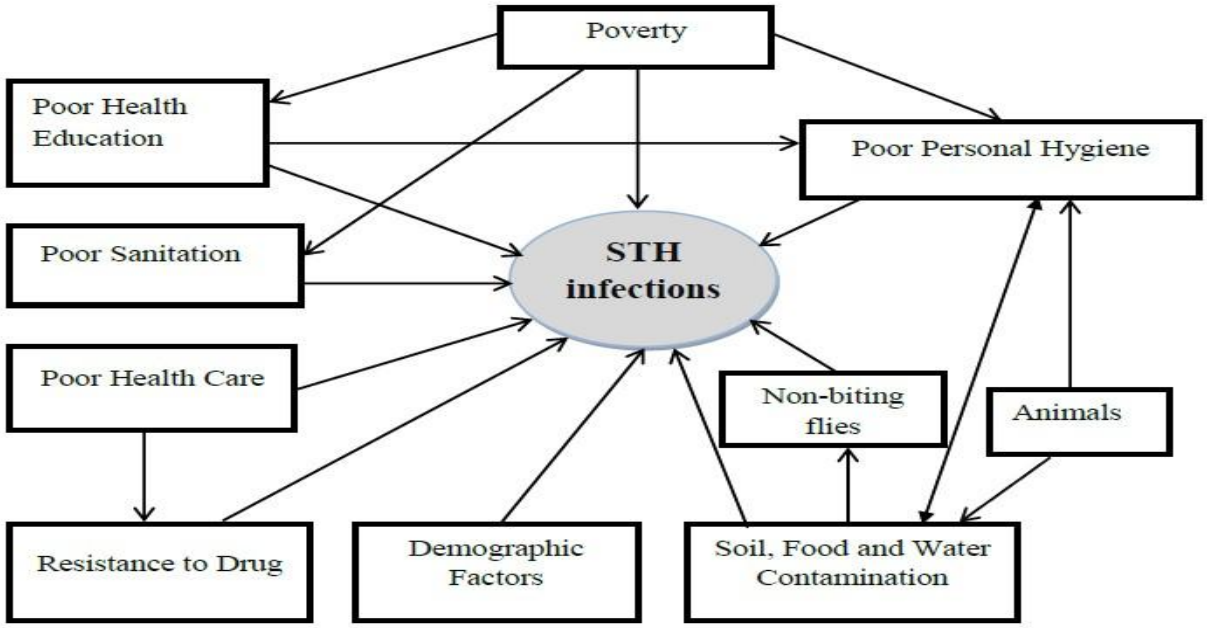

Figure 2: Risk factors of STH infections (the web of causation)(source: Nwaneri*et al*., 2013)

Gyang, *et al*. (2017) in their study intestinal parasitic infections: current status and associated risk factors among school aged children in an archetypal African urban slum in Nigeria, reported that the drinking untreated water was a significant risk factor for school aged children in acquiring protozoan infections after multivariate adjustment.

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6. Control Of Intestinal Parasitic Infection

There are three major interventions for control of helminth infections. These are antihelminthicdrug treatment, sanitation and health education. Anthelminthic drug treatment ('deworming') is aimed at reducing morbidity by decreasing the worms burden. Repeated chemotherapy at regular intervals (periodic deworming) in high risk groups can ensure that the levels of infection are kept below those associated with morbidity and will frequently result in immediate improvement in child health and development (Adams *et al*., 2014).

The international intervention programmes which necessitated the provision of anti-helminth drugs to the infected population(WHO, 2015) were not effective in reducing prevalence of helminth infections in Nigeria(Auta*et al*., 2014). The programme has yielded good results in a country like Cambodia who administered anti-helminth drugs to 84% of the infected school children. This programme should be reviewed in Nigeria to drastically reduce helminth infections. Peoples' attitudes and behaviours are needed to change for WAS H intervention programme to be effective. Sam-Wobo*et al*. (2015) in their study on intestinal helminth infections among school children in Ogun state recommended that school health programmes in government–owned schools, including deworming, health education andim provement of hygiene conditions must be observed towards control of helminthiasis.

Improved sanitation is another way of controlling transmission of helminths from soil and water contamination to humans. Sanitation is the only definite intervention to eliminate STH infections, but to be effective it should cover a high percentage of the population. Therefore, because of the high cost involved, implementing this strategy is difficult where resources are limited (Asaolu and Ofoezie, 2013). Moreover, when usedas the primary means of control, it can take yearsor even decades for sanitation to be effective(Brooker *et al*., 2016).

Health education is aimed at reducing transmission and reinfection by encouraging healthy behaviours. This is to reduce contaminations from soil and water by promoting the use of latrines and hygienic behaviour. Without a change in defecation habits, periodic deworming cannot attain a stable reduction in transmission. Health education can be provided simply and economically and presents no contraindications or risks (Hotez*et al*., 2016).Health education could be done through the provision of information via newspapers, radio or television and health counseling. Health education materials like posters, pamphlets, flip charts and calendars can also be introduced during group community mobilization sessions by teams composed of ministry of health workers and Carter Center personnel’s for community-directed distributors (CDDs) and community members.

The study suggested that if the entire population participated, periodic repetition of the mas expulsion therapy campaign at appropriate intervals combined with continual attention to environmental hygiene and prolonged health education could bring these infections under control within a few years.

7. Efficacy of Recommended Drugs

Recommended drugs for use in public health intervention to control STH infection are the benzimidazoleantihelmintics, albendazole or mebendazole and levamisole or pyrantelpamoate (WHO, 2015). The public health significance of soil-transmitted helminth infections is now widely

Received: 2025-08-19
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E-ISSN: 2833-7298, P-ISSN: 2833-7301

accepted, especially in children, for example, in 1993, the World Development Report considered that these infections are a major cause of morbidity in children aged 5-14 years (World Bank, 1993). Available evidence indicates that albendazole and mebendazole (benzimidazole compounds) may be used for treatment of STHs in children aged 12 months and older provided that the case for their use is established (Albonico*et al*., 2016).

8. Conclusion

This study has reviewed the current report on helminthiasis in Nigeria. The studies showed that *Ascarislumbricoides* isthe most prevalent helminth in the Southwestern and South-southern; hookworm inthe Southeastern and multiple infections in Northern Nigeria in North-central and in Northeast and Northwest. Cases of *Taeniasp*and *Shistosomamansoni* infections were also high inthe Northeastern and Northwestern Nigeria respectively. The Water, Sanitation and Hygiene (WASH) intervention programme has been effective in reducing incidences of helminth infections in the country. However, strong resistance to the programme has largely beenattributed to peoples' attitudes and behaviours to sanitation and hygiene. It is therefore necessary that the programme be geared towards working on peoples' attitudes and behaviours through health education and public enlightenment. Potable water should also be provided to the rural dwellers through sinking of boreholes in their communities. Periodic assessment of the intervention programme is also important.

Conflicts of interests

The authors declare that there are no conflicts of interests.

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Accepted: 2025-12-02
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Accepted: 2025-12-02
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Accepted: 2025-12-02
Published Online: 2025-12-30
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