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Epidemiology of Hookworm Infection and the Influence of Some Epidemiological Factors on their Prevalence in Some Farming Communities in Ebonyi State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author IAN designed the study, wrote the protocol and served as the principal investigator. Author OOO was the principal supervisor of the study; he coordinated all aspects of the study. Author AUN handled the statistical analysis and drafted the final manuscript. Authors OCA and CAU searched literatures and participated in the laboratory investigation while author CCE contributed in data analysis as well as sample collection. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study was carried out to assess aspects of the epidemiology of hookworm infection and the influence of some epidemiological factors on their prevalence in some farming communities in Afikpo South L.G.A. of Ebonyi State.
Study Design: This was a laboratory-based observational study.
Place and Duration of Study: This study was carried out in the Department of Applied Biology

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Laboratory, Ebonyi State University, Abakaliki, Nigeria between May, 2013 and November, 2013.
Methodology: A total of 442 stool samples from school children and adults were collected and examined using direct smear and formol-ether concentration techniques for the presence of the parasite eggs.
Results: Out of the 442 examined, 35(7.9%) samples were positive for hookworm infections. Other helminthic infections observed were *Ascaris lumbricoides* 192(43.4%) and *Trichuris trichiura* 4(0.9%). The only mixed infections were seen between hookworm and *Ascaris lumbricoides which* recorded 21(4.8%) prevalence. There was no significant difference in the rate of infection with hookworm between the different age groups (X^2=2.68; P>0.05), though 8-14 years age group had the highest infection rate (9.8%) while those between 21-30 had the lowest (3.5%). The sex distribution showed a higher infection rate in females with prevalence of 22(9.0%) while 13(6.6%) cases were recorded among the males, however, there was no significant difference in infection rate between the sexes (X^2=0.90; P>0.05).
Conclusion: This study shows that the occurrence and distribution of hookworm and other geohelminth infections were still high in Afikpo South L.G.A. despite the periodic deworming exercises by the governmental and non-governmental agencies. The different epidemiological factors analyzed including farming, use of streams and open defaecation presented the highest risk factors for hookworm infections. Hence, provision of portable drinking water, adequate sanitary disposal of faeces and refuse, health education on the mode of transmission of hookworm and improved personal hygiene should be integrated into the periodic deworming exercises for optimum result.

Keywords: Hookworm; epidemiology; geohelminth; prevalence; Ascaris lumbricoides; Trichuris trichiura.

1. INTRODUCTION

The prevalence of endemic infectious diseases is of grave public health concern globally. Hookworm infection constitutes a significant public health problem in many developing countries [1]. Humans are known to serve as hosts for over 300 species of helminths, about 200 species of which have been reported from the alimentary tract and its associated ducts and organs [2]. Humans become infected by infective larvae penetrating the skin before becoming adult after moving through the hearts and lungs for about 10 days. Many eggs are laid by the worms daily and they are expelled in the faeces of the infected persons. The ova develop and mature in the soil which may infect another human when the filariform larvae come in contact with the skin [2]. The epidemiology of hookworm infections depend on three interactive factors which include the following; the mode and extent of faecal pollution of the soil, the suitability of the soil for the eggs and larval development, the extent of contact between infected soil and skin, and the presence of abiotic factors on the viability of the egg [3].

Hookworm infection has been in the poor and has continued to re-emerge shortly after treatment. Re-infection by the worms has been reported to start after treatment and reaches and even exceeds pretreatment levels [4]. The symptoms from hookworm infection were previously not imagined to have resulted from a disease at all; the people who had it were merely assumed to be lazy and were thus disposed and stigmatized, when they should have rather been considered pathetic [5]. It is a neglected but serious health problem especially among the school-age children. The entire people of tropical Africa and Nigeria in particular especially those in the rural areas are characterized by ignorance, low educational status, over population, low income earning, poor environmental sanitation and resource constraints which favour intestinal parasites transmission [4].

Many infections caused by parasites, mostly those resulting from helminthes are asymptomatic, may produce mild or confounding symptoms and are always neglected until serious or insidious medical pictures are observed [6]. The most important medical feature of hookworm disease is iron deficiency anaemia and this is as a result of excessive blood loss and the degree of blood loss is correlated with the type of hookworm involved [7], the extent of iron deficiency anaemia resulting from hookworm is also connected to the number of hookworm which infect the individual [8]. Children, women of reproductive age and pregnant women are the ones most vulnerable to developing anaemia due

to hookworm infection because of their poor iron status [9]. Iron deficiency anaemia during pregnancy lead to adverse maternal-foetal consequences including prematurity, low birth weight and impaired lactation [10]. The infections play a central position as contributory factors in the cause of childhood malnutrition because heavy insidious infections with these worms may worsen malnutrition particularly among already malnourished families from socio- economically underprivileged communities. It is also recognized as one of the leading causes of child morbidity in the developing countries of the tropics and sub- tropics [11]. Hence, in infected children, this affects their cognitive ability and causes growth retardation [11]. Hookworm infection seldom lead to death, rather, the burden of disease is related less to mortality than to the chronic and insidious effects on the health and nutritional status of the hosts [12]. The iron deficiency anaemia that results from moderate or heavy hookworm burden is known as hookworm disease [13]. The rate of blood loss has been estimated to be 0.04ml per worm each day for *N. americanus* and 0.18ml per worm each day for *A. duodenale* [7].

In Nigeria, the disease is considered to be more prevalent among the lower class group and peasant farmers who are most probable to become in contact with the polluted soil while working [14]. This study therefore investigated the epidemiology of hookworm infections and the influence of some epidemiological factors on their prevalence in some farming communities in Afikpo South L.G.A. of Ebonyi State.

2. MATERIALS AND METHODS

2.1 Study Area

This study was carried out in Edda, Afikpo South Local Government Area of Ebonyi State. Edda is almost sandwiched between two major roads: the Okigwe-Afikpo road which runs across its northern borders, and the Umuahia-Ohafia-Arochukwu road on the southern borders. The landmass occupied by Edda people is estimated at ninety square miles or about 144 square kilometers [15]. Edda land is situated within the geographical longitudes 7.43 and 7.55 degrees east of meridian and between the latitudes 5.42 degrees and 5.58 degrees north of the equator [15]. Edda is bounded on the North by Okposi/Amasiri, on the south by Ohafia and on the East by Unwana while bounding it on the west is Nkporo. On the North- East of Edda is found Afikpo town, on the South-East is Erei (Enna) - a community in Cross River State. On the North- West, Edda is borded by Akaeze, and on the South-West by Abiriba [15].

Edda has a tropical climate and the vegetation is rain forest. It has average annual rainfall of about 1800 mm and average atmospheric temperature of 30ºC [16]. The two different seasons are the rainy and dry seasons, rainy season usually start in April and end in October while dry season occurs from November to March [15]. Edda is traversed by many streams which serve as the main sources of water supply to the communities in Afikpo South Local Government Area [16]. There is indiscriminate sewage and feacal disposition in the communities. The inhabitants are mainly subsistent farmers and petty traders and most of them lack formal education, however, there are few local government staff, health workers and school teachers in Edda. Social Amenities such as electricity and good road network are available while portable drinking water is essentially lacking. There is at least one health centre in each community with one general hospital in the whole area (at Owutu Edda).

2.2 Study Population

The population for this study included primary school pupils from three selected primary schools in the area, namely: Edda Central School, Igbara Primary School and Community Primary School, Ebunwana Edda and also one Secondary School, namely: Itim Secondary School, Itim Edda. Adults were also used for this study. Households were randomly selected and samples collected from volunteers from each household.

2.3 Ethical Consideration

Ethical clearance for this study was obtained from the research and ethics committee of the Department of Applied Biology, Ebonyi State University, Abakaliki, Nigeria. Permission was also taken from the head teachers of the various schools studied. The consents of the adults were duly sought and obtained after which all the participants were educated on the causes and health implications of hookworm infection. The information and results of each participant were handled with utmost confidentiality and for the purpose of this study only.

2.4 Sample Collection

Corked sterile bottles were given to the pupils for collection of their stool samples at home. The pupils were taught how to collect stool samples and demographic information such as age, sex, type of toilet facility used and parents occupation were collected from each pupil during submission of their stool samples. Adults were met at their various homes by house-to-house method. Households were randomly selected and samples collected from volunteers from each family. The same method used for school children was applied on them in collection of their stool samples. After collection, the stool samples were properly labelled and transported to the Applied Biology Laboratory, Ebonyi State University for analysis. Samples that were not examined the same day of collection were preserved with 10% formalin until examination [17].

2.5 Laboratory Examination

The stool samples were analysed using the direct smear and formol–ether concentration technique.

2.5.1 Direct smear method

Using the direct smear method, about 1 g of feaces was collected with an applicator stick and emulsified on a drop of normal saline on a glass slide that was labelled appropriately. The preparation was covered with a clean cover slip, avoiding air bubbles. The slide was then mounted under 10x and 40x objectives of the light microscope and examined for hookworm eggs [17].

2.5.2 Formol-ether concentration technique

Samples that were found to be negative by direct smear examination were re-examined using formol-ether concentration technique [18]. In this, about 1 g of the faeces was collected with a stick, mixed with physiological saline and put in a screw-cap bottle containing 4 ml of 10% formol water. The bottle was capped and mixed by shaking for about 20 seconds. Thereafter, the faeces were sieved and the suspension collected in a beaker. The suspension was poured into a tube and 3 ml of ether was added. The tube was stoppered and mixed by shaking for 1 minute, after which, the stopper was removed and the setup was centrifuged immediately at 3000 r.p.m. for 1 minute. An applicator stick was used to loosen the layer of faecal debris from the side of the tube after centrifugation. The layers of ether, debris and formal water that formed were decanted off, while the sediment was mixed, transferred to a slide and covered with a cover slip. The slide was examined under the microscope using 10x followed by 40x objective to identify the hookworm eggs [19].

2.6 Statistical Analysis

The data were analyzed using Chi-Square test. Statistical package used was SPSS (Scientific Package for Social Sciences) version 16.0.

3. RESULTS AND DISCUSSION

A total of 442 samples from different people were examined for hookworm eggs, out of which 35 (7.9%) were infected with hookworm while 192 (43.4%) and 4 (0.9%) were infected with *Ascaris lumbricoides* and *Trichuris trichiura* respectively. The only mixed infections observed were seen with hookworm and *A. lumbricoides* which accounted for 21 (4.8%) prevalence whereas 190 (43%) were uninfected with any of the helminth species (Fig. 1). The findings of this work confirm the existence of hookworm in Afikpo South (Edda) L.G.A of Ebonyi State. This showed that despite the periodic deworming exercises by the government, hookworm infection is still widespread mainly in the tropics. The prevalence rate of 7.9% recorded for hookworm infections in Edda is considerably lower than 68.2% obtained by Adenusi and Ogunyomi [20] in Ibadan, 22.26% recorded by Bala and Yakubu [21] in Jos and 8.6% by Ibrahim and Zubairu [22] in Kano. It is however higher than 6.6% reported by Chollom et al. [23] in Plateau State, 3.2% by Odebunmi et al. [24] in Vom, Plateau State and 2.5% by Ekpenyong and Eyo [25] in Enugu State. The reason for this low prevalence rate for hookworm in this study cannot be unconnected with the fact that children rarely walk barefooted in the area, hence, the rate of penetration of skin by the larvae of the parasite is reduced. Also, the massive deworming exercise should have reduced the hookworm burden in the area.

The study also revealed overall prevalence of geohelminthiases of 57% with hookworm (7.9%), *A. lumbricoides* (43.4%), *T. trichiura* (0.9%) while the only mixed infections were found between hookworm and *A. lumbricoides* (4.8%). *A. lumbricoides* had the highest prevalence (43.4%) followed by hookworm (7.9%) while the lowest was recorded for *T. trichiura* (0.9%). The high

prevalence of soil transmitted helminthiasis in Edda especially *A. lumbricoides* is comparable with previous general studies elsewhere in Nigeria [5,14,16,25-30] but disagrees with those of Udonsi et al. [31] and Suswan et al. [32] who reported higher prevalence of hookworm infections over other geohelminths, as well as those of Ogbe and Adu [33], Asaolu et al. [34] who observed higher prevalence of *T. trichiura* to both *Ascaris* and hookworm. The high prevalence of these infections may be attributed to poor personal hygiene among most of the inhabitants of the area which enhanced transmission. It was also established that *A. lumbricoides* infections are rarely found alone in human communities. The co-infection of hookworm with *A. lumbricoides* also agrees with the result of Ibidapo and Okwa [27].

The prevalence of hookworm infections in relation to age was also studied. In this study, children were mostly infected. Out of 205 children screened, 20 (9.8%) infected were within the age group of 8-14 years, while 6 (7.5%) infection rates were observed among children within 15-20 years of age. Those within 21-30 years old were least infected (3.5%), while adults within the age group of 41-50 had 4(7.7%) infected persons. Details of these and other results can be seen in the Table 2 below. There was no significant difference (X^2=2.68; P>0.05) in the rate of infection with respect to age (Table 2).

The high prevalence of hookworm (9.8%) reported among 8-14 years age group in this study is closely linked to their habits. This is generally the school age. This may be due to frequent exposure to infected soil as they play around. Furthermore in this study, contrary to the fact that the prevalence of most parasitic infections reduces with increase in age [13,35], adults within the age group 41-50 years recorded a high infection rate of 7.7%. This observation is likely to be a result of changes in behaviours as one gets older. People within the age group are mostly farmers in the studied area and frequently make contact with soil; this may further explain the high prevalence. The prevalence of hookworm infections among the different age groups was however not significant (X^2=2.68; P>0.05) and this indicates that the occurrence and distribution of hookworm in Afikpo South L.G.A. is not age-dependent. This is in agreement with the results of Ayorinde [36], Chollom et al. [23], Odebunmi et al. [24], Ekpenyong and Eyo [25]. On the other hand, it does not correlate with the findings of some workers who reported otherwise like those of Bala and Yakubu [21] in Jos North, Plateau State, Agi and Awi-waadu [37] in Amassoma community in Niger Delta and Njoku [38].

Table 3 presents the distribution of hookworm infection in Edda with respect to sex. Out of 198 males examined for hookworm, 13 (6.6%) were infected with the worm while 22 (9.0%) out of 224 females that were examined were as well infected. However, the difference in the rate of infection was not statistically significant (X^2=0.90; P>0.05). The results indicated that more females (9.0%) were infected with hookworm than males (6.6%). The higher prevalence found among the females could be due to the fact that they are involved more in farming activities in Afikpo South L.G.A and so they have greater possibility of making contact with contaminated soil than the males. Females are also more involved in domestic activities such as sweeping of the surroundings and fetching of water from the stream and these they mostly do barefooted; they probably step on areas contaminated with faeces harbouring hookworm larvae. This is in consonance with the reports of Ibrahim and Zubairu [22], Chollom et al. [23], Agi and Awi-waadu [37], Ekpenyong and Eyo [25], but disagrees with the results of Adewole and Akingbolu [39], Bala and Yakubu [21], Uneke et al. [16], Elom et al. [4], Njoku [38] who reported higher prevalence among the males than the females. This disparity in the results may be explained by differences in the sanitary conditions of the study areas as well as the level of personal hygiene among the studied population in those areas.

Table 1. Age distribution of hookworm infections in Afikpo South L.G.A.

Age (years)	No. examined	No. infected	No. uninfected	Prevalence (%)
8-14	205	20	185	9.8
15-20	80	6	74	7.5
21-30	57	2	55	3.5
31-40	48	3	45	6.3
41-50	52	4	48	7.7
Total	442	35	407	6.96

Table 2. Sex distribution of hookworm infections in Afikpo South L.G.A.

Sex	No. examined	No. infected	No. uninfected	Prevalence (%)
Male	198	13	185	6.6
Female	244	22	222	9.0
Total	442	35	407	6.96

A total of 26/285 school children examined were infected with hookworm, out of which pupils from Igbara primary school accounted for the highest rate of infection of 11.9%. This was followed by those from Edda central school (11%) and Itim secondary school (7.5%), while Community primary school had the least infection rate of 6.3%. The differences observed were not statistically significant (X^2=1.77; P>0.05) (Table 3). There was a striking difference in the distribution of the infection among the different schools sampled. Pupils from Igbara primary school and Edda central school recorded higher infection rates compared to children from Itim secondary school and community primary school, Ebunwana. This cannot be unconnected with the sanitary conditions of the school environments and the personal hygiene of the pupils. Nutritional status of individuals is a factor to be considered also [24], since the children of these schools sampled do engage in outdoor activities such as playing on moist soil that may be contaminated with filariform larvae, helping in the farm, thereby making them to be at risk.

A total of 157 adults were examined for hookworm and grouped based on occupation. Out of 82 farmers examined, 6(7.3%) were infected with hookworm while 2 (5.7%) out of 35 Artisans examined were infected. Civil servants accounted for 1(3.6%) out of 28, whereas no trader was infected with the worms. The influence of occupation as a predisposing factor for hookworm infections is presented in Table 4. Those that use water closet as toilet recorded 7.9% prevalence of hookworm infections while those that defaecate in open spaces had 8.3% and those that use pit latrine recorded 6.9% prevalence of the worms (Table 5). The impact of drinking water source in the epidemiology of hookworm infections is presented in Table 6. All the inhabitants of the area depend on streams as source of drinking water, thus, responsible for all the hookworm infections recorded. Water from bore-holes and wells are never used for drinking in the area. The investigation on the influence of some epidemiological variables on hookworm infection has confirmed the existence of variable factors associated with the infection. Such include: farming, use of open defaecation, use of streams as source of drinking water which was essentially higher risk factors for hookworm infections. Other variables like artisan, use of water closet and pit latrines were also risk factors for hookworm whereas civil service and trading had relatively no effect on the transmission of hookworm in the area. However, this result is not conclusive because of the multiple factors that enhance infection with hookworm in the area. This report is in line with the report of Nmorsi et al. [29] who observed that infection was highest among children who made use of bushes as their place of defaecation followed by pit latrines and the water closet, but oppose to the report of Ugbomike et al. [26] who observed that drinking of stream water had no effect on the transmission of any of the geohelminth species in Oba-Ile community of Osun State, Nigeria. The result, he stated may be attributed to the location of water body with respect to human habitation and the degree of human pollution in and around the water body.

Table 3. Distribution of hookworm infection among the different schools studied in Afikpo South L.G.A.

Schools	No. examined	No. infected	No. uninfected	Prevalence (%)
Edda Central School	82	9	73	11
Community Primary School, Ebunwana	64	4	60	6.3
Igbara Primary School	59	7	52	11.9
Itim Secondary School	80	6	74	7.5
Total	285	26	259	9.2

Table 4. Distribution of hookworm infections among different occupational groups

Occupational group	No. examined	No. infected	No. uninfected	Prevalence (%)
Farmers	82	6	76	7.3
Civil Servants	28	1	27	3.6
Artisans	35	2	33	5.7
Traders	12	0	12	0.0
Total	157	9	148	5.7

Table 5. Influence of type of toilet facility on the distribution of hookworm infections in Afikpo South L.G.A.

Toilet facility	No. examined	No. infected	No. uninfected	Prevalence (%)
Water Closet	38	3	35	7.9
Open Defaecation	302	25	277	8.3
Pit Latrine	102	7	95	6.9
Total	442	35	407	7.7

Table 6. Distribution of hookworm infections in Afikpo South L.G.A. based on the source of drinking water

Toilet facility	No. examined	No. infected	No. uninfected	Prevalence (%)
Stream	35	35	0	100
Bore-hole	0	0	0	0
Well	0	0	0	0
Total	35	35	0	100

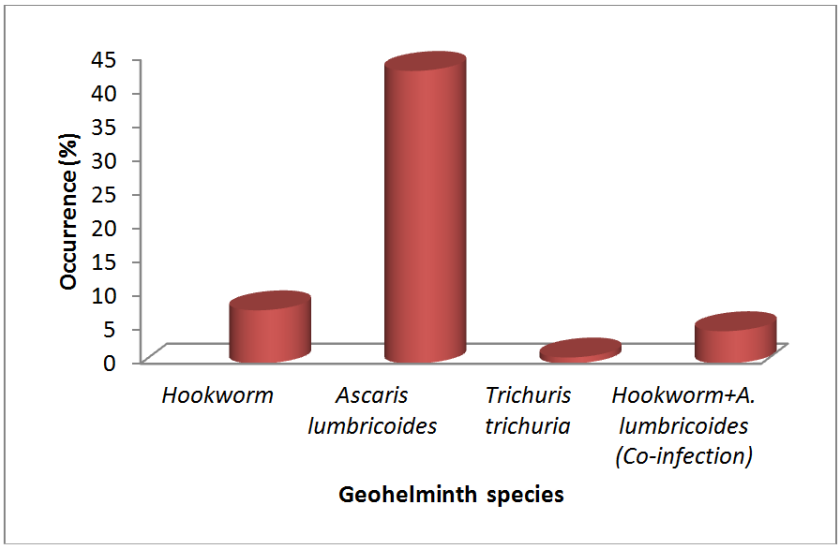

Fig. 1. Distribution of Geohelminth species in Afikpo South L.G.A.

4. CONCLUSION

The findings from this study indicated the existence of hookworm in Afikpo South L.G.A (7.9%). Based on the epidemiological factors analyzed, drinking water source, the kind of toilet used, occupation and poor environmental hygiene appear to be the major risk factors for

hookworm infections as infection rates were considerably higher for farmers, those that use stream water and use of open defaecation. In as much as ignorance of health rules contribute immensely to hookworm transmission, community mobilization and health education is paramount in enlightening the populace on the causes and health implications of hookworm infections. Health education is economical and presents no risks and the benefits do not center only on the control of helminth infections. Indiscriminate faecal deposition should be discouraged whereas, provision of potable pipe-borne water and provision of toilet facilities should be integrated into the control program as this will help in reducing the spread of the infection. There is also the need for concerted periodic mass deworming to effectively control the disease in the area. For sustainable mitigation of the infection rate with hookworm in Afikpo South L.G.A, the prevention strategies should also be based on economic development of the populace with consequent improvements on their socio-economic status, since poverty is a key factor on the epidemiology of hookworm.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Crompton DW. How much human helminthiasis is there in the World? Journal of Parasitology. 1999;85:397-403.
2. De Silver NR, Brooker S, Hotez PJ, Montresor A. Soil-transmitted helminth infections; updating the global picture. Trends in Parasitology. 2003;19:547-551.
3. Brooker S, Michael E. The potential of geographical information system and remote sensing in the epidemiology and control of human helminth infections. Advances in Parasitology. 2000;47:245-287.
4. Elom MO, Alo MN, Anyim C. Intestinal helminthiasis in two rural Communities in south-Eastern Nigeria. Advances in Applied Sciences Research. 2012;3(3): 1413-1417.
5. Schmidt GD, Roberts LS. Foundations of Parasitology. McGraw-Hill Higher Education, 6th edition; 2000.
6. Anosike JC, Zaccheaus VO, Abanobi OC, Dada EO, Oku EE, Obiukwu CE, Nwosu CE. Studies on the intestinal worm (Helminthiasis) infection in a central Nigerian Rural Community. Journal of Applied Sciences and Environmental Management. 2006;10(2):61-66.
7. Albonico M, Stoltzfus R, Savioli L, Tielsch J. The epidemiology of hookworm infection and its contribution to anaemia among pre-school children on the Kenyan coast. Medical Journal. 2004;80:240-246.
8. Stoltzfus RJ, Dreyfuss ML, Chwaya HM, Albonico M. Hookworm control as a strategy to prevent iron deficiency. Nutrition Review. 1997;55:223-232.
9. Brooker S, Bethony J, Hotez PJ. Human hookworm infection in the 21st century. Advances in Parasitology. 2004;58:197-288.
10. World Health Organization. Prevention and control of Schistosomiasis and soil-transmitted helminthiasis. World Health Organization Technical Report Series 912, Geneva; 2002.
11. Murray CJ, Lopez AD. The global burden of disease, a comprehensive assessment of mortality and morbidity from injuries and risk factors in 1990 and projected to 2020. Harvard University Press, Cambridge; 1996.
12. Stephenson LS, Latham MC, Ottesen EA.. Malnutrition and parasitic helminth infections. Parasitology. 2000;121:23-38.
13. Hotez PJ, Brooker S, Bethony J, Bottazzi ME, Loukas A. Current concepts. Hookworm infection. New England Journal of Medicine. 2005;351:799-807.
14. Uhuo AC, Odikamnoro OO, Ani OC.The incidence of intestinal nematodes in primary school children in Ezza North L.G.A, Ebonyi State, Nigeria. Advances in Applied Science Research. 2011;2(5):257-262.
15. Okoro UU. Towards the Rebirth of Edda. Eddawood Foundation, Akwakuma/ Amakohia Layout, Owerri, Imo State; 1990.
16. Uneke CJ, Eze KO, Oyibo PG, Azu NC, Ali E. Soil-transmitted helminth infection in school children in South-Eastern Nigeria; The public health implication. The Internet Journal of Third World Medicine. 2007; 4(1):10-16.

17. Cheesbrough M. District laboratory practice in tropical countries, Part I. Cambridge University Press, London; 1998.
18. Ozumba UC, Ozumba N. Patterns of helminth infection in the human Gut at the UNTH, Enugu, Nigeria. Journal of Health Science. 2002;48(3):263-268.
19. Ash K, Orihel T. Atlas of human parasitology, 4th edition. American Society of Clinical Pathologists, U.S.A.; 1997.
20. Adenusi AA, Ogunyomi EOA. Relative prevalence of the human Hookworm species, *N. americanus* and *A. duodenale* in an urban community in Ogun State, Nigeria. African Journal of Biotechnology. 2003;2(11):470-473.
21. Bala AY, Yakubu DP. A survey of hookworm infection among pupils of school age in Jos-North Plateau State, Nigeria. Nigeria Journal of Basic and Applied Sciences. 2010;18(2):237-242.
22. Ibrahim S, Zubairu ML. Prevalence of hookworm infection among patients attending Aminu Kano Teaching Hospital, Kano, Nigeria. Bayero Journal of Pure and Applied Sciences. 2010;3(2):84-86.
23. Chollom SC, Kaigama AJ, Gideon BA, Ajayi OT, Maxwell IK, Nwankiti OO. Prevalence and speciation of hookworm in Plateau State, Nigeria. Journal of Parasitology and Vector Biology. 2012; 4(2):14-19.
24. Odebunmi JF, Adefioye OA, Adeyeba OA. Hookworm infection among school children in Vom, Plateau State, Nigeria. American-Eurasian Journal of Scientific Research. 2007;2(1):39-42.
25. Ekpenyong EA, Eyo JE. Prevalence of intestinal helminth infections among school children in tropical semi-urban communities. Animal Research International. 2008;5(1):804-810.
26. Ugbomoike US, Onajole AT, Edungbola LD. Prevalence and intensity of geohelminth infections in Oba-Ile community of Osun State, Nigeria. Nigeria Journal of Parasitology. 2006;27:62-67.
27. Ibidapo CA, Okwa O. The prevalence and intensity of soil transmitted Helminths in a rural Community, Lagos suburb, Southwest Nigeria. International Journal of Agriculture and Biology. 2008;10:89-82.
28. Dangana A, Abayomi RO, Way GD, Akobi OA. Survey of *Ascaris lumbricoides* among pupils of primary school in Jos South L.G.A of Plateau State. Nigeria. African Journal of Microbiology Research. 2011;5(17): 2524-2527.
29. Nmorsi OPG, Isaac C, Aashikpelokhai IS, Ukwandu NCD. Geohelminthiasis among Nigerian pre-school age children. Bangladesh Journal of Scientific and Industrial Resources. 2009;44(4):399-411.
30. Adikankwu OR, Odikamnoro OO, Uhuo AC, Nwuzo AC. The prevalence of intestinal nematodes in school children in Ebonyi Local Government Area, Ebonyi State. Continental Journal of Biomedical Sciences. 2012;6(1):13-17.
31. Udonsi JK, Nwosu ABO,Anya AO. Necator americanus; population structure, distribution and fluctuations in population densities of infective larvae in contaminated farmlands. Parasitology Research. 1980;63:251-259.
32. Suswam EA, Ogbogu VC, Umoh JU, Ogunsusi RA. Intestinal parasites among school children in Sona and Igabi L.G.A of Kaduna state, Nigeria. Nigeria Journal of Parasitology. 1992;13:39-42.
33. Ogbe MG, Adu OO. Intestinal helminthiasis in an orphanage in Nigeria. Bioscience Research Communication. 1990;2:105-118.
34. Asaolu SO, Holland CV, Jegede JO, Stoddard RC, Crompton DWT. The prevalence and intensity of soil-transmitted helminthiasis in rural communities in Southern Nigeria. Annals of Tropical Medicine and Parasitology. 1992;86:279-287.
35. Bethony J, Chan J, Lin S,Zhan B. Emerging patterns of hookworm infections. Influence of aging on the intensity of Necator infection in hainan province, people's Republic of China. Clinical Infectious Diseases. 2002;35:1336-1344.
36. Ayorinde TA. Studies on the prevalence and intensity of Nematodiasis in school children in Ado-Ekiti. Excellent Publications. 2004;20:5-17.
37. Agi PI, Awi-waadu GDB. Hookworm infection in Amassoma community in the Niger Delta, Nigeria. Journal of Applied Sciences and Environmental Management. 2008;1(2):17-20.

38. Njoku IA. Coprological survey of geoheminth infections among school children in Rural Ebonyi State, Nigeria. Animal Research International. 2007;4(2): 653-661.

39. Adewole SO, Akingbolu IA. Prevalence and intensity of hookworm infection in Ekiti, Nigeria, a cross-sectional study in State Specialist Hospital and Federal Medical Center. Journal of Parasitology. 2009;3(2): 390-402.

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