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Prevalence and risk factors associated with *Entamoeba Sp*. and hookworm infections among vulnerable people attending clinics within Makurdi Metropolis, Benue State, Nigeria

Mark Ojonugwa Iboyi *, Cecilia Onyawole Ali, Moses Odoh and Peter Ogwuche Okpeji

Department of Zoology, College of Biological Sciences, Joseph Sarwuan Tarka University, P.M.B 2373, Makurdi, Nigeria.

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Abstract

Parasitic infections continue to be a major challenge to the world's health institutions. These infections have remained a major health hazard with more endemicity where poor sanitation, personal hygiene and general ignorance of the diseases are known to enhance spread. The study was aimed at investigating the prevalence and risk factors associated with *Entamoeba Sp.* and hookworm infections among vulnerable persons in Makurdi Metropolis, Benue State, Nigeria. The study is a cross-sectional study in which vulnerable patients who presented in different hospitals and health care centers in the study area were recruited for the study. A total of 384 stool samples were collected and examined from patients attending different medical facilities. Direct wet mount and Formalin-Ether Concentration Techniques (FECT) were adopted. Data were entered and cleaned on excel sheet. Prevalence of parasitic infections were calculated in percentage while data analysis was done using Chi-square on SPSS version 20. Values were considered significant at P≤0.05. Prevalence for both *Entamoeba Sp* and hookworm infection was 67(17.45 %). Female subjects showed higher prevalence for *Entamoeba Sp* and hookworm infection, However, the difference was not significant (P>0.05). Vulnerability related prevalence of infection revealed the highest case of hookworm infection among the aged with HIV 5(38.46%) and *Entamoeba Sp* among Children with HIV 1 (33.33%). Location related prevalence showed that the infection rate in Apir/Wadata was highest 18(33.96%) for both parasites (P>0.05). Infection was independent of water source although those who used rain water recorded higher infections. This was also the case for the relationship between infection and toilet types with those who used open field recording higher infections. Higher prevalence of infection was observed in subjects who had primary education only for both parasites. 41 (19.25%) who reported that they sometimes wash fruits/vegetables before consumption was infected also, 46 (18.90%) subjects who reported that they eat at home were positive. Therefore, this study calls for better personal hygienic living and improved environmental sanitation in the metropolis.

Keywords: *Entamoeba Sp*; Hookworm; Prevalence; Vulnerable

1. Introduction

Parasitic diseases have contributed greatly in undermining the health status of people and jeopardizing the economic development of nations particularly in the tropics. [1,2] *Entamoeba Sp* and Hookworm infections are among the most important human intestinal parasitic diseases which infect humans especially in the tropical and sub-tropical regions of the word. *Entamoeba histolytica* belongs to the genus *Entamoeba*.[3] This protozoan parasite causes the disease Amoebiasis with an estimated global prevalence of 500 million infected people and is responsible for 40,000 - 100,000 deaths each year. Amoebiasis predominantly infects humans and other primates; the active stage (trophozoite) exists only in the host and in fresh loose faeces while the cysts survive outside the host in water, soils, and on foods, especially under moist conditions. According to Brown *et al.* [4] the cysts are readily killed by heat and by freezing temperatures,

* Corresponding author: Iboyi M. O.

and survive for only a few months outside of the host. Infants, pregnant women, and patients who are taking immunosuppressive drugs are considered the high-risk populations for developing intestinal amoebiasis.[5,6] Amoebiasis is an important health problem, especially in developing countries. [7,8] The rate of infection by *Entamoeba Sp* differs among countries, socio-economic and sanitary conditions and populations.[9] The disease is highly endemic throughout poor and socio-economically deprived communities in the word. Environmental, socio-economic, demographic and hygiene-related behaviour is known to influence the transmission and distribution of intestinal parasitic infections. [10] Symptoms of amoebiasis can include fulminating dysentery, bloody diarrhea, weight loss, fatigue, abdominal pain, and amoeboma. The amoeba can actually 'bore' into the intestinal wall, causing lesions and intestinal symptoms, and it may reach the blood stream. From there, it can reach different vital organs of the human body, usually the liver, but sometimes the lungs, brain, spleen, etc. [4]

Hookworms on the other hand are parasites that live in the small intestine of their hosts where they suck blood or digested food.[11] They belong to the phylum *Nematoda* and Family Ancylostomatidae. Hookworms are of two species; *Ancylostoma duodenale and Necator americanus. N. americanus* is generally smaller than *A. duodenale.* The hook shape is much more defined in *Necator* than in *Ancylostoma*.[12]

Infection with hookworm occurs in areas where environmental conditions favour the development of the larvae.[13] The infective stage is the filariform larva which infects man through skin penetration or ingestion. Larval invasion of the skin gives rise to intense local itching usually on the foot. Hookworm infection leads to maternal and child morbidity, growth retardation in children, low birth weight among newborns born to infected mothers and anemia.[14] Factors responsible for the spread of hookworm include environmental, host related factors and human habits.[15,16] Symptoms of the infection include; localized rash, diarrhea, decreased appetite, severe weight loss, anaemia, abdominal discomfort, blood in the stool, bloody sputum, cough, fatigue, fever, nausea, vomiting and pallor.[17]

This study therefore determines the prevalence of and risk factors associated with *Entamoeba Sp.* and Hookworm infections among vulnerable persons attending clinics within Makurdi metropolis, Benue state, Nigeria.

2. Materials and Methods

2.1. Study Area

The study was conducted in Makurdi, the capital of Benue State, Nigeria. Makurdi is fast becoming a Metropolitan center with attendant health, social, housing and environmental problems. The town lies between latitude 07°15'-07°45' N and longitude 08°15'-08°40'E, and in the guinea savannah vegetative belt on the bank of the second largest river in Nigeria (River Benue). The river divides the town into the North and South Banks with the town covering an area of 16 $km^{2.}$

Makurdi is the gate way to the North from the Eastern flank of the country by road and rail and even by air.[18] The mean monthly temperature of Makurdi ranges between 27-38 ℃. The annual rainfall is over 100 mm with rain falling from the month of April through October. The population of Makurdi is 292,645 according to the GoeNames geographical database (2006).[19]

2.2. Ethical Clearance

Ethical approval was sought and obtained from the Benue State Health Management Board, the consent of the Medical Directors of all the Hospitals and Health Centers where samples were collected in Makurdi were also sought and obtained. Those who refused to give faecal samples or to answer the questionnaires were simply excluded from the study.

2.3. Sample Collection

Ten grams (10g) of fresh stool samples uncontaminated with urine were collected in the morning from subjects attending clinics within Makurdi metropolis in labeled sterile specimen bottles and transported to the laboratory for microscopic examination. Structured questionnaire was used to collect other socio-demographic data such as sex, location, hygienic practices, eve of education etc.

2.4. Laboratory Techniques

Portions of each stool sample collected were examined by direct wet mount preparation while another portion was preserved with 10% formalin for formol-ether concentration technique (FECT) which was used to detect the presence of cysts or trophozoites and ova of intestinal parasites that may be present. [20,21,22]

2.5. Direct wet mount preparation

The procedure as outlined by Cheesbrough[23] was followed: A drop of physiological saline was placed on the middle of a clean glass slide to which, a small portion of the stool from the mucoid and or bloody part (if any) was picked and emulsified in the physiological saline using an applicator stick. A cover slip was used to gently cover the smear and the preparation was systematically examined under the microscope using x10 objective.

2.6. Formol-ether concentration techniques.

The procedure was as presented by Cheesbrough[23] since this technique is rapid and can be used to concentrate a wide range of faecal parasite from fresh or preserved stool samples.

Using an applicator stick, 1g (pear size) of faeces was emulsified in 4mls of 10% formol solution contained in a tube. 4mls of 10% v/v formol water (10% of concentrated formalin and 90mls of water) was added and the bottle caped and mixed well by shaking. The emulsified faeces were filtered and the filtrate collected in a beaker. The filtrate was then transferred to a centrifuge tube and 4mls of diethyl ether was added after which, the tube was stopped and mixed for a minute. With a tissue wrapped around the top of the tube, the stopper was loosened (considerable pressure will have built up inside the tube). The sample in the tube was centrifuged immediately at 750-1,000g (approximately 3000rpm) for 1 minute. Using an applicator stick, the layer of the faecal debris was loosened from the side of the tube and the tube inverted to discard the ether-faecal debris and formol water, leaving behind the sediment. The tube was returned to its upright position for droplets on the side of the tube to drain to the bottom. The bottom of the tube was tapped to re-suspend and mix the sediment. Then, the sediment was transferred to a slide and covered with a cover slip. The preparation was examined microscopically using the X10 objective with the condenser iris closed sufficiently to give good contrast. X40 objective was used to examine the cysts or ova (if any).

2.7. Statistical Analysis

Data were entered and cleaned on an excel sheet. The prevalence of parasitic infection was calculated in percentage while data analysis was done using Chi-square on SPSS version 20. Values were considered significant at $P \leq 0.05$.

3. Results

A total of 384 were enrolled for the studies. Out of this number, 67(17.45 %) were positive for either *Entamoeba Sp* or Hookworm infections (Table 1). Female subjects showed higher prevalence for both *Entamoeba Sp* and hookworm infections, 37 (14.62%) and 14 (5.53%) respectively compared to the male subjects. However, these differences were not statistically significant (χ^2 =2.88; χ^2 =1.7798).

The prevalence of *Entamoeba Sp* and hookworm infections among the different vulnerable groups studied is contained on Table 2. The highest prevalence was recorded amongst the aged HIV patients 5(38.46%), followed by HIV infected children 1 (33.33%) and HIV infected youths 8 (33.33%) while the lowest prevalence was recorded in children 12 (11.77%). Prevalence of *Entamoeba Sp* infection was highest in children with HIV 1 (33.33%). However, the aged with HIV showed the highest prevalence for hookworm infection 2(15.38). Although the differences recorded were not statically significant (χ^2 =6.8482; χ^2 =4.6588).

The relationship between the prevalence of infection and location is shown on Table 3. Both infections were highest in Api/Wadata 18 (33.96%). *Entamoeba Sp* and hookworm infections recorded prevalence of 12(22.64%) and 6(11.32%) respectively (χ^2=5.8979; χ^2=3.8771).

Table 4 shows the relationship between sources of drinking water and infection in the population under study. The highest prevalence recorded was in subjects whose source of drinking water was rain 7 (21.88%). Similarly, both *Entamoeba Sp* and hookworm infection recorded prevalence of 5(15.63%) and 2(6.25%) respectively in subjects who use rain water (χ^2=2.1226; χ^2=0.4178).

Infections of *Entamoeba Sp* and hookworm occurred subjects who use different toilet types in the current study (Table 5). Open field had the highest prevalence 36 (25.17%), followed by Water closet 15 (14.71%), Pit latrine12 (12.90%) and Squat showed the least prevalence 4 (8.70%). Even though, the difference recorded was not statistically significant (χ^2=5.9055; χ^2=1.9702).

Table 6 shows the relationship between educational status and infection in the population under Study. The highest prevalence was observed in subjects who had primary education only 28(21.05%). Although subjects who were

uneducated recorded similar prevalence from hookworm infection with those who had only primary education, 4(5.26%) and 7(5.26%) respectively. However, the differences were not significant (χ^2=1.6961; χ^2=1.6447).

Of the 384 subjects, 41(19.25%) who reported that they sometimes wash fruits/vegetables before consumption were infected as against 11 (15.71%) subjects who reported that they never wash fruits/vegetables before consumption (Table 7). However, the least presence is in those who always wash fruits/vegetables before consumption (χ^2=3.1916; χ^2=2.2613).

Table 8 shows the relationship between eating habit and infection in the population under study. 46 (18.90%) subjects who reported that they eat at home were positive for both infections which were the highest. However, those who eat out had the highest prevalence for hookworm infection 2(5.56%). The result showed no significant difference (χ^2=7.7176; χ^2=1.4984).

Table 1 Prevalence of *Entamoeba Sp* and hookworm infection in relation to sex among Vulnerable Persons

Sex	No. examined	*Entamoeba Sp* (%)	Hookworm (%)	Total no. Positive (%)
Male	131	13 (9.92)	3(2.29)	16(12.21)
Female	253	37(14.62)	14(5.53)	51 (20.16)
Total	384	$\chi2$ =2.88	$\chi2$ =1.7798	67(17.45)

For relationship between Sex and *Entamoeba Sp* presence, χ^2= 2.88 tab at df_1=3.84(There was no significant association between sex and *Entamoeba Sp* infection) P>0.05.

For relationship between Sex and Hookworm presence, χ^2= 1.7798 tab at df_1=3.84(There was no significant association between sex and Hookworm infection) P>0.05.

Table 2 Relationship between level of vulnerability and Infection with *Entamoeba Sp* and Hookworm

Age (Months)	No. examined	*Entamoeba Sp* (%)	Hookworm (%)	Total no. Positive (%)
Children	102	12(11.76)	0(0)	12(11.76)
Aged	37	6(16.22)	3(8.10)	9(24.32)
Pregnant women	190	19(10)	9(4.74)	28(14.74)
HIV/Children	3	1(33.3)	0(0)	1(33.33)
HIV/Aged	13	3(23.08)	2(15.38)	5(38.46)
HIV/Pregnant	15	3(20)	1(6.67)	4(26.67)
HIV/Youth	24	6(25)	2(8.33)	8(33.33)
Total	384	χ^2 =6.8482	χ^2 =4.6588	67(17.45)

For relationship between Vulnerability and *Entamoeba Sp* presence, χ^2= 6.8482 tab at df_6=12.017 (There was no significant association between Vulnerability and *Entamoeba Sp* infection) P>0.05.

For relationship between Vulnerability and Hookworm presence, χ^2= 4.6588 tab at df_6=12.017(There was no significant association between Vulnerability and Hookworm infection P>0.05.

Table 3 Relationship between Location and Infection with *Entamoeba Sp* and Hookworm

Location	Number of Respondents	*Entamoeba Sp* (%)	Hookworm (%)	Total no. positive (%)
North-Bank	71	12(16.90)	3(4.23)	15 (21.13)
Kanshio	48	3(6.25)	1(2.08)	4 (8.30)

Fidii	14	1(7.14)	0(0.0)	1(7.14)
Adaka	46	2(4.35)	1(.17)	3 (6.52)
High-Level	54	7(12.96)	2(3.70)	9 (16.67)
Wurukum	66	9(13.64)	4(6.06)	13 (19.70)
Agan	32	4(12.50)	0(0)	4 (12.50)
Api/wadata	53	12(22.64)	6(11.32)	18 (33.96)
Total	384	χ^2=5.8979	χ^2=3.8771	67(17.45)

For relationship between location and *Entamoeba Sp* presence, χ^2= 5.8979 tab at df_7=14.067 (There was no significant association between location and *Entamoeba Sp* infection) P>0.05.

For relationship between location and Hookworm presence, χ^2=3.8771 tab at df_7=14.067 (There was no significant association between location and Hookworm infection) P>0.05

Table 4 Relationship between Sources of Drinking Water and Infection with *Entamoeba Sp* and Hookworm

Sources of drinking water	**No. examined**	**Entamoeba Sp (%)**	**Hookworm (%)**	**Total no. positive (%)**
Stream/ rivers	56	7(12.50)	3(5.36)	10(17.86)
Boreholes	129	17(13.18)	4(3.10)	21 (16.28)
Pipe borne	64	9(14.06)	3(4.69)	12(18.75)
Rain	32	5(15.63)	2(6.25)	7 (21.88)
Well	103	12(11.65)	5(4.85)	17(16.50)

For relationship between sources of drinking water and *Entamoeba Sp* presence, χ^2= 2.1226 tab at df_4=9.488 (There was no significant association between sources of drinking water and *Entamoeba Sp* infection) P>0.05.

For relationship between sources of drinking water and Hookworm presence, χ^2= 0.4178 tab at df_4=9.488 (There was no significant association between sources of drinking water and Hookworm infection) P>0.05.

Table 5 Relationship between type of Toilet and Infection with *Entamoeba Sp* and Hookworm

Type of toilet used	**No. examined**	***Entamoeba Sp* (%)**	**Hookworm (%)**	**Total no. positive (%)**
Water closet	102	11(10.78)	4(3.92)	15 (14.71)
Open field	143	27(18.88)	9(6.29)	36 (25.17)
Pit latrine	93	9(9.68)	3(3.22)	12 (12.90)
Squat	46	3(6.52)	1(2.17)	4 (8.70)
Total	384	χ^2=5.9055	χ^2=1.9702	67 (17.45)

For relationship between sources of type of toilet and *Entamoeba Sp* presence, χ^2= 5.9055 tab at df_3=7.815 (There was no significant association between type of toilet and *Entamoeba Sp* infection) P>0.05.

For relationship between type of toilet and Hookworm presence, χ^2= 1.9702 tab at df_3= 7.815 (There was no significant association between type of toilet and Hookworm infection) P>0.05.

Table 6 Relationship between Educational Status and Infection with *Entamoeba Sp* and Hookworm

Educational Status	**No. examined**	***Entamoeba Sp* (%)**	**Hookworm (%)**	**Total no. positive (%)**
Tertiary	84	9(10.71)	2(2.38)	11 (13.10)
Secondary	91	9(9.89)	4(4.40)	13 (14.29)
Primary	133	21(15.79)	7(5.26)	28 (21.05)
None	76	11(14.47)	4(5.26)	15 (19.74)
Total	384	χ^2=1.6961	χ^2=1.6447	67 (17.45)

For relationship between educational status and *Entamoeba Sp* presence, χ^2= 1.6961 tab at df_3=7.815 (There was no significant association between educational status and *Entamoeba Sp* infection) P>0.05.

For relationship between educational status and Hookworm presence, χ^2= 1.6447 tab at df_3=7.815 (There was no significant association between educational status and Hookworm infection) P>0.05.

Table 7 Relationship between Proper Washing of Fruits and Vegetables and Infection with *Entamoeba Sp* and Hookworm

Proper washing of fruits and Vegetables	**No. examined**	***Entamoeba Sp* (%)**	**Hookworm (%)**	**Total no. positive (%)**
Always	101	12(11.88)	3(2.97)	15 (14.85)
Sometimes	213	29(13.62)	12(5.63)	41 (19.25)
Never	70	9(12.86)	2(2.86)	11 (15.71)
Total	384	χ2=3.1916	χ2=2.2613	67 (17.45)

For relationship between proper washing of fruits and vegetables and *Entamoeba Sp* presence, χ^2= 3.1916 tab at df_2=5.991 (There was no significant association between proper washing of fruits and vegetables and *Entamoeba Sp* infection) P>0.05.

For relationship between proper washing of fruits and vegetables and Hookworm presence, χ^2= 2.2613 tab at df_2=5.991 (There was no significant association between proper washing of fruits and vegetables and Hookworm infection) P>0.05.

Table 8 Relationship between eating habit and Infection with *Entamoeba Sp* and hookworm

Eating Habit	**No. examined**	***Entamoeba Sp* (%)**	**Hookworm (%)**	**Total no. positive (%)**
Eat at home	243	36(14.81)	10(4.12)	46 (18.93)
Eat out	36	5(13.89)	2(5.56)	7 (19.44)
Eat at home/ eat out	105	9(8.57)	5(4.76)	14 (13.33)
Total	384	χ^2=7.7176	χ^2=1.4984	67 (17.45)

For relationship between eating habit and *Entamoeba Sp* presence, χ^2= 7.7176 tab at df_2=5.991 (There was a significant association between eating habit and *Entamoeba Sp* infection) P<0.05.

For relationship between eating habit and Hookworm presence, χ^2= 1.4984 tab at df_2=5.991 (There was no significant association between eating habit and Hookworm infection) P>0.05.

4. Discussion

The result of this study shows the prevalence and risk factors associated with *Entamoeba Sp* and hookworm infection among vulnerable people in Makurdi metropolis. The overall prevalence of *Entamoeba Sp* and hookworm infection was 67(17.45%). The result showed that the infection was moderate in Makurdi Metropolis compared to other studies in Nigeria. The most prevalent parasite in this current study was *Entamoeba Sp.* The prevalence of 13.02% for *Entamoeba Sp.* recorded in this study is slightly higher than the prevalence of 10% reported by World Health Organization [24] for developing countries. The higher prevalence recorded in this study may be due to lesser level of public health awareness in the area under study. The prevalence in this study is in agreement with Aribodor et al.[25] who reported *a* prevalence of 12.6% in Anambra, Nigeria but disagrees with previous studies by Nyenke et al.[26] who reported (9%) prevalence in Degema**.** The current finding is also not in agreement with previous studies published by Bala and Yakubu,[27] Houmsou et al.[28] Iboyi et al.[29] Meremikwu et al.[30] and Agi[31] who reported lower prevalence in their studies. However, higher prevalence was reported from previous studies where sanitation and personal hygiene were poor. Mbuh et al.[32] Ogunlesi et al.[33] and Egwera et al.[34] all reported higher prevalence in their studies.

Hookworm was observed to be the least, with the prevalence of 4.43% among the two parasites in this study. The total prevalence of hookworm in this study was lower when compared to the findings of Ito and Egwunyenga,[35] Ibrahim and Zubairu,[36] Rafindadi et al.[37] and Pal et al.[38] Comparing this prevalence rate with what was obtained in similar studies elsewhere such as Darjeeling, India,[38] Hoabinh, North western Vietnam,[39] and Minas Gerais, Brazil,[40] one can say that the prevalence recorded in this study is relatively very low. This can be attributed to the fact that the hospital is city–based, where a significant number of those patronizing it have better awareness compared to those in the rural areas although some of the cases could be referral type from other hospitals. The reason also may be that, there was an improved environmental sanitation coupled with interfering substances (laxatives) in Makurdi due to widespread unrestricted access to drugs in developing countries (Nigeria inclusive).[41]The total prevalence of hookworm in this study is higher when compared to the findings of Iboyi et al.[29] who reported 3.66% in Makurdi metropolis and Amoke et al.[42] who reported 0.8% in Elele, South-South, Nigeria.

This study indicated that infections were more common in the female than in the male subjects, although the difference was not significant. The higher prevalence among the females could be due to the fact that they are normally involved more in household activities such as food preparation, cleaning of surroundings and water fetching in which they work barefooted, thus possibly stepping on areas contaminated with faecal matter containing the larvae.[44] This study also agrees with the work of Orji et al.[44] who observed a higher prevalence of intestinal parasites in females than in males. The result is not in conformity however with Aribodor et al.[25] who reported that males were more infected than females. It also disagrees with previous studies published by Amoke et al.[42] who reported higher prevalence in males than in females.

Infection rate was higher among HIV-positive patients with the aged in this group recorded more cases as compared to the HIV-negative patients. This may be due to the fact that their immune system may have been compromised. The aged with HIV had higher infection than the children. This may be so because of their older ages. Hookworm infection is said to increase as a person progresses in life.[14] *Entamoeba Sp* infection was found highest in HIV-infected children, this might be as a result of their weak immunity since the infection could have impacted negatively on their immune system.

The result from this study showed that location or environment influenced infection with *Entamoeba Sp. and* Hookworm*.* This implies that both North-bank and Wadata's environments have the same predisposition of these parasitic infections. This is probably suggesting public health awareness within North-bank, Wadata and its environments. This result is in line with the work of Iboyi et al.[29] who reported higher prevalence in Wadata and North-Bank. However, this is contrary to Obadiah[41] who reported that outside Zaria City showed higher prevalence than Zaria City despite similar features that characterizes both locations. It was suggested that the personal hygiene was poor.

All the drinking water sources in this current study revealed the cases of infections. The highest prevalence was observed in patients who use rain water. Even though, the source of drinking water does not significantly influence the prevalence of these parasitic infections. This suggests an under lying factor influencing the prevalence of these parasites in the current study. Water, irrespective of its source can easily be contaminated during handling, especially where sanitation and personal hygiene are generally poor. It is easy to contaminate water by hands, utensils, contact with animals and certain agricultural practices such as organic manure, which may contain high number of cysts or oocysts or slurry washed off field into the rivers.[45] In a study conducted by Obadiah[41] in Zaria, Nigeria, it was reported that sources of drinking water did not have significant effect on the level of *Entamoeba Sp.* infection.

The infections occurred in all the type of toilets used with open field and water closet recording the highest respectively. This implies that irrespective of the type of toilet used transmission of these parasites can still occur. The prevalence recorded in this study could be explained by the toilet habits of the individuals which are largely responsible for feacal contaminated hands during clean-up process that accompanies defecation.[46] Poor personal health habits where daefecation occurs in the open area (very common practice in some parts of Makurdi have led to higher level of contamination of the environment). Pit toilet and open field were shown to be good sources of contamination of foods, vegetables, soil and water. The chances of encountering infection from the use of toilet cleaned regularly is very low while unclean toilet encourage the multiplication of synthropic insects, which are also transmitting agent of intestinal parasites.[47] Infective nature of the soil is maintained because of indiscriminate daefecation. For this reason, all fruits or vegetables grown on or that come in contact with contaminated environment would likely carry the ova or cysts on their surface.[48] The use of untreated human faeces and animal dung as fertilizer for agricultural farm and garden is a good channel for infection and transmission of hookworm.[11] These habits are compounded by social factors such as illiteracy, ignorance and low standard of living.[16]

The study showed similar results regarding the factors (literacy level) enhancing the risk of hookworm and amoebiasis with the highest case in persons with primary education. It was followed by persons who do not have formal education. The lowest prevalence was in people who are well educated. Nematian et al.[49] reports that low socioeconomic status of the people was a risk factor for intestinal parasites infections due to lack of access to clean water, poor hygienic environment, lack of access to education and overcrowded condition. This implies that prevalence of these parasitic infections cut across socio economic background of individual. The insignificance of socioeconomic status may not be easy to explain considering unemployment in the country, coupled with poverty in most developing countries.

In this study, it was revealed that persons who sometimes washed fruits or vegetables before consumption had higher infections followed by those who do not. In a separate study conducted by Adedoyin et al.[50] in Ilorin and Nzeako (1993)[51] in Nsukka, it was revealed that contaminated foods and vegetables are significantly associated with intestinal parasitosis respectively rather than water. Similarly, Alemu and Mama[52] revealed that eating of vegetables/fruits without washing or peeling was significantly associated with heminthiasis. This observation could be that the infective stages of the parasites are ingested with the food to initiate infection.[52]

In the current study, persons who eat at home had more infection compared to those who eat outside or both. Similar finding was also reported by Alemu and Mama[52] where they find that residents who commonly cook their own food at home were more infected than those who go to hotel. This could mean that the level of hygienic practices in the homes is less compared to the hotels. However, it was observed that those who eat out had the highest case of hookworm infection in the current study.

5. Conclusion

The presence of *Entamoeba Sp.* and Hookworm in Makurdi Metropolis is indication that amoebiasis and Hookworm exist in the area. Factors contributing to the occurrence and spread of the infection are likely; poor hygienic conditions, unavailability of portable water supply, eating habit, poor sanitary facilities, illiteracy and indiscriminate defecation. Therefore, more public health awareness programme should be promoted towards a better understanding of the source and adverse impacts of amoebiasis and Hookworm among vulnerable people.

Compliance with ethical standards

Disclosure of conflict of interest

No Conflict of interest exist amongst Authors.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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