Asian Pacific Journal of Tropical Disease

journal homepage: http://www.apjtcm.com

Review article https://doi.org/10.12980/apjtd.7.2017D7-235

A review of soil transmitted helminthiasis in Nigeria

John Asekhaen Ohiolei[1], Clement Isaac[1*], Oriri Asemota Omorodion[2]

[1]*Department of Zoology, Ambrose Alli University, Ekpoma, Nigeria*

[2]*Industrial Safety and Environmental Technology Department, Petroleum Training Institute, Effurun, Nigeria*

ARTICLE INFO

Article history:
Received 19 Oct 2017
Received in revised form 30 Oct 2017
Accepted 18 Nov 2017
Available online 29 Nov 2017

Keywords:
Soil transmitted helminthiasis
DALYs
YLD
Nigeria

ABSTRACT

Soil transmitted helminthiasis (STH) is often neglected possibly because of its low mortality rate; however, it accounts for the highest disability adjusted life years (DALYs) among parasitic diseases in the world. Nigeria is endemic to STH and control programmes/efforts have been ongoing. Here, data on the burden of STH infections in Nigeria in form of years of life lost due to mortality (YLLs), the distribution of the infection in the six geopolitical zones and the prevalence pattern over a 37-year period are presented. The prevalence data showed reduction in *Ascaris lumbricoides* and *Trichuris trichiura* infections; while infections with hookworm and *Strongyloides* showed irregular pattern with no significant differences. Notably, YLD for *A. lumbricoides* infection was the highest in the south-west; and the factors possibly impacting on the burden of STH in Nigeria were highlighted.

1. Introduction

Soil transmitted helminthiasis (STH) are parasitic infection caused mainly by *Ascaris lumbricoides* (common roundworms), *Trichuris trichiura* (whipworms), and the hookworms *Necator americanus* and *Ancylostoma duodenale*. Of the 1.5 billion infected, about 270 million and 600 million are preschool and school-aged children, respectively. Conditions relating to the epidemiology of STH are mostly linked to poverty as sufferers are mainly from the world's most impoverished regions[1]. The Americas, China, East Asia and sub-Saharan Africa account for over 56% of the STH infection globally[2].

The developmental stages of the nematodes causing STH are partly in the soil and in vertebrate host(s). In worse case scenarios, STH may impact on the mental health of children as well as bring about malnutrition leading to growth retardation[3,4]. Among neglected tropical diseases, STH accounts for the highest disability adjusted life years (DALYs), which include years of life lost due to mortality (YLLs) and years lived with disability (YLDs)[5]. Despite having the highest DALYs of approximately 5.2 million in comparison to schistosomiasis (3.3 million DALYs), lymphatic filariasis (2.8 million DALYs) and onchocerciasis (0.5 million DALYs)[5], STH receives relatively less attention in aspects of monitoring and treatment[6].

In Nigeria, the need to appraise prevalence data overtime is now imperative as this would inform on the possible gains/losses that have been made. Further, the challenges of current diagnostic methods used in the country with the problem of drug resistance in achieving the elimination goal are thus highlighted.

2. Methodology

Literature search was done on Google Scholar and PubMed databases using relevant keywords. Studies on the prevalence of STH (*Ascaris*, hookworm, *Trichuris* and *Strongyloides*) in Nigeria were selected and reviewed. Prevalence data from the surveyed States categorised under the six geopolitical zones were analysed.

*Corresponding author: Clement Isaac, Department of Zoology, Ambrose Alli University, Ekpoma, Nigeria.
Tel: +2347058777005
E-mail: cle21200@gmail.com
The journal implements double-blind peer review practiced by specially invited international editorial board members.

Rural to urban ratio, STH prevalence and YLD were estimated. Statistical analyses using One-way ANOVA were applied with GraphPad Prism version 5.01 (GraphPad software, San Diego, CA, USA). Mean differences are significant at $P < 0.005$.

3. Study on STH infection in Nigeria: the limitation

STH investigation in Nigeria spans over nine decades[7]. Historically till date, there are little or no changes regarding the tools/methods used for STH study as microscopy remains in-use. In some cases, geographic information systems have been applied in order to gather supporting data for risk mapping and predictive studies[8]. However, molecular techniques in relation to identification and prevalence studies of species of STH are yet to be applied in epidemiological surveys in Nigeria. This is due to its relatively high cost and the requirement of specially trained technical staff. The molecular technique is now becoming an unavoidable method because it is capable of overcoming the challenges of misidentification as it is highly sensitive and specific. A case in point is the difficulty in differentiating hookworm species for which data in Nigeria are largely speculative. In addition, the possibility of other *Trichuris* species to be responsible for trichuriasis is considerably high but has not been investigated using more species-specific methods. Meanwhile, elsewhere, there is the growing use of molecular techniques[9], and recently, *Necator americanus* was the dominant hookworm species among children[9]. Similarly, a relatively high prevalence of STH across some endemic countries was confirmed by using PCR-restriction fragment length polymorphisms and *Trichuris vulpi* was identified in some of the children[10]. The prospect and potential of PCR-based detection methods using next-generation sequencing approach is seriously gaining attention globally[11,12].

4. Prevalence and distribution of STH infection

In Nigeria, STH studies have been focused mostly on children (pre-school and school-age) (69%) than adults (31%); and mostly in rural (68.9%) than urban areas (31.1%) (Figure 1). Age group of 4–10 years is the high risk group and most infected[13-15]. Children within this age group are highly active with frequent soil contact during play hours both at home and in school. Infection in relation to sex is often linked to external/environmental factors with males indulging more in risk behaviour than their female counterparts[16,17].

Survey data (1980 to early 2017) from the six geopolitical zones showed a decreasing trend in prevalence for *A. lumbricoides* (F = 3.89; P = 0.012) and *T. trichiura* (F = 3.44; P = 0.021) (Figure 2). Meanwhile, hookworm (F = 1.506; P = 0.220) and *Strongyloides* (F = 0.705; P = 0.555) showed irregular prevalence pattern. Drugs against hookworm are most times ineffective because of the drug resistance[18-20].

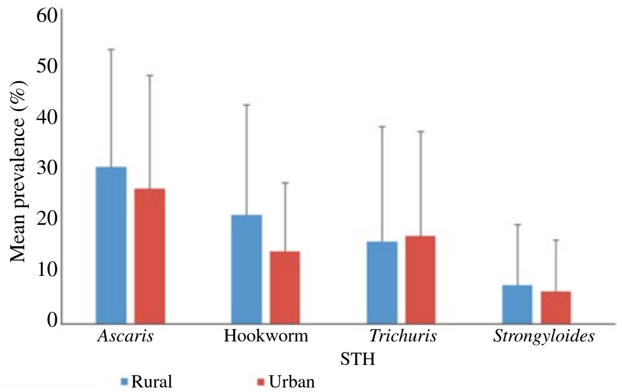

Figure 1. Urban-rural prevalence of STH infection.

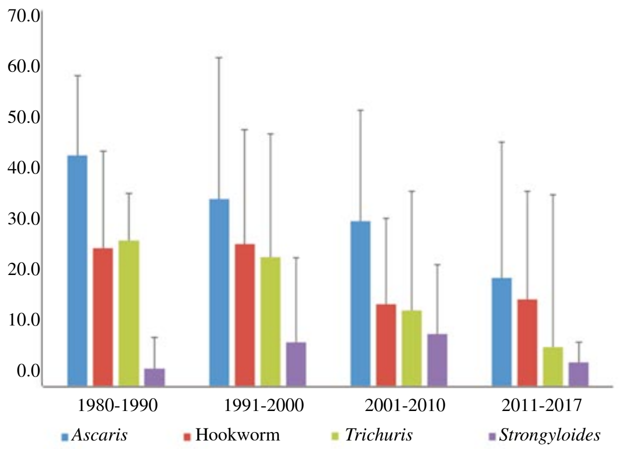

Figure 2. Mean prevalence of STH in the last four decades (1980–2017).

Across the geopolitical zones of the country, STH burden was the highest in the southern region (south-west, south-east, and south-south) compared to the northern region (Table 1). This could be attributed partly to the climatic conditions in the south where helminths thrive more in these conditions than in dry and arid conditions in the north. STH prevalence for the north-eastern region, however, could not be estimated due to limited available data.

Table 1

Mean prevalence and estimated YLD according to geopolitical zones (2005–2017).

Region	*Ascaris*		Hookworm		*Trichuris*		*Strongyloides*	
	Mean ± SD (%)	YLD per 10 000	Mean ± SD (%)	YLD per 10 000	Mean ± SD (%)	YLD per 10 000	Mean ± SD (%)	YLD per 10 000
South-west	31.9 ± 18.6	86.0	12.0 ± 13.5	32.5	8.5 ± 9.6	23.0	8.8 ± 10.1	23.8
South-south	23.7 ± 19.9	63.9	12.4 ± 10.2	33.4	8.5 ± 11.9	23.1	1.2 ± 0.5	3.0
South-east	18.1 ± 14.1	48.9	23.4 ± 26.9	63.3	7.0 ± 6.0	19.0	3.7 ± 4.9	10.0
North-central	6.6 ± 4.5	17.7	14.9 ± 12.6	40.2	6.3 ± 2.8	17.0	6.7 ± 8.4	18.2
North-west	9.1 ± 7.5	24.6	9.1 ± 8.5	24.7	3.2 ± 4.6	8.6	7.9 ± 10.9	21.3
North-east	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

N/A: Not available.

5. Risk factors

Environmental factors and conditions influencing STH transmission are similar to those existing elsewhere in the tropics and other sub-Saharan African countries. Meanwhile, habits known to impact on STH infection and prevalence include open bush defecation[21-23], walking barefooted, geophagy and onychophagy[21,24]. Other risk factors have been linked to occupation of parents, sources of drinking water and poor personal hygiene[21,22,25-30]. The role of the soil as reservoir in maintaining the transmission cycle cannot be overstated[31].

The burden of infection in relation to the immune status of individuals has demonstrated higher prevalence among HIV positives than HIV negatives. Prevalence of STH in HIV sero-positive group could be twice the prevalence in HIV sero-negative group[32-35].

6. DALYs and infection burden

DALYs have become a fast growing metric measurement to assessing disease burden[36]. A lot of reports on STH from Nigeria have been documented, especially from rural communities and in children but reports of infection burden measured in DALYs are unavailable. Here we provide an estimated value of YLD based on available prevalence data and morbidity of infection[37].

YLD due to STH in this review was estimated using the formula below[38]:

$YLD = P \times DW$

where, P = number of prevalent cases, DW = disability weight.

Here, prevalence was used rather than incidence[38] because in Nigeria, surveys are widely reported in prevalence (Table 2). DW (0.027) of intestinal helminth infection which is represented on a

Table 2

Epidemiological survey (prevalence) of STH in Nigeria (1977–2017).

State	No. Sampled	*Ascaris* (%)	Hookworm (%)	*Trichuris* (%)	*Strongyloides* (%)	Study population	Ref
Abia	338	36.60	26.00	13.00	-	Primary school children	[39]
Akwa Ibom	316	18.00	21.50	13.30	2.80	Primary school pupils	[40]
Akwa Ibom	405	24.20	41.70	4.70	-	School-aged children	[41]
Anambra	1536	20.80	13.00	15.30	1.30	School-aged children	[42]
Bauchi	1037	22.50	4.40	1.50	-	Rural dwellers	[43]
Benue	418	-	35.40	3.80	-	Pre-school children	[44]
Benue	580	11.89	18.62	4.65	1.89	Primary school children	[45]
Borno	257	19.10	N/A	3.50	N/A	Almajiris	[46]
Cross River	350	64.40	10.90	1.10	-	Preschool children	[47]
Delta	194	42.78	28.35	11.34	1	School-age children	[48]
Delta	1351	48.41	29.76	17.39	-	School-age children	[49]
Delta	211	45.97	13.27	20.38		School children	[50]
Ebonyi	576	10.90	7.50	4.20	-	School-aged children	[51]
Ebonyi	510	10.80	4.30	1.20	0.60	Primary school children	[52]
Edo	1166	10.80	9.20	1.70	-	Rural dwellers	[53]
Edo	200	4.00	15.00	0.50	1.00	Primary school children	[54]
Edo	192	25.00	13.02	-	1.00	School-age children	[48]
Edo	3601	6.50	2.80	1.40	-	Randomly selected individuals from the state	[55]
Edo	6213	19.50	16.90	5.90	-	Hospital patients	[56]
Edo	207	11.10	5.80	3.80	0.50	Outpatient children	[57]
Edo	2000	6.00	3.70	0.90	1.20	HIV infected individuals	[32]
Edo	500	4.20	1.40	-	-	HIV control individuals	[32]
Edo	496	6.90	2.40	0.20	-	Out-patient children	[30]
Edo	862	38.20	29.40	27.30	-	Individual from 3 geographic zones of the Defunct Bendel State	[58]
Edo	140	18.60	-	2.10	-	Children from orphanages	[59]
Enugu	6842	20.60	71.10	7.90	0.40	Rural dwellers	[60]
Enugu	407	22.90	32.40	2.50	1.00	School children	[13]
Enugu	1296	4.90	2.50	0.70	-	School children	[23]
Enugu	255	46.00	23.00	9.00	11.00	Primary school children	[14]
Enugu	1269					Children and adults	[61]
Enugu	242	12.40	29.30	16.50	0.40	Primary school pupils	[62]
Enugu	13385	7.40	14.30	2.20	0.90	Outpatients individuals	[63]
Enugu	1296	4.90	2.50	0.70		School children	[64]
Imo	284	2.30	94.20	-	-	Primary school pupils	[65]
Imo	96	28.10	5.20	-	-	School-aged children	[66]
Imo, Abia, Enugu and Ebonyi	231	2.60	3.90	-	1.70	Nomads	[67]
Kano	570	7.90	5.30	3.50	-	Apparently healthy children	[68]
Kano	105	-	3.80	-	-	HIV infected individuals	[34]
Kebbi	1357	9.95	13.63	0.29	-	Inhabitants of Bagudo, Dandi and Zuru L.G.A	[69]
Kwara	90	6.70	7.80	10.00	18.90	HIV positive individuals	[33]
Kwara	90	6.70	7.80	6.70	5.60	HIV negative individual	[33]

continued on next page

Table 2 (*continued*)

State	No. sampled	*Ascaris*	Hookworm	*Trichuris*	*Strongyloides*	Study population	Ref
Kwara	907	40.90	10.20	27.00	9.70	Children	[70]
Lagos	300	67.70	45.00	31.30	18.00	Rural dwellers (aged 1–80)	[71]
Lagos	1177	29.70	0.70	18.40	0.30	Randomly selected children	[72]
Lagos	5595	74.20	29.50	75.80	-	Primary school children	[73]
Ogun	218	9.60	4.13	1.84	-	Rural dwellers	[26]
Ogun	232	31.90	3.50	16.40	-	School children	[25]
Ogun	1059	53.40	17.80	10.40	0.70	School children	[27]
Ogun	479	40.00	19.20	23.20	2.10	Urban dwellers	[74]
Ondo	180	22.20	10.60	-	12.80	Primary school pupils	[75]
Ondo	1076	75.30	7.60	84.00	-	School children in riverine community	[3]
Osun	766	88.50	33.10	84.50	3.00	Primary school children	[76]
Osun	312	39.10	-	-	-	School children	[77]
Osun	625	47.60	4.30	3.70	-	School-aged children	[78]
Osun	162	36.40	5.60	-	3.70	Primary school	[79]
Osun	283	39.90	18.40	21.90	-	Individuals from Iwo LGA	[80]
Osun	369	12.20	-	1.40	-	0–25 months	[81]
Osun	395	44.80	19.50	14.00	-	Primary school	[15]
Osun	300	4.30	0.30	1.30	-	Diarrheic children	[82]
Osun	200	35.00	17.50	-	0.50	Children in secondary health care facility	[83]
Osun	52	1.90	-	-	-	HIV infected children	[35]
Osun	309	67.00	43.70	20.70	25.60	School-aged children	[84]
Osun	465	30.10	4.90	0.60		Malnourished school children	[85]
Osun	284	23.20	3.90	0.40		Well-nourished school children	[85]
Osun	250	14.80	9.20	2.00		Primary school pupils	[86]
Oyo	1434	61.5–72.2	52.4–63	65–74	-	Rural dwellers	[87]
Oyo	470	49.40	14.80	15.80	-	Rural dwellers	[88]
Oyo	248	40.70	4.40	4.80	-	School-aged children	[89]
Oyo	957	25.80	9.30	0.60	-	School-aged children	[90]
Oyo	478	70.00	46.00	4.00	-	N/A	[91]
Oyo	1273	39.00	26.50	28.40	-	Urban children	[92]
Plateau	300	0.70	17.00	1.70	0.23	Rural dwellers	[93]
Plateau	1080	84.70	91.90	74.20	50.30	Dry season farmers	[94]
Plateau	204	0.98	4.90	-	0.50	Rural and urban dwellers	[95]
Rivers	396	11.00	36.00	4.00	-	Rural dwellers	[96]
Rivers	5451	49.30	31.40	40.70	-	Rural dwellers	[97]
Rivers	280	18.20	5.40	3.50	3.50	Rural dwellers	[98]
Rivers	2008	24.10	18.00	17.30	10.10	Rural dwellers	[99]
Rivers	3826	14.30	6.90	4.20	2.00	School children	[100]
Rivers	300	54.00	42.70	43.70	33.00	Urban and suburban dwellers	[101]
Rivers	215	33.30	27.30	39.40	-	School children	[16]
Rivers	1062	51.90	1.00	41.70	1.40	Preschool children	[102]
Sokoto	1620	0.10	1.00	0.10	0.20	Infants (1–24 months)	[103]
Zamfara	519	18.50	22.00	8.80	15.60	Nomadic fulanis	[22]

N/A: Not available.

scale of 0–1 (0 = perfect health; 1 = death), was adopted[104]. YLDs due to STH according to the geopolitical zones are shown in Table 1.

7. Control efforts

The achievement of control and elimination relies largely on chemotherapy through mass drug administration (MDA). Drugs commonly administered against STH in Nigeria are albendazole, pyrantel and levamisole. These drugs have demonstrated varying egg reduction and curative rates (Table 3). There are increasing reports of mass deworming programme across the country[69,109,110], and studies have suggested that sustainable decrease in infection burden is a result of continuous use of antihelminthics[69,78].

The previously high and recently decreased rate of infection in communities may be due to MDA, increased community awareness and other control efforts[78]. Other practices largely responsible for decreasing STH prevalence across the country include growing educational and socio-economic status of parents/caregivers[25,26,30] with an increasing percentage of children now using foot wears both at home and in school[26]. Clearly, integrated control methods have been responsible for the observed trend in STH prevalence[111].

8. Conclusion

This review presents the limitations of the present tools used for STH investigation in Nigeria, and highlights the need to apply a more sensitive and specific diagnostic tool in epidemiological studies. Meanwhile, the mean prevalence of the pooled survey data over four

Table 3
Outcomes of chemotherapeutic studies in some states in Nigeria.

States	Drug type	Sampled population	Egg/worm reduction rate (%)	Cure rate (%)	Age group (years)	References
Ondo	Albendazole (200 mg)	1076	N/A	49.7%–94.4%	4–16	[3]
Delta	Albendazole (200 mg)	903	56.1–95.6	55.8	4–16	[105]
Osun	Albendazole (200–400 mg)	625	89	33	1–4	[78]
Rivers	Pyrantel pamoate	> 24000	> 70	NA	2–12	[106]
Ebonyi	Albendazole	576	100	> 90.6	6–17	[51]
Enugu	Levamisole (50 mg)	242	82.5	> 80	5–13	[62]
Akwa Ibom	Pyrantel	316	78.9	80.2	5–13	[40]
Enugu	Albendazole (400 mg)	1296	18.8	> 15.1	4–15	[107]
Edo	Albendazole, mebendazole, pyrantel pamoate	31	95.4	NA	1–5	[108]

decades across the country shows a decreasing trend for *Ascaris* and *Trichuris* infection. However, the need to regularly update the national prevalence and DALYs would be helpful in tracking the progress of control efforts. In addition, the government has to live up to its responsibility by ensuring it abides by the recommendation of the World Health Assembly of 100% target-treatment of school-age children annually in places with > 50% STH prevalence. It is also imperative to engage research in determining the level of drug resistance with the view to applying the most effective chemotherapy regimen. Ultimately, an approach for elimination is to identify risk factors peculiar to different communities/regions in Nigeria.

Conflict of interest statement

We declare that we have no conflict of interest.

References

[1] Hotez PJ. Mass drug administration and integrated control for the World's high-prevalence neglected tropical diseases. *Clin Pharmacol Ther* 2009; **85**: 659-64.

[2] World Health Organization. Soil-transmitted helminth infections. Geneva: World Health Organization; 2017. [Online] Available from: http://www.who.int/mediacentre/factsheets/fs366/en/ [Accessed on 10th October, 2017]

[3] Oyewole F, Ariyo F, Sanyaolu A, Oyibo WA, Faweya T, Monye P, et al. Intestinal helminthiases and their control with albendazole among primary schoolchildren in riverine communities of Ondo State, Nigeria. *Southeast Asian J Trop Med Public Health* 2002; **33**(2): 2214-7.

[4] Kaminsky RG, Castillo RV, Flores CA. Growth retardation and severe anemia in children with *Trichuris* dysenteric syndrome. *Asian Pac J Trop Biomed* 2015; **5**(7): 591-7.

[5] Vos T, Flaxman AD, Naghavi M, Lozano R, Michaud C, Ezzati M, et al. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012; **380**: 2163-96.

[6] Hotez PJ. *Forgotten people and forgotten diseases, the neglected tropical diseases and their impact on global health and development*. 2nd ed. Washington, DC: ASM Press; 2008.

[7] Ramsay GW. A study of schistosomiasis and certain other helminthic infections in Northern Nigeria. *West Afr Med J* 1934; **8**(2): 2-10.

[8] Oluwole AS, Ekpo UF, Karagiannis-Voules DA, Abe EM, Olamiju FO, Isiyaku S, et al. Bayesian geostatistical model-based estimates of soil-transmitted helminth infection in Nigeria, including annual deworming requirements. *PLoS Negl Trop Dis* 2015; **9**(4): e0003740.

[9] Hung BK, De NV, Duyet le V, Chai JY. Prevalence of soil-transmitted helminths and molecular clarification of hookworm species in Ethnic Ede primary schoolchildren in Dak Lak Province, Southern Vietnam. *Korean J Parasitol* 2016; **54**(4): 471-6.

[10] George S, Geldhof P, Albonico M, Ame SM, Bethony JM, Engels D, et al. The molecular speciation of soil-transmitted helminth eggs collected from school children across six endemic countries. *Trans Roy Soc Trop Med Hyg* 2017; doi: 10.1093/trstmh/trw078.

[11] Pilotte N, Papaiakovou M, Grant JR, Bierwert LA, Llewellyn S, McCarthy JS, et al. Improved PCR-based detection of soil transmitted helminth infections using a next-generation sequencing approach to assay design. *PLoS Negl Trop Dis* 2016; **10**(3): e0004578.

[12] Easton AV, Oliveira RG, Walker M, O'Connell EM, Njenga SM. Sources of variability in the measurement of *Ascaris lumbricoides* infection intensity by Kato-Katz and qPCR. *Parasit Vectors* 2017; **10**: 256.

[13] Nwaorgu OC, Okeibunor J, Madu E, Amazigo U, Onyegegbu N, Evans D. A school-based schistosomiasis and intestinal helminthiasis control programme in Nigeria: acceptability to community members. *Trop Med Int Health* 1998; **3**: 842-9.

[14] Emeka LI. Prevalence of intestinal helminthic infection among school children in rural and semi urban communities in Nigeria. *IOSR J Dental Med Sci* 2013; **6**: 61-6.

[15] Salawu SA, Ughele VA. Prevalence of soil-transmitted helminths among school-age children in Ife East Local Government area, Osun State, Nigeria. *FUTA J Res Sci* 2015; **1**: 139-51.

[16] Odu NN, Okonko IO, Erhi O. Study of neglected tropical diseases (NTDs): gastro-intestinal helminthes among school children in Port Harcourt, Rivers State, Nigeria. *Rep Opin* 2011; **3**: 6-16.

[17] Kamalu NA, Uwakwe FE, Opara JA. Prevalence of intestinal parasite among high school students in Nigeria. *Acad J Interdiscip Stud* 2013; **2**(7): 9-16.

[18] Smith JL, Brooker S. Impact of hookworm infection and deworming on anaemia in non-pregnant populations: a systematic review. *Trop Med Int Health* 2010; **15**(7): 776-95.

[19] Soukhathammavong PA, Sayasone S, Phongluxa K, Xayaseng V, Utzinger J, Vounatsou P, et al. Low efficacy of single-dose albendazole and mebendazole against hookworm and effect on concomitant helminth infection in Lao PDR. *PLoS Negl Trop Dis* 2012; **6**(1): e1417.

[20] Adegnika AA, Zinsou JF, Issifou S, Ateba-Ngoa U, Kassa RF, Feugap

EN, et al. Randomized, controlled, assessor-blind clinical trial to assess the efficacy of single- versus repeated-dose albendazole to treat *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworm infection. *Antimicrob Agents Chemother* 2014; **58**(5): 2535-40.

[21] Agbolade OM, Agu NC, Adesanya OO, Odejayi AO, Adigun AA, Adesanlu EB, et al. Intestinal helminthiases and schistosomiasis among school children in an urban center and some rural communities in Southwest Nigeria. *Korean J Parasitol* 2007; **45**(3): 233-8.

[22] Jombo GT, Damen JG, Safiyanu H, Odey F, Mbaawuaga EM. Human intestinal parasitism, potable water availability and methods of sewage disposal among nomadic Fulanis in Kuraje rural settlement of Zamfara State. *Asian Pac J Trop Med* 2010; **3**(6): 491-3.

[23] Edelduok E, Eyo J, Ekpe E. Soil-transmitted helminth infections in relation to the knowledge and practice of preventive measures among school children in rural communities in South-Eastern Nigeria. *IOSR J Pharm Biol Sci* 2013; **5**: 33-7.

[24] Green KI, Ojule JD. Helminthiasis in pregnancy in the Niger-Delta region of Nigeria. *Niger Health J* 2015; **15**(2): 69-77.

[25] Ekpo UF, Odoemene SN, Mafiana CF, Sam-Wobo SO. Helminthiasis and hygiene conditions of schools in Ikenne, Ogun State, Nigeria. *PLoS Negl Trop Dis* 2008; **2**(1): e146.

[26] Sam-Wobo SO, Asiwaju R, Idowu OA, Eromosele CO, Adeleke MA. Communal evaluation of intestinal helminthes in some guineaworm-controlled communities in Ogun State, Nigeria. *J Entomol Nematol* 2012; **4**(2): 7-11.

[27] Elom MO, Eze UA, Nworie A, Akpotomi IO. Prevalence of geohelminths on edible fruits and vegetables cultivated in rural villages of Ebonyi State, South East Nigeria. *AJFN* 2012; **2**(3): 58-64.

[28] Ekwunife CA, Uzoma EM, Nwaorgu OC, Ozumba NA, Aribodor DN, Ezeunala MN. The role of date palm fruits (*Phoenix dactylifera*) in the transmission of geohelminths in Nigeria. *Bioscientist* 2013; **1**(1): 1-5.

[29] Ishaku AA, Ishakeku D, Agwale S. Prevalence of parasitic contamination of some edible vegetables sold at Alhamis market in Lafia metropolis. *Scholarly J Biotechnol* 2013; **2**(2): 26-9.

[30] Ogbaini-Emovon EA, Eigbedion AO, Ojide CK, Kalu EI. Prevalence and impact of socio-economic/enviromental factors on soil-transmitted helminth infection in children attending clinic in a tertiary hospital in Benin City, Nigeria. *Int J Basic Appl Innov Res* 2014; **3**(2): 65-70.

[31] Maikai BV, Umoh JU, Ajanusi OJ, Ajogi I. Public health implications of soil contaminated with helminth eggs in the metropolis of Kaduna, Nigeria. *J Helminthol* 2008; **82**(2): 113-8.

[32] Akinbo FO, Okaka CE, Omoregie R. Prevalence of intestinal parasitic infections among HIV patients in Benin City, Nigeria. *Libyan J Med* 2010; **5**: 5506.

[33] Babatunde SK, Salami AK, Fabiyi JP, Agbede OO, Desalu OO. Prevalence of intestinal parasitic infestation in HIV seropositive and seronegative patients in Ilorin, Nigeria. *Ann Afr Med* 2010; **9**(3): 123-8.

[34] Jegede EF, Oyeyi ETI, Bichi AY, Mbahm HA, Torpey K. Prevalence of intestinal parasites among HIV/AIDS patients attending Infectious Disease Hospital Kano, Nigeria. *Pan Afr Med J* 2014; **17**: 295.

[35] Oyedeji OA, Adejuyigbe E, Oninla SO, Akindele AA, Adedokun SA, Agelebe E. Intestinal parasitoses in HIV infected children in a Nigerian Tertiary Hospital. *J Clin Diagn Res* 2015; **9**(11): 1-5.

[36] Brooker S. Estimating the global distribution and disease burden of intestinal nematode infections: adding up the numbers–a review. *Int J Parasitol* 2010; **40**(10): 1137-44.

[37] Bartsch SM, Hotez PJ, Asti L, Zapf KM, Bottazzi ME, Diemert DJ, et al. The global economic and health burden of human hookworm infection. *PLoS Negl Trop Dis* 2016; **10**(9): e0004922.

[38] Murray CJL, Ezzati M, Flaxman AD, Lim S, Lozano R, Michaud C, et al. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012; **380**: 2197-223.

[39] Amaechi EC, Ohaeri CC, Ukpai OM. Prevalence of helminthiasis among school children in somerural communities of Abia State, Nigeria. *Anim Res Int* 2013; **10**(3): 1817-25.

[40] Usip LPE, Matthew EE. The prevalence of intestinal helminthes and efficacy of anthelmintic (pyrantel) drugs among primary school children in Obot Akara Local Government Area, Akwa Ibom State, Nigeria. *Peak J Public Health Manag* 2015; **3**(3): 46-55.

[41] Opara KN, Udoidung NI, Opara DC, Okon OE, Edosomwan EU, Udoh AJ. The impact of intestinal parasitic infections on the nutritional status of rural and urban school-aged children in Nigeria. *Int J MCH AIDS* 2012; **1**: 73-82.

[42] Enekwechi LC, Azubike CN. Survey of the prevalence of intestinal parasites in children of primary school age. *West Afr J Med* 1994; **13**: 227-30.

[43] Akogun OB. Some social aspects of helminthiasis among the people of Gumau District, Bauchi State, Nigeria. *J Trop Med Hyg* 1989; **92**: 193-6.

[44] Tyoalumun K, Abubakar S, Christopher N. Prevalence of intestinal parasitic infections and their association with nutritional status of rural and urban pre-school children in Benue State, Nigeria. *Int J MCH AIDS* 2016; **5**: 146-52.

[45] Banke ROK, Omudu EA, Ikenwa DA, Feese IJ. Prevalence of gastro-intestinal parasites in relation to availability of sanitary facilities among schooling children in makurdi, Nigeria. *Anim Res Int* 2006; **3**(2): 489-93.

[46] Damen JG, Luka J, Biwan EI, Lugos M. Prevalence of intestinal parasites among pupils in rural North Eastern, Nigeria. *Niger Med J* 2011; **52**(1): 4-6.

[47] Anah MU, Ikpeme OE, Etuk IS, Yong KE, Ibanga I, Asuquo BE. Worm infestation and anaemia among pre-school children of peasant farmers in Calabar, Nigeria. *Niger J Clin Pract* 2008; **11**(3): 220-4.

[48] Omorodion AO, Nmorsi OPG, Isaac C, Umukoro DO, Akhile AO. Distribution of intestinal parasites among school-age children in Delta and Edo States of Nigeria. *PUJ* 2012; **5**(2): 121-6.

[49] Egwunyenga OA, Ataikiru DP. Soil-transmitted helminthiasis among school age children in Ethiope East Local Government Area, Delta State, Nigeria. *Afr J Biotechnol* 2005; **4**(9): 938-41.

[50] Ito EE, Egwunyenga AO. Soil-transmitted helminthiasis in Aviara Community: an observation from primary school children in Nigeria. *Int Med J* 2017; **24**(2): 205-8 ,

[51] Oyibo PG, Uneke CJ, Oyibo IA. Efficacy of single dose anthelminthic treatment against soil transmitted helminth infections and schistosomiasis among school children in selected rural communities in South East Nigeria. *J Commun Med Prim Health Care* 2011; **23**: 98-105.

[52] Uneke C, Eze K, Oyibo P, Azu N, Ali E. Soil-transmitted helminth infection in school children in South-Eastern Nigeria: the public health implication. *Int J Third World Med* 2006; **4**(1): 1-7.

[53] Alakija W. Prevalence of intestinal parasitic disease agents in stools of people in a rural area of Nigeria. *Ann Trop Med Parasitol* 1986; **80**: 545-7.

[54] Oguanya FC, Okogun GRA, Akhile AO, Eloka CCV, Okoro CJ, Okpe AC. Prevalence of soil-transmitted helminths infections among public primary school pupils in Ekpoma, Edo State, Nigeria. *Int J Comm Res* 2012; **1**(1): 30-4.

[55] Mordi RM, Okaka CE. Prevalence of intestinal parasites in Edo State. *Int J Health Res* 2009; **2**: 253-8.

[56] Obiamiwe BA. The pattern of parasitic infection in human gut at the Specialist Hospital, Benin City, Nigeria. *Ann Trop Med Parasitol* 1977; **71**: 35-43.

[57] Wagbatsoma VA, Aisien MS. Helminthiasis in selected children seen at the University of Benin Teaching Hospital (UBTH), Benin City, Nigeria. *Niger Postgrad Med J* 2005; **12**(1): 23-7.

[58] Obiamiwe BA, Nmorsi P. Human gastro-intestinal parasites in Bendel State, Nigeria. *Angew Parasitol* 1991; **32**: 177-83.

[59] Nwaneri DU, Omuemu VO. Intestinal helminthiasis and nutritional status of children living in orphanages in Benin City, Nigeria. *Niger J Clin Pract* 2012; **16**: 243-8.

[60] Nwosu ABC. The community ecology of soil-transmitted helminth infections of humans in a hyperendemic area of southern Nigeria. *Ann Trop Med Parasitol* 1981; **75**: 197-203.

[61] Aniwada EC, Uleanya ND, Igbokwe LN, Onwasigwe C. Soil transmitted helminths; prevalence, perception and determinants among primary school children in rural Enugu State, Nigeria. *Int J Trop Dis Health* 2016; **15**(1): 1-12.

[62] Ukwubile CA, Otalu O, Akpabio U, Agu MO. The prevalence of parasitic human intestinal helminthes and the efficacy of anthelmintic drug in children in Uzo-Uwani Local Government Area, Enugu State, Nigeria. *Open J Med Microbiol* 2013; **3**: 213-8.

[63] Ozumba CC, Ozumba N. Patterns of helminth infection in the human gut in the University of Nigeria Teaching Hospital, Enugu, Nigeria. *J Health Sci* 2002; **48**: 263-8.

[64] Ekpenyong EA, Eyo JE. Prevalence of intestinal helminths infections among schooling children in tropical semi urban communities. *Anim Res Int* 2008; **5**(1): 804-10.

[65] Odinaka KK, Nwolisa EC, Mbanefo F, Iheakaram AC, Okolo S. Prevalence and pattern of soil-transmitted helminthic infection among primary school children in a rural community in Imo State, Nigeria. *J Trop Medicine* 2015; doi: 10.1155/2015/349439.

[66] Iwu RU, Ikeanumba M, Azoroi AV. Hookworm and *Ascaris* infections among school-aged children in Ehime Mbano Local Government Area of Imo State, Nigeria. *J Bacteriol Parasitol* 2016; **7**: 278.

[67] Anosike JC, Nwoke BEB, Onwuliri COE, Obiukwu CE, Duru AF, Nwachukwu MI, et al. Prevalence of parasitic diseases among nomadic Fulanis of South-Eastern Nigeria. *Ann Agric Environ Med* 2004; **11**: 221-5.

[68] Ihesiulor GU, Emokpae MA, Adeeke SI, Samaila AB. Soil transmitted helminthiasis among apparently healthy children in Kano municipality. *Afr J Clin Exp Microbiol* 2007; **8**: 81-7.

[69] Oluwole AS, Isiyaku S, Aliero AA, Nwosu C, William A, Elhassan E, et al. Assessment of the burden of soil-transmitted helminthiasis after five years of mass drug administration for onchocerciasis and lymphatic filariasis in Kebbi State, Nigeria. *Parasite Epidemiol Control* 2017; **2**: 21-9.

[70] Adedoyin MA, Awogun IA, Juergensen T. Prevalence of intestinal parasitoses in relationship to diarrhoea among children in Ilorin. *West Afr J Med* 1990; **9**: 83-8.

[71] Ibidapo CA, Okwa O. The prevalence and intensity of soil transmitted helminths in a rural community, Lagos Suburb, South West Nigeria. *Int J Agric Biol* 2008; **10**: 89-92.

[72] Adeoye GO, Osayemi CO, Oteniya O, Onyemekeihia SO. Epidemiological studies of intestinal helminthes and malaria among children in Lagos, Nigeria. *Pak J Biol Sci* 2007; **10**(13): 2208-12.

[73] Ejezie GC. The parasitic diseases of school children in Lagos State, Nigeria. *Acta Trop* 1981; **38**: 79-84.

[74] Reinthaler FF, Mascher F, Klem G, Sixl W. A survey of gastrointestinal parasites in Ogun State, southwest Nigeria. *Ann Trop Med Parasitol* 1988; **82**: 181-4.

[75] Simon-Oke IA, Afolabi OJ, Afolabi TG. The prevalence of soil transmitted helminthes among school children in Ifedore Local Government Area of Ondo state, Nigeria. *Eur J Biol Med Sci Res* 2014; **2**(1): 17-22.

[76] Holland CV, Asaolu SO, Crompton DW, Stoddart RC, Macdonald R, Torimiro SE. The epidemiology of *Ascaris lumbricoides* and other soil-transmitted helminths in primary school children from Ile-Ife, Nigeria. *Parasitology* 1989; **99**: 275-85.

[77] Awolaju BA, Morenikeji OA. Prevalence and intensity of intestinal parasites in five communities in south-west Nigeria. *Afr J Biotechnol* 2009; **8**(18): 4542-6.

[78] Kirwan P, Asaolu SO, Molloy SF, Abiona TC, Jackson AL, Holland CV. Patterns of soil-transmitted helminth infection and impact of four-monthly albendazole treatments in preschool children from semi-urban communities in Nigeria: a double-blind placebo-controlled randomised trial. *BMC Infect Dis* 2009; **9**: 20.

[79] Ojurongbe O, Oyesiji KF, Ojo JA, Odewale G, Adefioye OA, Olowe AO, et al. Soil transmitted helminth infections among primary school children in Ile-Ife Southwest, Nigeria: a cross-sectional study. *Int Res J Med Med Sci* 2014; **2**(1): 6-10.

[80] Adeyeba OA, Dipeolu OO. A survey of gastrointestinal parasites in a local government area of south-west Nigeria. *Int J Zoonoses* 1984; **11**: 105-10.

[81] Kirwan P, Asaolu SO, Abiona TC, Jackson AL, Smith HV, Holland

CV. Soil-transmitted helminth infections in Nigerian children aged 0–25 months. *J Helminthol* 2009; **83**(3): 261-6.

[82] Tinuade O, John O, Saheed O, Oyeku O, Fidelis N, Olabisi D. Parasitic etiology of childhood diarrhea. *Indian J Paediatr* 2006; **73**(12): 1081-4.

[83] Awoyeni EA, Olaniran O, Hassan-Olajokun RE, Adewuyi IK. Prevalence of intestinal nematodes among children in a secondary health care delivery in Osogbo, Nigeria. *Int Invent J Med Med Sci* 2015; **2**(3): 40-3.

[84] Ugbomoiko US, Ofoezie IE. Multiple infection diagnosis of intestinal helminthiasis in the assessment of health and environmental effect of development projects in Nigeria. *J Helminthol* 2007; **81**: 227-31.

[85] Oninla O, Onayade AA, Owa JA. Impact of intestinal helminthiases on the nutritional status of primary-school children in Osun state, south–western Nigeria. *Ann Trop Med Parasitol* 2010; **104**(7): 583-94.

[86] Olabiyi KO, Udoh SJ, Olaniyan OO, Adeleke IA, Lawal RT. Prevalence of gastro-intestinal parasites among pupils of Ile-Ife, Nigeria. *Cont J Trop Med* 2013; **7**(1): 3-7.

[87] Asaolu SO, Holland CV, Jegede JO, Fraser NR, Stoddard RC, Crompton DW. The prevalence and intensity of soil-transmitted helminthiases in rural communities in southern Nigeria. *Ann Trop Med Parasitol* 1992 **86**: 279-87.

[88] Arinola O, Fawole O. Age and sex graded helminth infections in a Nigerian village. *East Afr Med J* 1995; **72**: 110-2.

[89] Adeyeba OA, Tijani BD. Intestinal helminthiais among malnourished school age children in peri-urban area of Ibadan. *Afr J Clin Exper Microbiol* 2002; **3**: 24-8.

[90] Efunshile AM. School based mass de-worming initiative in South-West Nigeria. *Afr J Clin Exper Microbiol* 2017; **18**(2): 110-4.

[91] Ayanwale FO, Esuruoso GO, Dipeolu OO. The epidemiology of human intestinal helminthiasis in Ibadan, South Western Nigeria. *Int J Zoonoses* 1982; **9**: 69-72.

[92] Adekunle LV, Bammeke AO, Lucas AO. Family influence on incidence of intestinal parasites among Nigerian children. *J R Soc Health* 1986; **106**: 66-8.

[93] Okafor CN, Azubike CN. Studies in intestinal parasitic disease agents in stools of people in rural area of Nigeria. *West Afr J Med* 1992; **11**: 106-11.

[94] Okoronkwo MO. Parasitic infections of dry season farmers in some parts of Plateau State, Nigeria. *Afr J Clin Exper Microbiol* 2002; **3**: 104-10.

[95] Ikeh EI, Obadofin MO, Brindeiro B, Baugherb C, Frost F, Vanderjagt D, et al. Intestinal parasitism in Magama Gumau rural village and Jos Township in north central Nigeria. *Niger Postgrad Med J* 2007; **14**(4): 290-5.

[96] Arene FO. Preliminary parasitological survey of intestinal parasites among inhabitants of Okrika Island in the Niger Delta. *J Infect* 1984; **9**: 309-10.

[97] Udonsi JK, Ogan VN. Assessment of the effectiveness of primary health care interventions in the control of three intestinal nematode infections in rural communities. *Public Health* 1993; **107**(1): 53-60.

[98] Agi PI. Pattern of infection of intestinal parasites in Sagbama community of the Niger Delta, Nigeria. *West Afr J Med* 1995; **14**(1): 39-42.

[99] Agi PI. Comparative helminth infections of man in two rural communities of the Niger Delta, Nigeria. *West Afr J Med* 1997; **16**(4): 232-6.

[100] Abah E, Arene FOI. Status of intestinal parasitic infections among primary school children in Rivers State, Nigeria. *J Parasitol Res* 2015; doi: 10.1155/2015/937096.

[101] Udonsi JK, Behnke JM, Gilbert FS. Analysis of the prevalence of infection and associations between human gastrointestinal nematodes among different age classes living in the urban and suburban communities of Port Harcourt, Nigeria. *J Helminthol* 1996; **70**(1): 75-84.

[102] Arene FO, Akabogu OA. Intestinal parasitic infections in pre-school children in the Niger Delta. *J Hyg Epidemiol Microbiol Immunol* 1986; **30**(1): 99-102.

[103] Isyaku NT, Nock IH, Ndams IS, Luka SA. Status and risk factors associated with infantile geohelminths infections in Sokoto State, Nigeria. *IOSR J Pharm Biol Sci* 2015; **10**: 34-40.

[104] Salomon JA, Haagsma JA, Davis A, de Noordhout CM, Polinder S, Havelaar AH, et al. Disability weights for the Global Burden of Disease 2013 study. *Lancet Glob Health* 2015; **3**: e712-23.

[105] Oyewole F, Ariyo F, Oyibo WA, Sanyaolu A, Faweya T, Monye P, et al. Helminthic reduction with albendazole among school children in riverine communities of Nigeria. *J Rural Trop Public Health* 2007; **6**: 6-10.

[106] Odu NN, Akujobi CO, Maxwell SN, Nte AR. Impact of mass deworming of school children in rural communities in Rivers State, Nigeria: option for programme sustainability. *Acta Parasitol Glob* 2011; **2**(2): 20-4.

[107] Edelduok EG, Eke FN, Evelyn NE, Atama CI, Eyo JE. Efficacy of a single dose albendazole chemotherapy on human intestinal helminthiasis among school children in selected rural tropical communities. *Ann Trop Med Public Health* 2013; **6**: 413-7.

[108] Nmorsi OPG, Isaac C, Aashikpelokhai IS, Ukwandu NCD. Geohelminthiasis among Nigerian preschool age children. *Int J Med Med Sci* 2009; **1**(10): 407-11.

[109] Eigege A, Pede E, Miri E, Umaru J, Pearce PO, Jinadu MY, et al. Triple drug administration (TDA), with praziquantel, ivermectin, and albendazole, for the prevention of three neglected tropical diseases in Nigeria. *Ann Trop Med Parasitol* 2008; **102**: 177-9.

[110] Evans D, McFarland D, Adamani W, Eigege A, Miri E, Schulz J, et al. Cost-effectiveness of triple drug administration (TDA) with praziquantel, ivermectin and albendazole for the prevention of neglected tropical diseases in Nigeria. *Ann Trop Med Parasitol* 2011; **105**(8): 537-47.

[111] Pullan RL, Smith JL, Jasrasaria R, Brooker SJ. Global numbers of infection and disease burden of soil transmitted helminth infections in 2010. *Parasit Vectors* 2014; **7**: 37.