Prevalence of Human Intestinal Parasites, It's Detection on Dumpsite and Relationship with the Environmental Factors in Ogbo Hill, Aba, Eastern Nigeria

Amadi, A. N. C., Chukwuemeka, B. C. and Obeten, P. I.

Abstract

Growing population, increase in urbanization, and consumption of packaged food, drinks have complicated the waste management problems in developing countries, thus raising serious concern over public health. This study was conducted to determine the prevalence of intestinal parasites, in relation to the dumpsite of Ogbor Hills, Aba Abia State, Nigeria. Formal-ether concentration and Baermann funnel techniques were used for faecal and refuge sludge examination. Questionnaire was administered to elicit residents' responses. A total of 423 faecal samples were examined and 164(38.8%) persons were infected. The parasite found among residents were Necatoramericanus 51(12.1%), Entamebahistolytica 45(10.6%), Ascarislumbricoides 38(9.0%), Trichuristrichiura 21(5.0%) and Taeniasaginata 9(2.1%). N. americanus eggs were highest (34.5%). Females (48.8%) were more infected than males (34.5%). Age group 21–30years recorded the highest 49(58.3%) infection. Age range 7–9years (OR=2.6222) has greater chances of infection. Those whose residence are <6 houses apart (OR=1.1282) and 9 houses apart (OR=1.9771) have greater chances of infection. Dumpsite parasitic species were A. lumbricoides (47.6%), E. histolytica (37.4%), B. coli (16.9%), T. species (13.8%), N. americanus (9.3%), E. coli (6.2%) and T. trichiura (6.0%). The overall intensity of parasitic infestation showed a positive correlation (R=0.161). Majority (87.5%) of the residents are aware that they are at risk of contracting the parasite. Improper waste management leads to the spread of infectious diseases. A well fenced dumpsite, away from residential will help to reduce the potential of being infected with intestinal parasites in the area.

Keywords: Parasites, Hookworm, Dumpsite, Relation, Faecal, Ogbor Hill

Department of Zoology and Environmental Biology, College of Natural Sciences and Environmental Biology, Michael Okpara University of Agriculture, Umudike

Correspondence: amadi.anthonia@mouau.edu.ng

Introduction

The National Institute for Occupational Safety and Health (1997) defined waste as "a material which is a prime product (i.e. waste products produced from the market) in which the initial user have no need for further usage with regards to him/her own purposes of production, transformation and consumption of which him/she wants to discard", which may consist of organic-matter (degradable) or inorganic-matter (non-degradable, for-example: metals, plastics, bottles, and broken-glasses) (Zhang *et al*., 2010).. These wastes can be produced during the extraction and processing of raw materials into intermediate and final products and other human activities.

Solid waste characteristics differ, depending on source and nature; and exist in two-forms, namely; refuse and trash (EPA, 2009). Refuse; includes garbage (highly de-compostable food-waste), rubbish (dry material, such-as: metal, cans, glass, slow-decomposing-materials, combustible-materials, textile, and woods). Trash, on the other hand, comprises of bulky-waste-materials, which require special-handling, for-example: electronics, furniture, and household-items and equipment (World Bank, 2005).

The rapid increase of urban population brings about a rising demand for food and other essential services which in turn increases waste generation daily by each household (Zhu *et al*., 2008). According to Drew *et al*. (2007) a designated places set aside for waste disposal and management is known as municipal waste dumping site. Depending on a city's level of waste management, waste can be discarded in an indiscriminately, separated for recycling purposes, or simply burnt. Poor waste management poses a great challenge to the health of the residents, particularly those living close to a solid waste dumpsite, due to potential of waste to pollute the water, air, land and vegetation (Lou and Nair, 2009). Poor waste disposal and handling therefore leads to environmental degradation and destruction of ecosystem which poses great risks to public health.

Wastes are usually collected by the municipal waste collection centers to be thrown into the landfills and dumpsites. However, not all of this waste gets collected and transported to the final dumpsites, either due to resource crunch or inefficient infrastructure. Improper waste management and disposal of waste causes serious health problems to the surrounding environments. It has become a common sight in Nigeria today to see heaps of festering refuse dumps in our urban and commercial cities (Adewole, 2009). Sule (2004) stated that most of the Nigerians life styles today are a reflection of their consumption and solid waste generation pattern they adopted. Indiscriminate refuse dumps is known to supports the breeding of biological vectors such as mosquitoes, rodents which enhances disease transmission such as malaria, diarrhea, Lassa fever etc, which are of public health concern (Sule, 2004; Basavanthappa, 2008; Onyido *et al.*, 2009).

Studies have revealed incidence and distribution of many intestinal parasites and bacterial agents from refuse which infect both man and animals (Okoronkwo and Onwuliri, 1998; Adeyeba and Akinbo, 2002; Cletus *et al*., 2015). Intestinal parasites are life threatening in many communities and are of a major international health concern (Williams-Blangero *et al*., 1998) and it has been shown that refuse dumps are significant source of transmission for intestinal parasitic infection in Kampala, Uganda and Jos, Nigeria (Kabaterein, *et. al*., 1997 and Okoronkwo and Onwuliri, 1998).

Therefore, solid waste that is not properly managed, is a serious health hazard and can lead to the spread of infectious diseases. Thus, this study was aimed at evaluating the prevalence of intestinal parasites in relation to dumpsite and environmental factors of Ogbor hill, Aba.

Materials and Methods

Study area

The study was conducted in Ogbor Hill waste dump site located around within latitude 5º 06' 09"N and Longitude 7º 23' 41"E. The

area is situated East of the Aba river, along Emelogu Street, Ehere in Ogbor Hill, Aba Municipal area of Abia state, Nigeria.

According to the 2006 National Population Census results, the Aba Municipal principally consists of Aba North LGA and Aba South LGA which has a combined population of 534,265 persons; of which Aba North has 106, 844 while Aba South has 427,421 persons (NPC, 2010). By extrapolating to the year 2020, using the national average population growth rate of 3%, Aba Municipal is expected to have reached about 808,123 persons (Ngiabuna and Uzobo, 2016). The area is very densely populated, being a major commercial centre of not only Abia state, but also SouthEast Nigeria (Tobias, *et. al*., 2013).

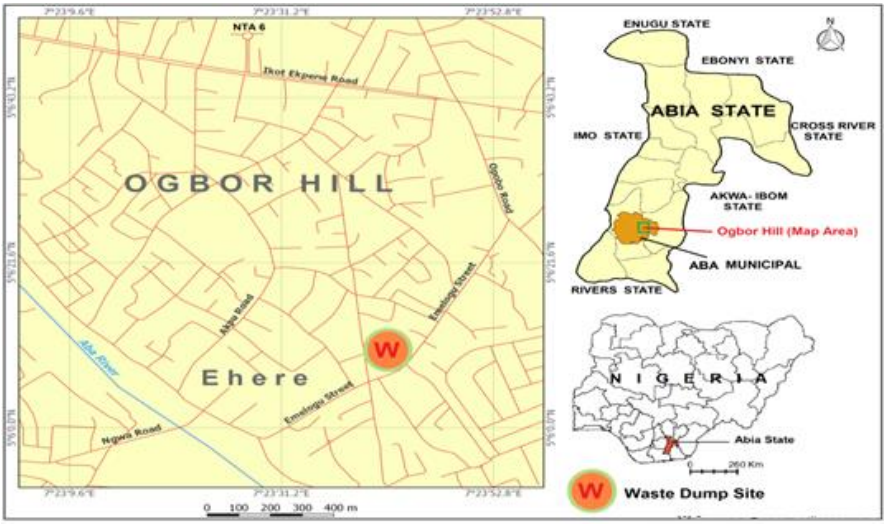

Fig. 1 Location of Waste Dump Site, Ogbor Hill in Aba Municipal, Abia State, Nigeria

Methodology

The baermann funnel examination of refuse sludges for intestinal parasites.

Ten (10) gram each of refuse sludge (soft mud) was taken from ten different locations with the aid of a metal spatula into a sterile screw-capped container. This gave a total of 100g of refuse sludge. Samples were collected only in the morning hours when the refuse were damp, between 7:00am and 8:30am (Adeyeba. and Akinbo, 2002). The baermann funnel method of refuse sludge analysis described by Van-bezooijen (2006) was used to examine the refuse sludge collected.

Analysis of faecal samples using Formol-ether concentration technique

Faecal samples were collected from only individual living or working close to the dumpsite area, which includes students, teachers, dumpsite workers, eatery owners, informal recyclers (scavengers), residents and other petty traders/shop owners These samples were examined using the method described by Cheesebrough (2006),

Questionnaire survey method

A well-structured questionnaire was used to collect information from students, workers (which include teachers, dumpsite workers, eatery owners and other petty traders/shop owners) who are closer to the dumpsites, informal recyclers (Scavengers) and residents living close to the dumpsite.

Data analysis

Paleontological Statistics Software Package version 3.1 was used for the data analysis. Chi squares, Odd Ratios Analysis and correlation were used to test significant relationships and were considered significant when the p-value was <0.05.

Results

Out of 423 persons examined, 164 (38.8%) were infected. The prevalence was higher in females (48.8%) than males (34.5%). The highest prevalence 49(58.3%) prevalence according to age group was observed in age group 21-30 years, followed by age group 11-20 years 56(54.4%) then age group 0-10 years (33.3%) and the least 1(3.7%) was among age group 51 years and above. There was no significant difference (P=0.00) in prevalence between the age groups. Educational status related prevalence revealed highest prevalence among those in Secondary school 67(54.5%) followed by those without any education 12(46.2%) then those in Primary school 52(33.5%) but lowest was found among those in Polytechnic 21(26.9%). However, there was no significant association in educational related prevalence (P=0.06) (Table 1). (Table 1).

Out of a total of five parasites identified, the highest occurring intestinal parasite was *N.americanus* 51(31.1%), followed by *E.histolytica* 45(27.4%), the least was *T.saginata* 9(5.5%) (Table 2).

The result of the odd ratio analysis revealed that residents that have stayed in the dumpsite area between 7 – 9years (OR=2.6222) are 2 times more likely to be infected than those that have stayed for 9years and above (OR=1.5641). Those whose residence are less than 6 houses (OR=1.1282) apart and 9 houses (OR=1.9771) apart are more likely to be more infected than the others (Tables 3).

The eggs of *N.americanus* was found to have the highest prevalence of 34.4% followed by that of *A. lumbricoides* 23.5%, while *T. saginata*9.7% had the least prevalence (Table 4).

Table 5 presents the profile of the parasite stages (eggs, cyst and trophozoites) isolated from the refuse waste dumpsite. *A.lumbricoides* 200 (47.6%) was the most encountered parasite, followed by *E.histolytica* 157 (37.4%) while *T.trichiura* was the least encountered.

A.lumbricoides was found to have the highest 287(33.8%) number from the two samples followed by 285(33.5%) *N.americanus,* 114(13.4%) *E.histolytica,* and 94(11.1%) *T.saginata* whereas *T.trichura* had the least 70(8.2%) number. The both samples were found to correlate positively (R = 0.161). (Table 6).

Table 7 shows the awareness on hazards/risk of parasitic infections associated with the dumpsite. Majority 370(87.5%) of the residents are aware that they are at risk of contracting human intestinal parasite for living close to the site, while very few 14(3.3%) are not aware and 39(9.2%) are not sure. Majority 413(97.6%) responded to odour as the hazards/risks they are experiencing for staying close to the dumpsite, 384(90.8) leachate water, 258(61.0%) litter, 225(53.2%) birds, 121(28.6%) pest and 113(26.7%) surface water contamination, while fire and smoke had the least responses of 48(11.3%) each.

Table 1 Socio-demographic characteristics of infected Respondents with Intestinal Parasites

Variable	No. of respondents	No. infected (%)	P value
GENDER			**0.07**
Male	296	102(34.5)	
Female	127	62(48.8)	
TOTAL	**423**	**164(38.8)**	
AGE RANGE			**0.00**
0 – 10	93	31(33.3)	
11 – 20	103	56(54.4)	
21 – 30	84	49(58.3)	
31 – 40	75	23(30.7)	
41 – 50	41	4(9.8)	
51 and above	27	1(3.7)	
TOTAL	**423**	**164(38.8)**	

Educational Background			**0.06**
No education	26	12(46.2)	
Primary education	155	52(33.5)	
Secondary education	123	67(54.5)	
University	41	12(29.3)	
Polytechnic	78	21(26.9)	
TOTAL	**423**	**164(38.8)**	

Table 2: Prevalence of human intestinal parasite identified in Ogbor Hill AbA

Parasite species	Number infected	Prevalence (%)
Entamoebahistolytica	45	27.4
Ascarislumbricoides	38	23.2
Taeniasaginata	9	5.5
Necatoramericanus	51	31.1
Trichuristrichuira	21	12.8
TOTAL	**164**	**38.8**

Table 3: Rate of Intestinal parasite infection according to age group and distance from the dump site.

Variable	No. of respondents	No. infected (%)	P. value	Odds ratio
Length of stay in the area			**0.001**	
1 - 3 years	108	24(22.2)		0.3571
4 - 6 years	85	22(25.9)		0.4820
7 - 9 years	121	67(55.4)		2.6222*
Above 9 years	109	51(46.8)		1.5641*
Total	**423**	**164(38.8)**		
Distance of your house or work place from the dumpsite			**0.46**	
Less than 3 houses apart	159	61(38.4)		0.9730
Less than 6 houses apart	120	49(40.8)		1.1282*
Less than 9 houses apart	37	20(54.1)		1.9771*
More than 9 houses apart	107	34(31.8)		0.6664
Total	**423**	**164(38.8)**		

Table 4: Eggs per gram of human intestinal parasites identified among the residents in the study area

Parasite seen	No. of parasite egg seen (%)	Formed stool (x1)	Unformed/ watery stool (x4)	Semi-formed stool (x2)	Total no. of egg per gram(x100)*
E. histolytica	75(20.2)	43	11	21	12900
A. lumbricoides	87(23.5)	59	15	13	14500
T. saginata	36(9.7)	13	9	14	7700
N. americanus	128(34.5)	89	12	27	19100
T. trichura	45(12.1)	21	6	18	8100
Total	**371 (100)**	**225**	**53 (x4)**	**93 (x2)**	**62300**

Table 5: Intestinal Parasites identified from the dumpsite in relation to their forms

Parasites seen	Parasitic forms recovered			Total
	Egg	Cyst	Trophozoites	
A. lumbricoides	137	63	0	200(34.2)
E. coli	0	26	0	26(5.0)
B. coli	0	0	71	71(12.3)
E. histolytica	21	18	0	39(6.8)
N. americanus	157	0	0	157(27.3)
T. trichura	25	0	0	25(4.3)
T.saginata	58	0	0	58(10.1)
Total	**321(55.7)**	**184(31.9)**	**71(12.3)**	**576**

Table 6: Association of the recovered parasites from the resident and dumpsite samples

Parasites	Number recovered parasites from the resident samples	Number recovered parasites from the dumpsite	TOTAL (%)
E. histolytica	75	39	114(13.4)
A. lumbricoides	87	200	287(33.8)
T. saginata	36	58	94(11.1)
N. americanus	128	157	28(33.5)
T. trichiura	45	25	70(8.2)
Total	**371(43.6%)**	**479(56.3%)**	**850(100)**

Table 7: Awareness on hazards/risk of parasitic infections associated with the dumpsite

CHARACTERISTICS	NO OF RESPONDENT	PERCENTAGE (%)
Are you exposed to any risk of intestinal parasitic infection for living close to the dumpsite?		
Yes	370	87.5
No	14	3.3
Not sure	39	9.2
Total	**423**	**100**
Which of these hazards/risks are you experiencing for staying close to the dumpsite?		
Odour	413	97.6
Fire	48	11.3
Smoke	48	11.3
Pest(fly, rats and vermin)	121	28.6
Birds	225	53.2
Litter	258	61.0
Leachate (black liquid from dumpsite)	384	90.8
Surface water contamination	113	26.7
All of the above	48	11.3
None of the above	0	0

Total for each variable	**423**	**100**
Waste at the site can breed flies, insect or worms, which can cause intestinal parasites		
Yes	307	72.6
No	81	19.1
Not sure	35	8.3
Total	**423**	**100**
Waste from the dumpsite can be washed into nearest water body such as waterside and cause intestinal worms to those that uses it		
Yes	304	71.9
No	21	5.0
Not sure	98	23.2
Total	**423**	**100**

Discussion

This study revealed observable relationships between intestinal parasitic infection and some socio-demographic factors. The females recorded higher prevalence (48.8%) of intestinal parasite than the male (34.5%). This was in line with the study of Ejinaka *et al.* (2019) in Jos, Plateau State, who recorded higher prevalence in female. The variation in prevalence among the gender was not significant, which is in agreement with the work of Shehu *et al*. (2013), who stated that infection with intestinal parasites is not sex dependent but rather depends on the level of exposure to predisposing factors as intestinal parasite are prevalent in many tropical countries due to the climatic conditions that influence the survival of the parasites. The age specific prevalence profile of the study population showed that infections were highest with age group 21–30 years (58.3%) and age group 11–20 years (54.4%) and least within age group 57 and above (3.7%). The observations in this study are in line with other studies, Nduka *et al*. (2006) in Ishiagu, Abia State and Rufai *et al* (2018) in Osogbo in Osun State Southwestern Nigeria, who reported a high infection rate within age group 16 to 30 years. This result however, differs from the studies of Akinbo *et al.* (2011) in Benin city, were prevalence drops from <10 years to 50 years age group, before increasing in ≥ 51 years. The variations in prevalence among the age group was not significant probably due to the fact that this is the age of school children and working people who are actively involved in outdoor activities in damp, muddy contaminated areas, to fetch water, dispose waste and also involve in agricultural activities. These age groups are exposed to higher risk of infection than the other age groups. Concerning the educational level of the respondents, it was found that majority (54.5%), of the infected respondents were attending secondary education followed by those who had No Education (46.2%) and those with Primary Education (33.5%) while least infection was recorded among the Polytechnics students (26.9%). The high prevalence of infection among the different

groups could be due to the fact that these set of people often spend more of their leisure time outdoors, playing or foraging in garbage dumps. They are also more often in contact with sand and eat indiscriminately with unwashed hands (high school attendants). The low prevalence of infection observed in the highly educated group may be due to the fact that this set of people become more hygiene-conscious and are able to avoid as much as possible practices that could lead them being infected. This is consistent with the findings of Luka *et al*. (2000) in Kaduna and Akinbo and Arimokwu (2016) in Edo State.

The prevalence of intestinal parasites in the study population was 38.8%. This classifies the area as a "moderate risk area" for preventive therapy by WHO standards (WHO, 2012). Therefore, the population infected could be said to be moderate in accordance with finding of Nwoke, *et al.* (2012) on the prevalence of soil transmitted helminthes among primary school pupils in Owerri West Local Government Area, Imo State. The prevalence was lower when compared to the findings of Babatunde *et al.* (2013) in Kwara State and Adefioye *et al*. (2011) in Osun State where 41.9% and 52% were recorded respectively. This could be as a result of differences in the attitude of the group of people used with regards to environmental and personal hygiene practices. However, the overall prevalence recorded in this present study was higher compared to 16.9% reported by Uneke *et al*. (2007) in South East Nigeria and Hassan (2017) reported 15.6% in South West, Nigeria. The moderate prevalence rate observed in this study indicates that majority of the residents may suffer the infections overtime. Out of the five species of human intestinal parasites observed among the residents in the study area *N. americanus* had the highest 51(31.1%) occurrence followed by 45(27.4%) while the least was *T. saginata* (12.8%). This was in contrast to the study carries out by Emmy-Egbe *et al*. (2012) in Anambra, who observed high prevalence of *A.lumbricoides*. These variations explain the fact that, community is not a yardstick for measurement, as the prevalence of intestinal

parasites is a function of many interacting factors. These factors vary in different communities and even in the same community at different period of time. However, there are some potential limitations to be considered while comparing the results of this study. Such limitations include the difference in climatic conditions, environmental sanitation and time of the study (Léo, *et. al.*, 2003).

In relation to duration of by the respondents, most of infected respondents who have stayed between 7 – 9 years (OR=2.6222) were 2 times more likely to be infected than those that have stayed for 9years and above (OR=1.5641). Babs-Shomoye and Kabir (2016) ascertained that waste dumps near residential areas are detrimental to good health. Russell and Felicia (2016) in Olusosun Dumpsite in Lagos State, Nigeria also stated that residents closer to a refuse dumpsite tends to be more infected than those whore side faraway. However, there was a relationship between residents' closeness and rate of parasites exposure. Those whore sideless than 6 houses (OR = 1.1282) away and 9 houses (OR=1.9771) apart are more likely to be more infected than the others, this agrees with the finding of Sankoh *et al.* (2013) in Freetown, Sierra Leone who reported that distance between community and dumpsite reduces the chances of being infected. Those that reside closer to the dumpsite were found to be more likely to get infected than those residing far away. This implies that resident's close to refuse dumpsites are at risk of being infected with human intestinal parasites. In Accra Ghana, Boadi and Markku (2005) Stated that dumpsites pose diseases on residents staying near and far from them. According to them, these diseases have causative agents; flies, mosquitoes, rats etc. were observed on waste heaps and around open dumps. They indicated that decomposing organic materials had become breeding sites for pests that enhance the likelihood of disease transmission. According to WHO (2008) these diseases are transmitted to humans through contact with food or household items contaminated by these agents.

Prevalence of parasites in refuse sludge samples in relation to their forms, revealed *A.lumbricoides* had the highest prevalence 47.6%, *N. americanus* 37.4%%, while *T. trichiura* had least prevalence (6.0%). High prevalence of *A.lumbricoides* in this study corroborates with the findings of other studies by Abah and Arene (2015) in Rivers, Egwuyenga and Ataikiru, (2005) in Delta and Chukwuma*et al*. (2009) in Anambra state. This could be due to the fact that eggs of *A.lumbricoides* can withstand harsh environmental conditions and can remain in the environment for longer period (Emmy-Egbe *et al*. 2012). *N.americanus*prevalence of (37.4%) was slightly higher when compared with the reports of Emmy-Egbe *et al.* (2012) in Anambra. However, *N.americanus* transmission is highly seasonal, their larva are capable of vertical migration up and down in contaminated soil, depending on soil moisture and temperature and can also remain in the soil until a suitable host is available. *T.trichiura* had the least prevalence (6.0%), this was considered low as compared with the findings of Anosike*et al*. (2002) in Imo State who reported *T.trichiura* prevalence to be 14.0%.

The number of eggs of *N.americanus* and *A.lumbricoides*eggs identified among the residents was an indication that *both* may be prevalent in the area. The present study is therefore consistent with the previous study of Cletus *et al*. (2015) in Calabar on undisposed refuse dumps, where they found *A. lumbricoides* as the most prevalent parasite. This explains the fact that there was faecal contamination of leach ate in the dumpsite from both human and animals, there was improper solid waste management and thus it provides a perfect environment for breeding of vector-diseases causing organisms such as rodents, flies etc. Listorti (1996) stated that organic material in waste provides breeding sites for insects and rodents of varied species. *A.lumbricoides* is also known with ability to withstand harsh environmental conditions and can remain in the environment for longer period of time (Khuroo, 1996).

The positive correlation found between the forms of parasites in the study dumpsite and number of eggs per gram identified among the resident was an indication of the fact that infection can be contracted from the dumpsite. This is in line with the assertion of Aibor and Olorunda (2006) in Akure that poor waste management practice contaminates the environment, contributes to flooding and serves as potential means to increasing transmission of diseases. In Ghana, Babatunde, *et al* (2013) revealed that high incidence of diarrhea in children under six years is interrelated to food contamination by flies who had fed on wastes UNEPA (2006) reported that waste which are not properly managed especially excreta other liquids and solid wastes from households and the community, can cause serious health hazard and may also result in forming of stagnant water bodies that become the breeding ground of disease causing organisms.

The number of respondents (87.5%) who are aware that they are at risk involved on human intestinal parasitic infections for residing close to the dumpsite is a clear indication of the existence of the infection. When asked about the hazards that they experience for residing close to the dumpsite, 11.8% responded positively to all the hazards, but majority of them (97.6%) agreed that odour was the most serious hazards experienced. This is in line with the findings of Aluko (2001) that people are aware of the bad odours that emanate from refuse dumps and that they diminish aesthetic quality of environment. This also supported the insertion of *Mirian* (2011) in Delta State, who stated that waste left unmanaged for a long time constitute serious hazards and produces unbearable odour which can cause serious health challenges to those residing around the site. In identifying the specific type of environmental problem, they faced, 72.6% of the respondents agreed that, solid waste is a breeding ground for flies, worms etc. that can transmit intestinal parasites. This is in line with the report of Olaniran (1995) that relationship between environment and health is misunderstood by the average people in most developing countries. Majority (71.9%)

of the respondents are aware that waste from the site can be washed into the nearest water bodies thereby causing intestinal parasitic infections to those that use it. In his study, Owoh (2000) also reported positive correlation with frequent contact with solid waste polluted river and incidence of water related diseases of with intestinal parasite infections.

Conclusion

A high degree of contamination of solid waste dumpsite with human intestinal parasitic agents was observed in the study. *N.americanus* was more prevalent among the study population and its egg was also found to be the highest in occurrence in the refuse sludge. The identified parasites were found to correlate positively indicating the possibility of contracting the infection from the dumpsite.

It is glaring that people living close to solid waste dumpsites are not ignorant of the fact that human intestinal parasites can be contacted from solid waste dumpsites. The percentage of those that have had about intestinal parasites and the possibility of contracting it from solid waste dumpsite were relatively high. Most residents dispose waste at dumpsites on daily basis and maintain that, waste management at the site should be carried out on a daily basis. The dumpsite workers revealed increased industrialization and consumption of fresh raw materials, lack of pollution control devices and increasing population were the most militating factors against the efficiency in waste management at the site. Therefore, the government and relevant agencies should encourage municipality participation in sanitation improvement programmes. Intensify efforts in public health education and manage the waste generated. This will go a long way to reduce the risk of being infected with waste related diseases since the waste will not be left untreated for a long time

Acknowledgements

We appreciate the Management and Staff of Seventh Day Adventist Hospital, for allowing us to make use of their laboratory facilities. We also thank the dumpsite workers and the residents close to the site for their active participation during questionnaire survey and faecal samples collection for the study. Our gratitude also goes to the laboratory staff of Parasitology Unit, Department of Zoology and Environmental Biology, Michael Okpara University of Agriculture Umudike. May God bless you all!

Reference

Abah, A. E. and Arenes, F. O. I. (2015). Status of intestinal parasitic infections among primary school children in Rivers State, Nigeria.*Journal of Parasitology Research* 10: 1 – 7.

Adefioye, O. A. (2011). "Intestinal Helminthiasis among School Children in Ile-Ife, Osun State, Southwest, Nigeria". *Sierra Leone Journal of Biomedical Research,* 3(1) : 36 - 42.

Adewole, A. T. (2009). Waste management towards sustainable development in Nigeria: A case study of Lagos state. International.*NGO Journal*, 4(4): 173-179.

Adeyeba, O. A. and Akinbo, J. A. (2002). Pathogenic intestinal parasites and bacterial agents in solid wastes in Ibadan, Nigeria.*East African Medical Journal,* 79(11): 600 - 603.

Aibor, M. S. and Olorunda, J. O. (2006).*A Technical Handbook of Environmental Health in the 21st Century for Professional Students*. His Mercy Publishers, Akure.

Akinbo, F. O. and Arimokwu, S. (2016) Intestinal parasitic infections among spare parts traders in Benin city, Nigeria. *Sub-Sahara African Journal of Medicine.*3(3) 153 – 157.

Akinbo, F. O., Omoregie, R., Eromwon, R., Igbenimah, I. O. And Airueghiomon, U. E. (2011). Prevalence of intestinal parasites patients of a tertiary hospital in Benin city, Nigeria. *North American Journal of Medical Science*. 3(10): 462–464.Aluko, O. O. (2001). Characterization and treatment of leachates from

a municipal solid waste landfill site in Ibadan, *Journal for Parasitology*, 18: 19 – 34

Anosike, J. C., Njoku, A. J., Nwoke, B.E.B., Ajero, C. M. U., Osagiede, U. R., Okoro, O. U. and Nwosu, D. C. (2002). Epidemiological of urinary schistosomiasis in Ebonyi State, Nigeria, *International Journal of Child Health and Human Development*, 3(1): 59 - 65.

Babatunde, S. K., Adedayo, M. R., Ajiboye, A. E., Sunday, O. and Ameen, N. (2013) Soil transmitted helminth infections among school children in rural communities of Moro Local Government Area, Kwara State, Nigeria. *African Journal of Microbiology Research*, 7 (45): 5148 - 5153.

Babs-Shomoye, F. and Kabir, R. (2016). Health effects of solid waste disposal at a dumpsite on the surrounding human settlements. *Journal of Public Health in Developing Countries*, 2(3): 268 – 275.

Basavanthappa, B. T. (2008). *Community Health Nursing.*2nd ed. Jaypee Brothers Medical Publishers, New Delhi, India.

Boadi, K. O. and Markku, K. (2005). Environment and health impacts of household solid waste handling and disposal practices in the third world cities: The case of Accra metropolitan area. *Ghana Journal of Environmental Health*, 68(4): 34 - 36.

Cheesebrough, M. (2006). *District Laboratory Practice in Tropical Countries.*Parts 2.4thEdition, Cambridge University Press, Edinburgh.

Chukwuma, M. C., Ekejindu, I. M., Agbakoba, N. R., Ezeagwuna, D. A., Anaghalu, I. C. and Nwosu, D. C. (2009). The prevalence and risk factors of geohelminth infections among primary school children in Ebenebe Town, Anambra State, Nigeria.*Middle-East Journal of Scientific Research*, 4(3): 211 - 215.

Cletus, I. I., Okoi, E. E., Stephen, C. E. and Atting, I. (2015). Parasitological Evaluation of Un-Disposed Refuse Dumps in

Calabar South, Crossriver State, Nigeria. *International Journal of Pure and Applied Zoology*, 3(3): 232 – 239.

Drew, G., TarmerVestlund, A., Hough, R. L., Chackiath, S. J., Broomfied, M. and Longhurst, P. S. (2007). Health impart assessment of alternate week waste collection of bio degradable waste. *Waste Management and Research Journal of the International Solid Waste Association,* 34(5): 23 – 32.

Egwunyenga, O. A. and Ataikiru, D. P. (2005). Soil transmitted helminthiasis among school age children in Ethiope East L.G.A. Delta State, Nigeria. *African Journal of Biotechnology,* 4 (9): 938 - 941.

Ejinaka, O. R., Obeta, M. U., Jwanse, R.I., Lote-Nwaru, J. P., Agbalaka, P. I. and Friday, P. E. (2019). Prevalence of Intestinal Parasites among Students of a Tertiary Institution in Jos, Nigeria.*Journal of Bacteriology and parasitology* 10(4): 360 – 364.

Emmy-Egbe, I. O., Ukaga, C. N., Nwoke, B. E. B., Eneanya, C. I. and Ajero, C. M. U. (2012) Prevalence of human intestinal helminthiasis in Njikoka area of Anambra State, Nigeria. *Nigeria Journal of Parasitology,* 33(1): 15 – 19.

EPA (2009). U.S. Environmental Protection Agency: Persistent Organic Pollutants: A Global Issue, A Global Response, by Kovner, K.

Hassan, A. A., (2017). "Spatial patterns of soil transmitted helminthsin soil environment around Ibadan, an endemic areain south-west Nigeria". *Nigerian Journal of Parasitology* 38.2(2017): 179-184

Kabatereine N.B., Kemijumbi J., Kazibwe F. and Onapa, A.W. (1997) Human intestinal parasites in primary school childrenin Kampala Uganda. East Afrrican Medical Journal; 74:311-314

Khuroo, M. S. (1996). Ascariasis.*Gastroenterology of North America,* 25: 553.

Listorti, J. A. (1996). Bridging Environmental Health Gaps: Lessons for Sub-Saharan Africa Infrastructure Projects.*Journal of Public Health and Epidemiology*, 20: 1 – 64

Léo H., Enrico, A. C. and Carlos, M. A. (2003) Environmental sanitation conditions and health impact: a case-control *studyRevista da SociedadeBrasileira de MedicinaTropical*.36(1): 1 - 8

Lou, X. F and Nair, J. (2009). The impact of landfilling and composting on greenhouse gas emissions – *A review. Bioresour Technology*, 100:3792–3798.

Luka, S. A., Ajogi, I. and Umoh, J. U. (2000). Helminthosis among primary school children in Lere Local Government Area, Kaduna State, Nigeria.*The Nigerian Journal of Parasitology*, 21: 109 - 116.

Mirian, O. I. (2011). Refuse disposal and its attendant health hazards: A Case Study of Agbor, Delta state of Nigeria. *Global Journal of Environmental Sciences,* 10(2): 12 – 32.

NIFOSH (1997). Preventing worker injuries and deaths from moving refuse collection vehicles. Public Health Service, Centers for Disease Control and Prevention, U.S. Department of Health and Human Services, USA.

Nduka, F. O., Nwaugo, V. O. and Nwachukwu, N. C. (2006). Human intestinal parasite infections in Ishiagu, A Lead Mining Area of Abia State, *Animal Research International* 3(3): 505 – 507.

Ngiabuna, T. E. and Uzobo, E. (2016) Population And Development In Nigeria: An Assesment Of The National Policy On Population And Sustainable Development International Journal of *Development* and Management Review 23 (2): 80 - 102

NPC (2010). Federal Republic of Nigeria, (2006). Population and Housing Census -Priority Table. National Population Commission, Abuja.

Nwoke, B. E. B., Ogomaka, I. A., Ukaga, C. N., Nwokeji, C. M., Ajero, C. M. andNwachukwu, M. I. (2012). Prevalence of soil transmitted helminthes among primary school pupils in Owerri West Local Government Area in Imo State, Nigeria. *Nigerian Journal of Parasitology,* 33(1): 37 - 43.

Okoronkwo, M. O. and Onwuliri, C. O. E. (1998). Intestinal parasites from refuse dumps and abattoir wastes in plateau State Nigeria.*JournalofMedical Laboratory Science,* 7 : 25 - 33.

Olaniran, N. S. (1995). Relationship on the environment to health. *Environment and Health*, 34(13): 112 – 119.

Onyido, A. E., Okolo, P. O., Obiukwu, M. O., and Amadi, E. S. (2009). A Survey of vectors of public health diseases in un-disposed refuse dumps in Awka Town, Anambra State, South EasthernNigeria.*Research Journal of Parasitology,* 4: 22 - 27.

Owoh, E. B. (2000) Clean up Nigerian boss speaks on waste management crsis in Lagos. *Nature*, 45 – 48.

Rufai, A. M., Saliu, N. A. and Adafioye, O. A. (2018). Studies on the Prevalence and Intensity of Gastrointestinal Helminthes Infections among Post-Primary School Students in Osogbo Metropolis, Southwestern Nigeria.*Ife Journal of Science*. 20(3): 617 - 626.

Russell, K. and Felicia, B. S. (2016). Health effects of solid waste disposal at a dumpsite on the surrounding human settlements. *Environment Science*, 2(4): 129-136.

Sankoh, F. P., Xiangbin, Y and Tran, Q. Y. (2013). Environmental and health impact of solid waste disposal in developing cities: A Case Study of Granville Brook Dumpsite, Freetown, Sierra Leone. *Journal of Enironmental Protection,* 4(7): 11 – 32.

Shehu, M. M., Kabiru, A., Abubakar, U. and Muhammad, U. K. (2013). Prevalence of intestinal helminth infections among school children in relation to occupation of parents and toilet

facilities in Maru, L.G.A., ZamfaraState.*Journal of Biology, Agriculture and Health care*. 3(19): 87-91.

Sule, R. O. (2004). The environmental consequences of rapid urbanization in countries of the developing world. Calabar: thumbprints international company. P. 9

Tobias I. N., Udebuani, A. C., Ezeji, E. U., Ayalogbu, E. A., Azuwuike, C. O., Ezejiofor, A. N., Adjero, L. A., Ihejirika, C. E., Ujowundu, C. O. and Ngwogu, K. O. (2013) Environmental metals pollutants load of a densely populated and heavily industrialized commercial city of Aba, Nigeria Journal of Toxicology and Environmental Health Sciences; 5(1): 1-11

Uneke, C. J., Eze, K. O., Oyibo, P. G., Azu, N. C. and Amlt, E. A. (2007). Soil transmitted helminth infections in school children in South East Nigeria: The Public Health Implication. *Journal of Third World Medicine*, 4(1): 1539 - 4646.

U N E P A (2006). Informal Solid Waste Management. *International Environmental Management*, 36: 64 – 75.

Van-bezooijen, J. (2006). *Methods and Techniques for Nematology*.Wageningen University, Wageningen, The Netherlands. https://www.wur.nl/upload_mm/f/9/3/10aac0cb-8289-400a-a6e5-c4687461d138_MethodsandTechniquesforNematology.pdf Accessed June 22, 2016.

Williams-Blangero, S., Subedi, J., Upadhayay, R. P., Manral, D. B., Khadka, K., JireL, S., Robinson, E. S. and Blangero, J. (1998). Attitudes towards helminthic infection in the Jirel population of eastern Nepal. *Social Science and Medicine*, 47(3): 371 – 379.

World Bank (2005). Waste Management in China: Issues and Recommendations. Urban Development Working Papers 9. East Asia Infrastructure Department. 15 - 156

WHO (2008). UN Water Global Annual Assessment of Sanitation. Geneva World Health OrganizationP.125.

WHO (2012). Soil transmitted helminthiasis: Eliminating Soil-Transmitted Helminthiasis as a Public Health Problem in Children: Progress Report 2001–2010 and Strategic Plan 2011–2020, World Health Organization, Geneva, Switzerland. P. 342.

Zhang, D.; Tan, S. and Gersberg, R. (2010). "Municipal Solid Waste Management in China: Status, Problems and Challenges", *Journal of Environmental Management*.91(1).

Zhu, D., Asnani, P. H., Zurbrugg, C., Anapolsky, S. and Mani, S., (2008). Improving municipal solid waste management in India.*Environment and Science*, 12: 1 - 12