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Parasitic infestations in houseflies and soils collected from garbage dumps in parts of Ijebu-North, Ogun State Nigeria: A cross-sectional study

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ABSTRACT

Open defecation and indiscriminate disposal of waste is a common practice and has been highlighted as a risk factor promoting transmission of gastrointestinal parasiteshence, we investigated the prevalence of parasites in Houseflies (*Musca domestica)* and soil samples from garbage dumps in Ijebu-North, Ogun State, Nigeria, where such data is non-existent. Flies were collected using baited traps and approximately 100g of surface soil were collected from the garbage dumps in the study area. Standard flotation and sedimentation techniques were used to process collected soil samples, including external and internal contents from *Musca domestica* (*M. domestica*). Isolated parasites were identified under a binocular microscope. Our findings showed that all the houseflies examined were infested with at least one kind of parasite on either external or internal surfaces. A total of 328 (78.8%) of the flies were infested with *Taenia* sp.*,* followed by 296 (74.0%) for *Ascaris lumbricoides*, 200 (48.1%) for hookworms, and the least was 64 (15.6%) for *Toxocara canis*. There were significant differences in the proportions observed across the different garbage dumps in the study area for Hookworm (p=0.048), *Fasciola* sp. (p=0.002) and *Toxocara canis* (p=0.033). On their internal surfaces by location, Oru had the highest prevalence for all the parasites except for Hookworms, *Toxocara canis*, *Strongyloides stercoralis* and *Trichuris trichuria*. Significant differences were observed across the garbage dumps in the study area and Hookworm (p = 0.015) and *Strongyloides stercolaris* (p = 0.014). Similarly, at least one kind of parasite was recovered from all the 32 soil samples examined, with *Taenia* sp. (90.0%), *Ascaris lumbricoides*. (83.3%) and Hookworms (60.0%) been the most common parasites. This study highlights an important issue of gross environmental contamination with parasite eggs/larvae across garbage dumps which requires prompt clearing of garbage dumps and proper sanitization to prevent disease epidemics.

Keywords: Garbage dumps, *Musca domestica*, Nigeria, Parasites, Soil

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1 INTRODUCTION

Open defecation and indiscriminate disposal of waste is a common practice in marginalized settings, and has been highlighted as a risk factor promoting transmission of gastrointestinal parasites (WHO/UNICEF, 2021). Garbage dumps consisting of dumped food wastes, papers, plastic packaging and metals provide breeding grounds for important vectors of communicable diseases such as houseflies and rodents (Iboh et al., 2015; Ike-Ihunwo and Gboeloh, 2019; Haywood et al., 2021). Houseflies have been implicated in the transmission cycle of more than 100 pathogens including gastrointestinal parasites which are known to cause a range of morbidities including anemia, malnutrition, lowered cognition, amongst others (Elkanah et al., 2020). Houseflies are known for their ubiquitous presence and preference for breeding in unhygienic surroundings, such as areas contaminated with human or animal

excreta, carcasses, organic waste, and exposed garbage, As such, they continue to serve as a notable mechanical vector for the transmission of pathogens (Nwangwu et al., 2013). The structural adaptations on the external and internal body surfaces of houseflies are suited for picking dirt including ova stages of parasites from garbage dumps and further transmitting them (Gordon and Lavoipierre, 1976; Awache and Farouk, 2016; Farghly et al., 2016). There is plethora of evidence from Nigeria on the prevalence of parasites in houseflies (Adenusi and Adewoga, 2013; Oghale et al., 2013; Balla et al., 2014; Amaechi et al., 2017; Deakpe et al., 2018; Khamesipour et al., 2018; Nwadike and Agbolade, 2020; Elkanah et al., 2020), and on soil samples (Adewole and Ajayi, 2010; Lebari 2021).

However, the degree of parasite contamination in houseflies and soils from garbage dumps is largely unknown in some parts of the country, for instance Ogun State. An available study reported the high prevalence of houseflies from several garbage dumps in Ogun State, with no information on parasites infestation (Banjo et al., 2012). It is therefore important to provide up-to-date data on parasite infestation in houseflies and soil samples to support efforts targeted at controlling disease epidemic (Oyebamiji et al., 2018). This present study therefore aimed to provide information on parasite infestations in houseflies and soil samples collected from garbage dumps across three communities in Ijebu-North Local Government Area, Ogun State, Nigeria.

2 MATERIALS AND METHODS

2.1 Study Area and Design

This study was conducted between August and December 2021, employing a cross-sectional design and purposive selection of 16 garbage dumps across three communities (Ago-Iwoye, Oru and Ijebu-Igbo) located in Ijebu-North a Local Government Area (LGA) within the study area (Figure 1). Ogun State, Southwest Nigeria at 6º 57'N 4º00'E has an area of 967 km^2 with a population of 420,817 (2021 NPC estimated census). The study area is located in the tropical rain forest belt with hot and humid climatic conditions. The average temperature is 27.6 ºC with mean annual precipitation of 2020mm. The indigenes of these towns are mainly Ijebus (Yoruba) with a relatively little proportion of non-indigenous people. It is also a host to a number of higher educational institutions.

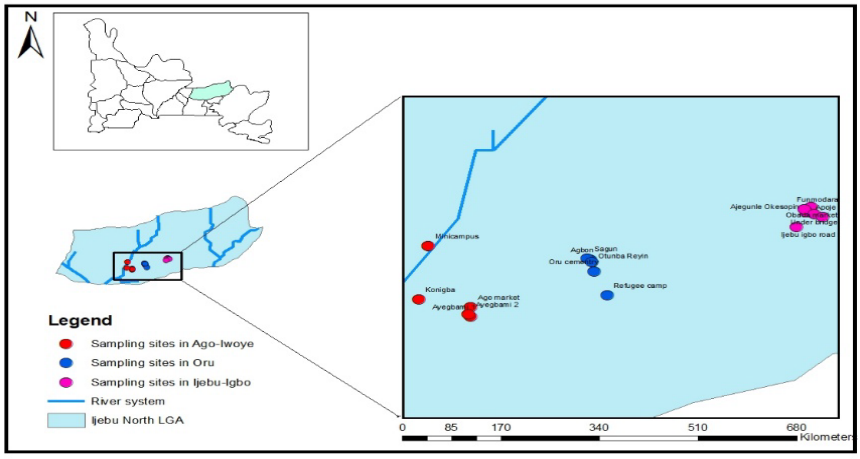

Figure 1: Map showing the visited garbage dumps in Ijebu-North Local Government Area
This Figure was created by the authors in ArcGIS 9.3 Software using their primary data and base shapefiles from openly accessible site. The authors therefore give permission for re-use of this map.

2.3 Processing of Samples

The internal and external surfaces of the trapped *M. domestica* were processed using sedimentation techniques as described by Nwadike and Agbolade (2020). The housefly was first introduced into 5mL normal saline (0.85% NaCl solution) in a test tube, shaken less vigorously to disallow disintegration of body parts, and the resultant saline was concentrated by centrifugation at 2000 rpm for 5 minutes. The flies were later dissected under a microscope and the intestinal content was centrifuged at 2000 rpm for 5 minutes. The resulting precipitate from each procedure was stained with 1 drop of Lugol's iodine. Sucrose floatation and Baermann technique was employed in isolation of parasites eggs, larvae or cysts from the soil samples. This method has been previously described by Nkouayep et al. (2017) and Imalele et al. (2021). A trichome staining procedure was used to ascertain *Entamoeba histolytica* (*E. histolytica*). All prepared slides were observed under a binocular microscope using x10 and x40 objective lens.

The Atlas of Medical Helminthology and Protozoology by Sullivian
(2009) was used as a reference guide to identify isolated eggs, larvae or cysts.

2.4 Statistical Analysis

Using Social Packages for Social Sciences (version 25) for analysis, descriptive statistics: frequencies and percentages were employed, followed by chi-square tests to estimate the degree of association between parasites prevalence and location. A significant difference was established when $p \leq 0.05$.

3 RESULTS

3.1 Overview of houseflies collected and Examined

(Table 1) were collected across the three communities in Ijebu-North LGA; majority 152 (36.6%) of the houseflies were collected from Ago-Iwoye, followed by 144 (34.6%) from Ijebu-Igbo and 120 (28.8%) from Oru. All the *M. domestica* collected parasites, except in Ago-Iwoye, where only 136 of the 152 houseflies were examined for internal parasites. were examined for external and internal prevalence was recorded for *Toxocara canis* (*T. canis*) eggs 64 (15.4%). By location, Ijebu-Igbo had the highest prevalence for *A. lumbricoides*, *E. histolytica* cysts and *T. canis.* There were significant differences in the prevalence of hookworms, *Fasciola* sp. and *T. canis* across the study communities ($p < 0.05$).

Table 1: Overview of houseflies collected and examined

Communities	Number of houseflies examined for external parasites	Number of houseflies infected with at least one external parasite (%)	Number of houseflies examined for internal parasites	Number of houseflies infected with at least one internal parasite (%)
Ago Iwoye	152	152 (100)	136	136 (100)
Oru	120	120 (100)	120	120 (100)
Ijebu-Igbo	144	144 (100)	144	144 (100)
Total	416	416 (100)	400	400 (100)

**: houseflies infested with at least one kind of parasite; S. stercoralis - Strongyloides stercoralis; NE: Number Examined; NI: Number Infected*

3.2 Prevalence of parasites on the external surface of *M. domestica*

As shown in Table 2 below, all the 416 *M. domestica* examined had at least one kind of parasites on their external surface. An overall

prevalence of 100% was observed. By species', prevalence was highest for eggs of *Taenia* sp. 328 (78.8%), followed by *Ascaris lumbricoides* (*A. lumbricoides*) eggs 296 (71.2%), Hookworms 200 (48.1%), *Fasciola* sp. 192 (47.1%) and *Trichuris trichiuria* (*T. trichiuria*) eggs 192 (46.2%). The lowest

Table 2: Prevalence of parasites on the external surface of *M. domestica* examined

	COMMUNITIES				
	Ago-Iwoye (NE=152)	Ijebu-Igbo (NE=144)	Oru (NE=120)	Total (N=416)	*p*-value
Parasites	NI (%)	NI (%)	NI (%)	NI (%)	
Infested houseflies*	152 (100)	144 (100)	120 (100)	416 (100)	
Taenia sp.	112(73.7)	112 (77.8)	104 (86.7)	328 (78.8)	0.649
Ascaris lumbricoides	96 (63.2)	112 (77.8)	88 (73.3)	296 (71.2)	0.603
Hookworms	40 (26.3)	80 (55.6)	80 (66.7)	200 (48.1)	0.048
Fasciola sp.	24 (15.8)	80 (55.6)	88 (73.3)	192 (47.1)	0.002
Trichuris trichiuria	72 (47.9)	56 (38.9)	72 (53.3)	192 (46.2)	0.703
Entamoeba histolytica	40 (26.3)	80 (55.6)	24 (20.0)	144 (34.6)	0.065
S. stercoralis	24 (15.8)	48 (33.3)	56 (46.7)	128 (30.8)	0.147
Toxocara canis	8 (5.3)	48 (33.3)	8 (6.7)	64 (15.6)	0.033

**: houseflies infested with at least one kind of parasite; S. stercoralis - Strongyloides stercoralis; NE: Number Examined; NI: Number Infected*

3.3 Prevalence of parasites on the internal surface of *M. domestica* examined

All the houseflies examined were infested with at least one kind of parasite on their internal surface (Table 3). By species', a total of 296 (74.0%) of the flies were infested with *A. lumbricoides* (74.0%), 296 (74.0%) for Taenia sp., followed by *Fasciola* sp. with 232 (58.0%), 208 (52.0%) for Hookworms and 192 (48.0%) for *E. histolytica*. The lowest prevalence was recorded with 8 houseflies (2.0%) infested with *Enterobius vermicularis* (*E. vermicularis*) cysts. By location, Ago-Iwoye had the least prevalence for all the parasites except for *Fasciola* sp., *T. canis*, *Strongyloides stercoralis* (*S. stercoralis*) larvae and *T. trichiuria*. There were significant differences in the prevalence of *Taenia* sp., Hookworms and *S. stercoralis* across the study communities ($p < 0.05$).

Table 3: Prevalence of parasites on the internal surface of houseflies examined

	COMMUNITIES				
	Ago-Iwoye (NE=136)	Ijebu-Igbo (NE=144)	Oru (NE=120)	Total (N=400)	*p*-value
Parasites	NI (%)	NI (%)	NI (%)	NI (%)	
Infested houseflies*	136 (100)	144 (100)	120 (100)	400 (100)	
Ascaris lumbricoides	88 (64.7)	112 (77.8)	96 (80.0)	296 (74.0)	0.555
Taenia sp.	72 (52.9)	120 (83.3)	104 (86.7)	296 (74.0)	0.050
Fasciola sp.	88 (64.7)	56 (38.9)	88 (73.3)	232 (58.0)	0.108
Hookworms	40 (29.4)	112 (77.8)	56 (46.7)	208 (52.0)	0.015
Entamoeba histolytica	56 (41.2)	72 (50.0)	64 (53.3)	192 (48.0)	0.772
Trichuris trichiuria	48 (35.3)	88 (61.1)	40 (33.3)	176 (44.0)	0.187
S. stercoralis	40 (29.4)	88 (61.1)	16 (13.3)	144 (36.0)	0.014
Toxocara canis	32 (23.5)	24 (16.7)	0 (0)	56 (14.0)	0.147
Enterobius vermicularis	0(0)	0(0)	8 (6.7)	8 (2.0)	0.304

NE: Number Examined; NI: Number Infected
**: Soil samples infested with at least one kind of parasite; S. stercoralis - Strongyloides stercoralis;*
NE: Number Examined; NI: Number Infected

3.4 Overview and Prevalence of Parasites on Soil Samples collected and examined

As shown in Table 4, a total of 32 soil samples were examined across the three communities in Ijebu-North LGA; majority of the samples 12 (37.5%) were collected from Ijebu-Igbo, followed by 10 (31.25%) from Oru and 10 (31.25%) from Ago-Iwoye. All the 32 soil samples examined had at least one kind of parasites. An overall prevalence of 100% was observed. Prevalence was highest with 24 (75.0%) soils infested with *Taenia* sp., followed with 22 (68.8%) for *A. lumbricoides*, *Fasciola* sp. 18 (56.2%) and Hookworms 14 (43.8%).

The lowest prevalence in the soils was recorded for *E.vermicularis and T. trichuria with 5* (15.6%) and 5 (15.6%) respectively. By location, *A. lumbricoides* (83.3%), *S. stercolaris* (33.3%), *T. canis* (33.3%) and *E. vermicularis* (25.0%) were more common in soils collected from Ijebu-Igbo (83.3%). *Taenia* sp. (90.0%), *Fasciola* sp. (70.0%) and *T. Trichuria* (20.0%) was more common in Ago-Iwoye. However, Hookworms (60.0%) and *E. histolytica* (40.0%) was more common in Oru. There were no significant differences in the prevalence of parasites recovered from soil samples across the study communities ($p > 0.05$).

Table 4: Prevalence of parasites on soil samples examined

	Communities				
	Ago-Iwoye (NE=10)	Ijebu-Igbo (NE=12)	Oru (NE=10)	Total (N=32)	*p*-value
Parasites	NI (%)	NI (%)	NI (%)	NI (%)	
*Infested soil samples**	10(100)	12 (100)	10(100)	32(100)	
Taenia sp.	9 (90.0)	8(66.7%)	7 (70.0)	24 (75.0)	0.411
Ascaris lumbricoides	4 (40.0)	10 (83.3)	8 (80.0)	22 (68.8)	0.060
Fasciola sp.	7 (70.0)	5 (41.7)	6 (60.0)	18 (56.2)	0.394
Hookworm	3 (30.0)	5 (41.7)	6 (60.0)	14 (43.8)	0.394
Entamoeba histolytica	3 (30.0)	3 (25.0)	4 (40.0)	10 (31.2)	0.748
Toxocara canis	2 (20.0)	4 (33.3)	2 (20.0)	8 (25.0)	0.701
S. stercoralis	1 (10.0)	4 (33.3)	1(10.0)	6 (18.8)	0.262
Enterobius vermicularis	1 (10.0)	3 (25.0)	1 (10.0)	5 (15.6)	0.527
Trichuris trichiuria	2 (20.0)	2 (16.7)	1 (10.0)	5 (15.6)	0.821

**: Soil samples infested with at least one kind of parasite; S. stercoralis - Strongyloides stercoralis; NE: Number Examined; NI: Number Infected*

4 DISCUSSION

Our study provided information on parasites associated with houseflies and soil samples collected from different garbage dumpsites in parts of Ijebu-North, Ogun State, Nigeria. Houseflies are biologically adapted to efficiently transfer pathogenic organisms from their body surface and gut to humans. They accomplish this by depositing these organisms on human food through their activities, making them effective mechanical vectors for disease transmission (Deakpe et al., 2018). Our results shows that all the captured houseflies were infected with at least one parasite either on their external or internal surface. This is consistent with report by Mbakwe et al. (2021) which noted that infectious disease-causing organisms frequently adhere to the mouth, body, hairs and sticky pads of the feet of these flies. The results also indicate that all the houseflies caught in the study area have at least a 50% chance of being exposed to a garbage dump infected with faecal parasites. *M. domestica* is closely associated with faeces, as the latter serves as a protein source and substrate for the growth of the former (Adenusi and Adewoga, 2013). The low-earning population who cannot afford good housing structures with potable good water and toilets may be forced to make use of their surroundings including garbage dumpsites for the passing of faeces and urine. These practices have been previously highlighted in previous studies (Iboh et al., 2015; Ahmadu et al., 2016; Lebari, 2021).

Our findings are also consistent with other published reports, where parasites recovered from the external surfaces of the examined houseflies were also detected in the internal guts of the flies except for *E. vermicularis* (Deakpe et al., 2018; Issa, 2019; Szalanski et al., 2004). These findings suggests that faeces and vomits may also serve as major routes of transmission of pathogens (Khamesipour et al., 2018). Furthermore, we found very high prevalence of *Taenia* sp. eggs on the external surface (78.8%) and internal surface (74%) of the flies examined. The findings are particularly higher than previous reports by Nwadike and Agbolade (2020), Adenusi and Adewoga (2013) and

Ahmadu et al. (2016). These differences could be attributed to contamination of the houseflies with faecal droppings of high numbers of straying animals (cows and pigs) in the vicinity. The presence of *T. canis* in the results suggests the presence of infested dogs in the study area. Similarly, *A. lumbricoides,* Hookworm, *T. trichiura* and *E. histolytica* which are generally known to cause gastrointestinal diseases in humans, and are significantly associated with morbidities like anaemia, malnutrition, and lower cognitive abilities were recovered. These parasites have also being listed by Khamesipour et al. (2018).

On the other-hand, our findings show significant similarities in the range of parasites recovered across the study sites which reiterated that residents irrespective of their location may likely share similar risk that contributes to the preponderance of these gastrointestinal parasites. Although, this present study did not investigate the potential risk factors associate with parasite infestation, common factors from literatures includes practice of open defecation, unmanaged animal waste near animal or human activities, environmental and seasonality conditions for insect vector proliferation and ingestion of infected insect vectors by animals or humans (Patel et al., 2022). Our analysis of soil sample, corroborates the evidence of soil contamination with infective eggs, which could be transmitted to inhabitant who do not practice adequate hand-mouth hygiene, or do-not engage in regular usage of footwear. Other studies within the country, and elsewhere have extensively reported the contamination of soils from garbage sites with pathogenic protozoan and helminths. (Ikpeama et al., 2016; Adesewa and Morenikeji, 2017; Nkengazong et al., 2021; Steinbaum et al., 2016). Hence it is important to address social-infrastructure disparities and implement interventions targeted at modifying behavioral practices such as open defeaction, and poor hand to mouth hygiene that increase exposure to these pathogens.

4.1 CONCLUSION

In conclusion, the transmission of gastrointestinal parasites could be associated with the houseflies and soils gotten from the garbage dumps in the study area. Constant health enlightenment programs should be done on quarterly basis on the implication of open defecation and improper disposal of wastes, especially in relation to disease transmission with emphasis on houseflies as an agent of transmission. Appropriate usage of footwears, hand-washing hygiene with soaps, improved food preparation/processing, and regular deworming exercise should also be prioritized in developed enlightment programs.

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