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Original Article

Occurrence of Gastrointestinal Parasites among Patients Attending Designated Tuberculosis Clinics in Rivers State, Nigeria

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ABSTRACT

Diseases of gastrointestinal parasites remain a major public health concern. This study was aimed at determining the occurrence of gastrointestinal parasites among patients attending designated tuberculosis clinics in Rivers State, Nigeria. The clinics included Chest clinic, Rumuigbo, General hospital, Ahoada and Meridian hospital. The study was conducted between July 2020 and August 2021. Stool and blood samples were collected from 1288 participants and examined for the presence of ova, cysts, oocyst and trophozoites of gastrointestinal parasites using formol-ether concentration and Modified Ziehl-Neelsen staining techniques. ELISA was used to examine the blood samples for the presence of Cryptosporidium spp. and Giardia lamblia. Out of the 1288 patients examined, 580 (45%) were infected and this was statistically significant ($p<0.05$). Gastrointestinal parasites identified included Ancyclostoma spp., Ascaris lumbricoides, Cryptosporidium spp, Entamoeba histolytica, and Giardia lamblia. Cryptosporidium spp. was the most prevalent ($p<0.05$). Females had a higher prevalence (55.9%) than males (44.1%), and the age group 11-20 years were most infected. The occurrence of gastrointestinal parasite infection was higher in the wet season ($p<0.05$). Sources of drinking water and housing types were risk factors that had a significant influence on the infection ($p<0.05$). The gastrointestinal parasite was not influenced by the occupation, as well as the educational levels of the participants. The study showed that tuberculosis patients were more infected than non-tuberculosis patients, and occurrence was higher in rural areas than in urban areas; both were significant ($p<0.05$). Detection of Giardia lamblia and Cryptosporidium using non-ELISA and ELISA techniques were not statistically significant ($p>0.05$). The study showed a higher prevalence of infection; therefore, there is a need to enhance health education on the mode of transmission of gastrointestinal parasites and improve on personal and environmental hygiene of tuberculosis patients and the population as a whole; to reduce the occurrence of infection.

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INTRODUCTION

Parasitic diseases contribute greatly to the global burden of infectious diseases (Vivornpun *et al.*, 2016) and most of the parasitic infections encounter in several studies are common among people living in developing countries of the world (Cedric et al., 2020). These countries are characterised by poor socio-economic status, poor sanitation, and personal hygiene. The situation is further compounded by its occurrence with tuberculosis (coinfection). This occurrence of gastrointestinal parasites among tuberculosis patients is cosmopolitan in distribution (Li & Zhou, 2013).

The occurrence of gastrointestinal parasites and tuberculosis is mostly found in individuals with compromised immunity. Coinfection has become a serious public health concern and it has an enormous impact on the infected individual. Coinfection can increase the difficulty of prevention and control of pulmonary tuberculosis and parasitic gastrointestinal diseases in co-endemic regions (George et al., 2013). This is due to the increased lowering of patients' immune response. As well as the enhancement of infection in multiple organs, leading to increased intolerance and deteriorated progress of the disease (Li & Zhou, 2013; Aleme et al., 2019). The occurrence of tuberculosis and gastrointestinal parasites in some cases can be deadly, where there is ulceration and blockage of organs.

Moreover, tuberculosis and gastrointestinal parasites primarily affect low social and economic level populations, living clustered in precarious habitation settings, and Nigeria is among such countries. 1/6 of the global population is infected by parasitic gastrointestinal infections (Dudlova et al., 2016). Globally, 3.5 billion are infected with intestinal parasites; 450 million are ill as a result of the infection (protozoa and helminths), while an estimated one-quarter of the global population is infected with tuberculosis (Sitotaw et al., 2019). Globally, a monthly estimate of 2 billion people have been infected with tuberculosis annually (Tegegne et al., 2018). Nigeria is 1st in Africa & 6th in the world among countries with the highest global TB burden (Ugwu et al., 2021).

Gastrointestinal parasitic diseases and tuberculosis belong to neglected tropical diseases (NTDs) and remain a major public health issue (Alemu et al., 2019). *Mycobacterium tuberculosis* is the causative agent of tuberculosis and this bacterium predisposes people to gastrointestinal tract infection. Therefore, the need for continuous stool examination for the detection and treatment

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of suspected patients to get their current records which would help in health improvement.

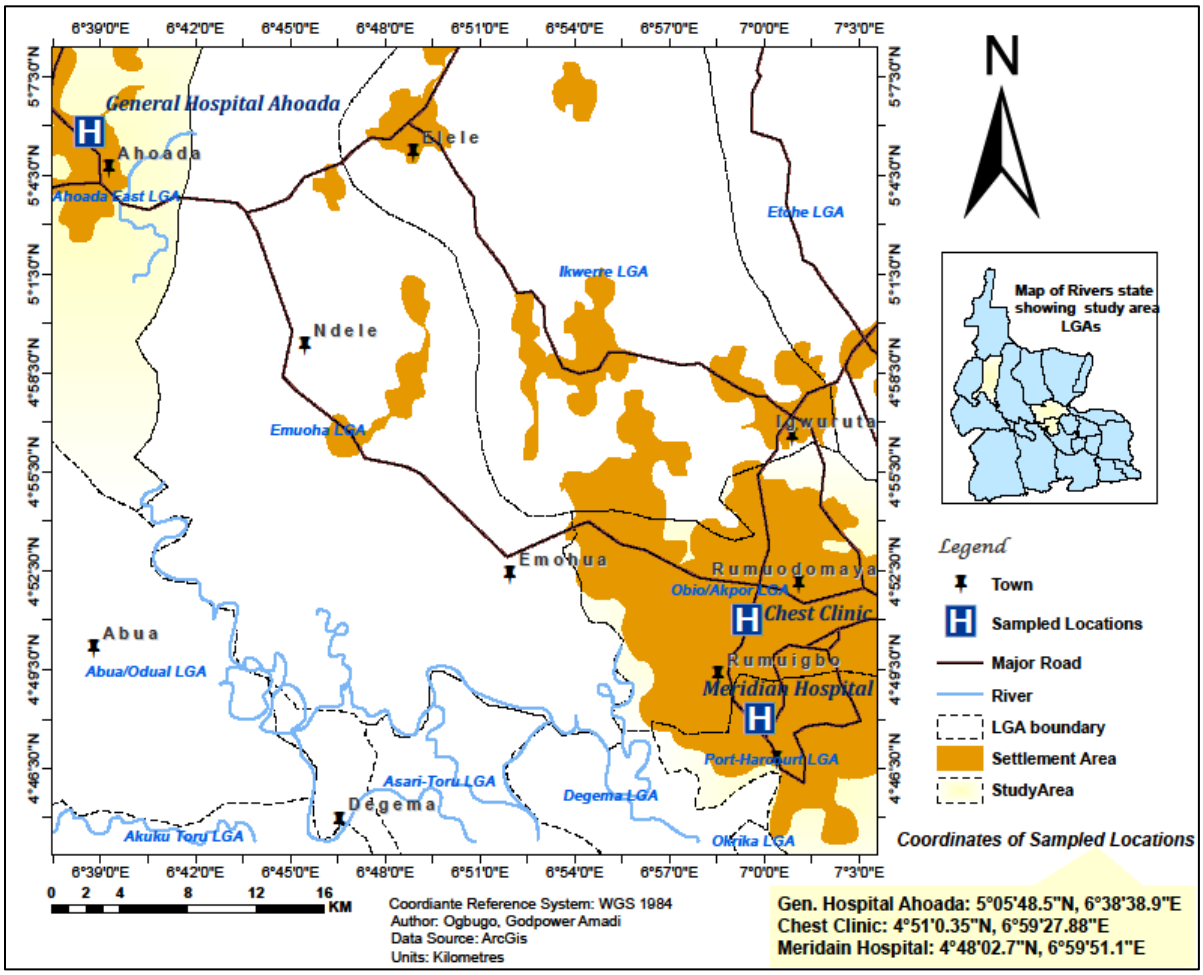
The aim of this study was to determine the occurrence of gastrointestinal parasites among tuberculosis patients attending designated TB clinics in Rivers State, Nigeria. Chest clinic in Rumuigbo, General hospital in Ahoada and Meridian hospital in Port Harcourt were the three designated TB clinics selected for this study. The data obtained from this research would be a useful tool in organising public health priorities and policies for assessing and comparing the relative burden of gastrointestinal parasites and tuberculosis, as there are few statistics about tuberculosis and gastrointestinal parasites coinfection in humans and its associated effect in this part of the country

MATERIALS AND METHODS

Study Area

The research was carried out in designated TB clinics used for the treatment of patients in Rivers State (*Figure 1*). The clinics were the Chest clinic (latitude N4° 51'0 .34.946", longitude E6°59'27.88298"), sited within the model primary health centre, Rumuigbo, Obio-Akpor Local Government Area; DOTS clinic, General hospital, Ahoada (Latitude N 5°5'48.51492, longitude E6°38'38.8896"), Ahoada-East Local Government Area and Meridian hospital, Port Harcourt.

Figure 1: Map of Study Area (H: Sample collection sites and designated tuberculosis)



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Sample Collection

Stool samples were collected from a total of 1,288 patients with confirmed cases of tuberculosis from the designated clinics on their specified clinic days. The patients were given a sterile universal bottle labelled with a unique identification number for the collection of faecal samples. They were instructed on how to produce and handle the stool specimen to avoid contamination. Freshly voided stool samples submitted by each participant were preserved in 10% formalin and transported to the medical microbiology and parasitology laboratory at the University of Port Harcourt Teaching Hospital for parasitological examination. Detection of *Cryptosporidium* spp in faecal samples was done using the Modified Ziehl-Neelsen technique. Similarly, blood samples were also collected from the 1288 participants for the detection of *Cryptosporidium* spp and *Giardia lamblia* using enzyme-linked immunosorbent assay (ELISA).

Laboratory Analysis

The stool samples were examined using the method of Arora and Brij (2010) adopted for the detection of parasites by formol-ether concentration technique. The modified Ziehl-Neelsen technique was used for the detection of *Cryptosporidium* spp. Using the method as recommended by Ochei and Kolhatkar (2007). Blood samples were collected from the participants, from which the serum was obtained to run enzyme link immunosorbent assay (ELISA) based on Manufacturer's Manual (Glory Science Co., Ltd. USA).

Data Analysis

Data obtained were analysed using the Statistical Package for Social Sciences (SPSS) ver. 20. Independent T-test was used to test for differences between categorical variables in comparison to the diagnostic techniques. A p-value of ≤ 0.05 was considered statistically significant.

RESULTS

Overall Prevalence

The result showed that out of 1,288 participants examined for the presence of gastrointestinal parasites, 580 were positive. This represents an overall prevalence of 45% (*Table 1*). The results obtained showed a significant difference in the overall prevalence of gastrointestinal parasites among tuberculosis patients in Rivers State ($p< 0.05$). The results indicated that General Hospital, Ahoada (GHA) had the highest prevalence of 100(69.4%), followed by Chest Clinic (CC) 456(43.7%) and Meridian Hospital (MH) 24(24%).

Table 1: Overall prevalence of gastrointestinal parasites among tuberculosis

Location	Number examined	Number Infected (%)	Infected Mean±Std. Error	F-value	P-value
CC	1044	456 (43.7)	38.00±8.23	15.20	0.000
GHA	144	100 (69.4)	8.33±2.16		
MH	100	24 (24)	2.00±0.60		
Total	1288	580 (45)			

CC = Chest clinic, Rumuigbo; GHA = General hospital, Ahoada; MH = Meridian hospital, Port Harcourt.

Parasite species belonging to five genera were identified from the samples (*Figure 1*). The parasites were two helminths: *Ancyclostoma* spp. and *Ascaris lumbricoides*, and three protozoa: *Cryptosporidium* spp., *Entamoeba histolytica*, and *Giardia lamblia*. *Cryptosporidium* spp. was the most prevalent parasite in all the locations, *Ancyclostoma* spp. was found in only two locations (Chest clinic, Rumuigbo and General Hospital, Ahoada), while the least prevalent parasite was *E. histolytica* found only in Chest clinic. The occurrence of gastrointestinal parasites found between groups and within groups was only statistically significant <0.05 (*Table 2*).

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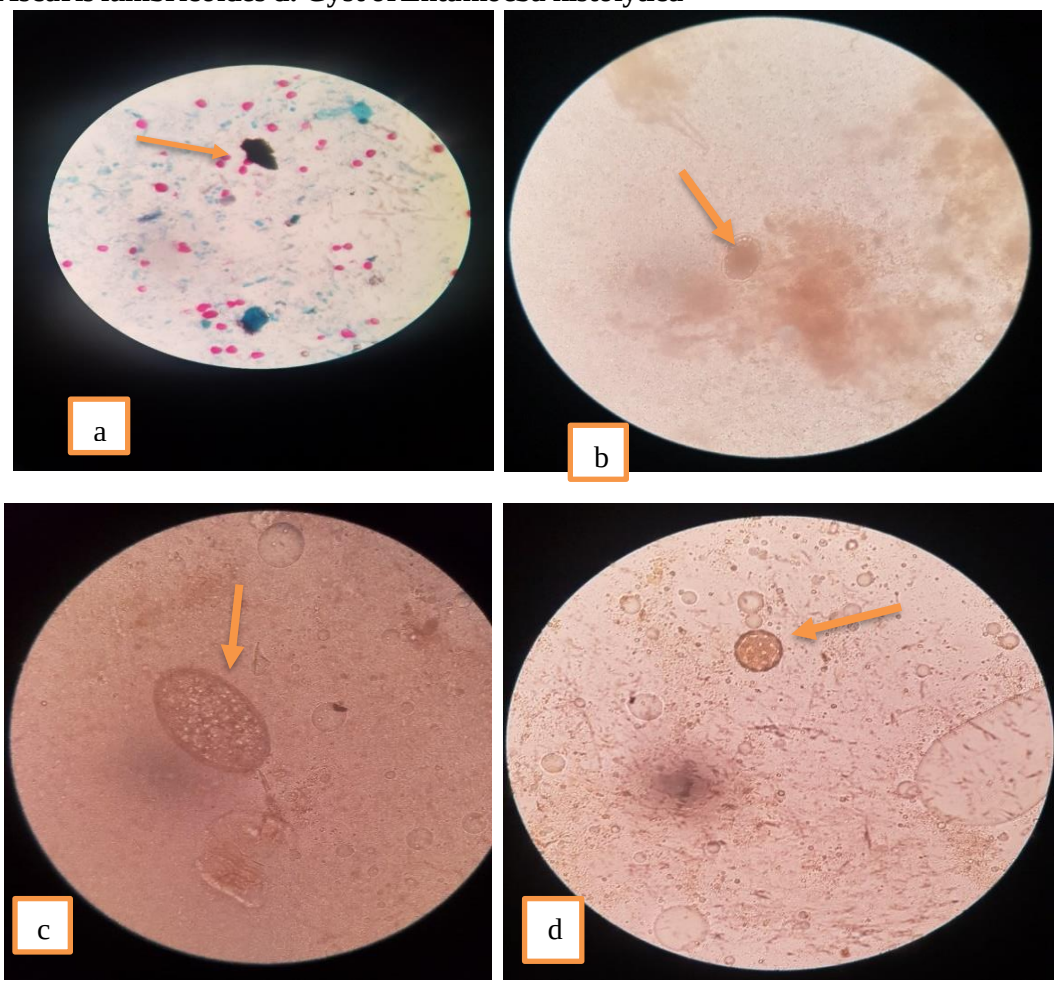
Table 2: Prevalence of gastrointestinal parasites in TB patients in relation to species of parasites

Locations	*Ascaris lumbricoides*	*Ancyclostoma spp.*	*Cryptosporidium spp.*	*Entamoeba histolytica*	*Giardia lamblia*
CC	1.66±0.44	1.66±0.08	20.33 ±5.31	0.66± 0.28	15.00±6.15
GHA	0±0.00	0.33±0.14	5.00±0.55	0 ±0.00	3.16±0.67
MH	0.66±0.28	0.±0.00	1.41±0.58	0 ±0.00	0±0.00
P- value	0.002	0.048	0.000	0.009	0.014

CC = Chest clinic, Rumuigbo; GHA = General hospital, Ahoada; MH = Meridian hospital, Port Harcourt.

Plate 1: a: Oocyst of Cryptosporidium spp; b: Ova of Ancyclostoma spp; c: Fertilised ova of Ascaris lumbricoides d: Cyst of Entamoeba histolytica



Prevalence in Relation to Gender, Sex and Other Variables

The epidemiological prevalence of gastrointestinal parasites was assessed in relation to the gender, age, occupation, and educational status of the participants. The result of the study shows a significant difference in the prevalence of gastrointestinal parasites among male tuberculosis patients in Rivers State, as well as in females ($p<0.05$). The overall age group prevalence revealed that the age bracket of 11-20 years had the highest prevalence (78%). The age-related prevalence of gastrointestinal parasites among tuberculosis patients in each age group was statistically significant ($p<0.05$). The study revealed that the highest prevalence of parasitic gastrointestinal infection was found among farmers (67.9%); and the least among the unemployed (25%). However, the influence of occupation on the prevalence of gastrointestinal was not statistically significant ($p> 0.05$).

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Additionally, the study assessed the influence of educational status (primary school, post-primary, tertiary education and informal education) on the prevalence of gastrointestinal parasites among the participants. The prevalence pattern varied among different educational groups in the locations. The educational group that had the highest prevalence were those with informal education (85.7%), followed by those with primary education (46.4%). The least infected group were those with tertiary education, 35.5% (*Table 3*).

Prevalence in Relation to Some Risk Factors

The study showed a significant difference in relation to water sources from the borehole and sachet ($p<0.05$) but did not show any significant difference from drinking water obtained from wells. The occurrence of gastrointestinal parasites was not influenced by the toilet type ($p>0.05$). But the occurrence of gastrointestinal parasites was influenced by the housing type, with those living in 1-bedroom and 2-bedroom apartments showing a significant difference (p-value <0.05); while those living in 3-bedroom apartments recorded no significant difference ($p>0.05$) (*Table 4*).

The study also showed that there was statistical significance in the occurrence of the gastrointestinal parasite during the rainy season ($p<0.05$) as compared to the dry season. A total of 1024 and 264 patients were examined in the rainy and dry seasons, out of which 77.9% and 22.1% were infected, respectively (*Table 5*).

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Table 3: Prevalence of gastrointestinal parasites coinfection among tuberculosis patients in relation to gender, age, occupation, and educational status

Variables		No examined (CC)	No Infected	No examined (GHA)	No Infected	No examined (MH)	No Infected	Total Examined (% Infected)	P-value
Gender	Male	440	224(39.4)	88	48(8.5)	40	8(1.4)	568(49.2)	0.000
	Female	604	232(32.2)	56	52(7.2)	60	16(2.2)	720(41.1)	0.000
	Total	1044	456	144	100	100	24	1288	
Age Group	0-10	148	52(32.5)	0	0(0)	12	0(0)	160(32.5)	0.024
	11-20	118	92(78)	0	0(0)	0	0(0)	118(78)	0.000
	21-30	280	108(32.5)	20	12(3.6)	32	12(3.6)	332(39.6)	0.000
	31-40	272	92(27.7)	40	20(6)	20	4(1.2)	332(34.9)	0.000
	41-50	132	80(35.7)	72	68(30.4)	20	8(3.6)	224(69.6)	0.005
	>50	94	32(26.2)	12	0(0)	16	0(0)	122(26.2)	0.001
	Total	1044	456	144	100	100	24	1288	
Occupation	Student	320	128 (35.6)	8	4(1.1)	32	8(2.2)	360(38.9)	
	Farmer	72	40(35.7)	40	36(32.1)	0	0(0)	112(67.9)	
	Self-employed	440	212(36.1)	96	60(10.2)	52	12(2.0)	588(48.3)	
	Civil servant	168	64(35.6)	0	0(0)	12	4(2.2)	180(37’8)	
	Unemployed	44	12(25)	0	0(0)	4	0 (0)	48(25)	
	Total	1044	456	144	100	100	24	1288	0.757
Educational status	Primary	208	76(27.54)	52	52(18.8)	16	0(0)	276(46.4)	
	Post-primary	476	192(32.2)	76	40(6.7)	44	16(2.7)	596(41.6)	
	Tertiary	272	100(32.9)	8	0(0)	24	8(2.6)	304(35.5)	
	Informal	88	88(78.6)	8	8(7.1)	16	0(0)	112(85.7)	
	Total	1044	456	144	100	100	24	1288	0.756

CC = Chest clinic, Rumuigbo; GHA = General hospital, Ahoada; MH = Meridian hospital, Port Harcourt

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Table 4: Prevalence in relation to risk factors associated with the transmission of tuberculosis and gastrointestinal parasites in different locations.

Variables		Location						P-value
		CC		GHA		MH		
		No. Examined	Mean Infection	No. Examined	Mean Infection	No. Examined	Mean Infection	
Source of drinking water	Borehole	780	21.50±6.34	76	3.16±1.35	66	1.16± 0.86	0.001
	Well	56	4.00±2.06	24	1.25±0.50	7	0±0.00	0.077
	Sachets	208	12.50±2.97	44	3.00±0.78	27	1.66± 0.83	0.000
Toilet type	Water system	868	30.33±6.04	48	1.66±0.66	84	1.66±0.66	0.421
	Pit	132	5.66±0.60	72	5.66±1.60	8	0.33±0.13	0.646
	Open defecation	40	1.66±0.60	16	1.00±0.05	8	0± 0.00	0.577
	River	4	0.33± 0.01	8	0±0.00	0	0±0.00	0.555
Housing type	1 bedroom	379	15.33±2.31	65	4.66±2.77	52	1.00±0.36	0.000
	2 bedrooms	424	16.00±4.54	63	3.16±0.99	12	0±0.00	0.000
	3 bedrooms	241	6.66±2.07	16	0.66±0.14	36	5.83±2.37	0.060

CC = Chest clinic, Rumuigbo; GHA = General hospital, Ahoada; MH = Meridian hospital, Port Harcourt

Table 5: Prevalence of gastrointestinal parasites among tuberculosis patients in relation to seasons

Season	CC		GHA		MH		Total	P-Value
	No. Examined	Mean Infection	No. Examined	Mean Infection	No. Examined	Mean Infection		
Rainy Season	840	62.66±14.09	96	9.33±3.63	88	3.33± 0.61	1024(77.9)	0.000
Dry Season	204	13.33 ± 7.39	48	3.66±0.32	12	0.66± 0.33	264(22.1)	0.148
Total	1044		144		100			

CC = Chest clinic, Rumuigbo; GHA = General hospital, Ahoada; MH = Meridian hospital, Port Harcourt

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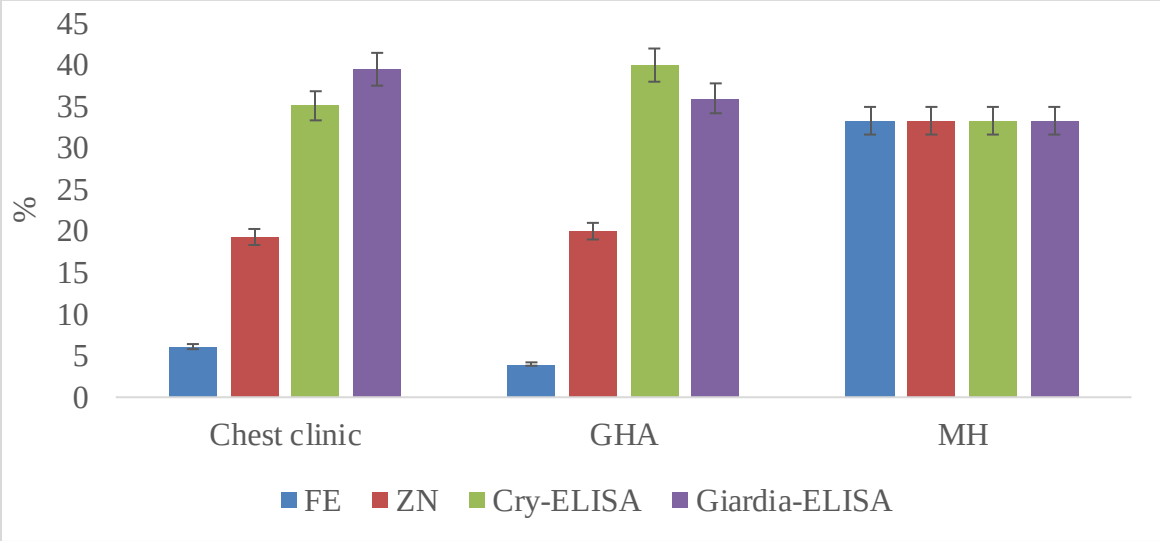
Prevalence of *Gardia lambia* and *Cryptosporidium* spp. in Relation of Diagnostic Techniques

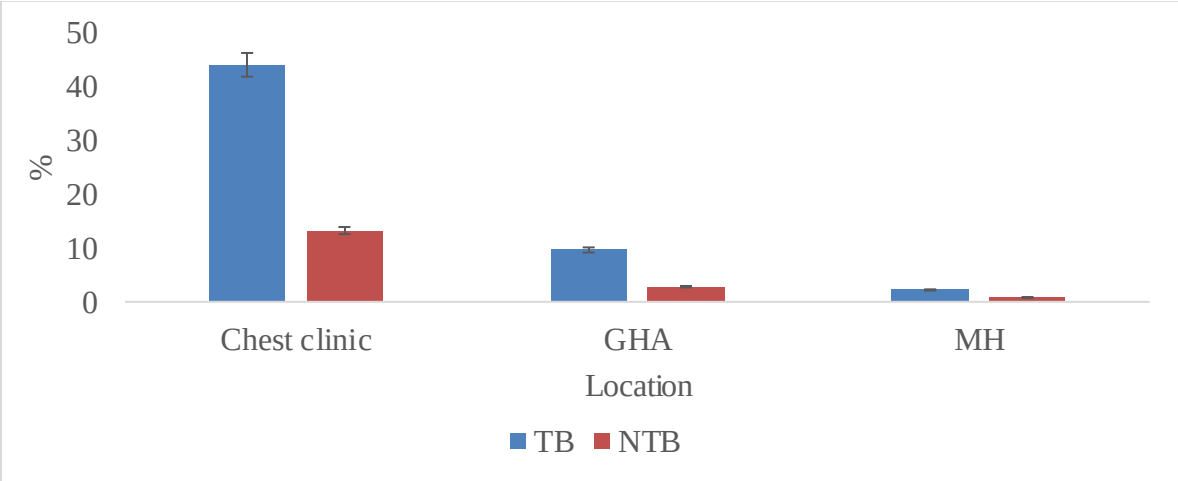
Testing the efficacy of diagnostic techniques for *Cryptosporidium* and *Giardia lamblia* detection among tuberculosis patients showed that the formol ether technique detected fewer parasites as compared to the ELISA technique (*Figure 2*). However, the detection of *Giardia lamblia* and *Cryptosporidium* using non-ELISA (microscopy) and ELISA techniques was not statistically significant ($p>0.05$). The study showed that out of 932 TB patients examined, 520 (55.7%) were infected with gastrointestinal parasites. Among the 356 non-tuberculosis patients (control groups) examined, 60 (16.85%) were infected with gastrointestinal parasites (*Figure 2*). This difference in prevalence among TB patients and non-TB patients was significant ($p<0.05$). The results also indicated a significant ($p>0.05$) high rate of infection of gastrointestinal parasites in tuberculosis patients compared to non-tuberculosis patients at all the locations (Fig. 3.0).

Figure 2: Prevalence of gastrointestinal parasites in relation to diagnostic techniques



Key: *GHA = General Hospital Ahoada, MH = Meridian Hospital, FE = Formol Ether, ZN = Ziehl Neelsen, Cry-ELISA = Cryptosporidium spp. (ELISA)*

Figure 3: Prevalence of gastrointestinal parasites among tuberculosis and non-tuberculosis patients



Key: TB = Tuberculosis patients, NTB = Non tuberculosis patients (control group), GHA = General Hospital Ahoada, MH = Meridian Hospital

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DISCUSSION

Gastrointestinal parasitic infections have become a major health and socio-economic challenges, especially in developing countries (Centre for Disease Control [CDC], 2020). The outcome of this study has shown that parasites ova, cyst and oocyst can be seen in faecal samples of tuberculosis patients in the study areas. The outcome agrees with the findings of other researchers that reported coinfection of gastrointestinal parasites among tuberculosis patients. The 45% overall prevalence recorded in this study is higher than the 38.4%, 31.8%, 34%, 19.6%, 36.1%, and 33% reported by Idu et al., 2016, Mhimbrira et al., 2017, Taghipour et al., 2019, Tegene eta l., 2018, Alemu et al., 2019 and Alemu et al., 2020 respectively. This difference is likely due to differences in the socio-demography characteristics and awareness levels of participants in the various study areas. The high prevalence rate in our study could also be attributed to the low standard of living, self-medication, as well as ignorance among the tuberculosis patients in the study area (Azuonwu & Wokem, 2018).

The gastrointestinal parasites (*Ascaris lumbricoides*, *Ancyclostoma* spp., *Cryptosporidium* spp., *Entamoeba histolytica* and *Giardia lamblia*) identified in this study have been reported in other studies (Akinbo et al., 2016., Eze et al., 2019., Alemu et al., 2020, Tegegne et al., 2018) The authors including Abate et al. (2012) recorded *Ascaris lumbricoides* as the most frequently encountered parasites in their studies. The identification of *Cryptosporidium* spp. in our study also agrees with the report of Alemu et al. (2019) who recorded low prevalence among tuberculosis patients and not among non-tuberculosis participants. They attributed their identification to the use of the modified Ziehl Neelsen staining method, but the low identification was attributed to their exclusion of HIV-infected tuberculosis patients in their study. The occurrence of *Cryptosporidium* spp. and *Giardia lamblia* as the highest parasites identified in this study could be attributed to the inclusion of HIV-infected TB patients. HIV-AID is known for lowering the immunity of patients and predisposing HIV-positive patients to opportunistic infections including gastrointestinal parasites. It can also be attributed to the diagnostic methods used. The modified Ziehl Neelsen staining method for *Cryptosporidium* and ELISA technique for *Cryptosporidium* and *Giardia lamblia* was used in this study, and the methods are reported to be more sensitive than the formol ether method (Cirak & Bauer, 2004; Youn et al., 2009).

The overall prevalence of parasitic gastrointestinal infection was higher in males (49.2%) than females (41.1%) with a significant difference. Similar results reflecting a higher prevalence of the parasites in males than females have been recorded by other researchers. Akinbo et al. (2011) reported 18.3% and 13.7% in males and females, respectively. Aleme & Mama (2017) recorded 53.3% and 42.7% for males and females, respectively; Tegegne et al. (2018) reported 61.7% and 38.3% for males and females respectively; Ayele et al. (2019) reported 77.7% for males and 22.3% for females; Taghipour et al. (2019) recorded 84% and 16% for males and females respectively; while Mohammed et al. (2019) had 11.9% for males and 11,7% for females respectively. The higher prevalence in the males in this study could be attributed to a large proportion of men eating outside their homes while carrying out their daily activities to provide for their families (Mohammed et al., 2019).

The results of our study contradict previous records which report a higher prevalence in females than in males (Mekonnen & Ekubagewargies (2019); Cedric et al. (2020); Hajare et al. (2021). Mekonnen and Ekubagewargies (2019) recorded 51% and 59% for females and males, respectively; Cedric et al. (2020) reported 22% for females and 11% for males, while Hajare et al. (2021) recorded 66.2% and 33.8% for females and males respectively.

This present study revealed that the age-related prevalence of gastrointestinal parasites was significant with those in the age group 11-20 years

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having the highest prevalence of 92(78%). This finding was in line with the record of Mohammed et al. (2019); Al-Doody et al. (2021); and Eze et al., 2019), even though their difference in age was not significant.

Parasitic infection is most severe in ages less than 12 years (Eze et al., 2019). Alemu and Mama (2017) also reported that age was not significantly associated with parasitic intestinal infections. The age group with the least prevalence in this study was those > 50 years 32 (26.2%). The difference in the prevalence of the parasites in the different age groups in this present study could be attributed to the fact that few TB patients within the age group of 12 years participated in the research. This can be linked to low TB case-finding among those under 12 years in Nigeria (TB Report, 2021).

The farmer had the highest prevalence of infection; this agrees with the works of Nigu & Amir (2021) and Alemu & Mama (2017); the researchers reported farmers as the highest infected group. But, in contrast, Mekonnen & Ekubagewargies (2019) in a study conducted in Ethiopia, recorded that housewives had the highest prevalence of gastrointestinal parasites while farmers had the least infection. The high rate of infection among farmers recorded in this study could be attributed to their regular contact with soils harbouring eggs and cysts of gastrointestinal parasites.

This study did not find any relationship between parasitic gastrointestinal infection and participants' educational level. However, the prevalence rate was higher among those with informal education, followed by tertiary and post-primary and the least prevalence was found among those with a primary level of education in the Chest clinic. This is in consonance with Tesfaye et al. (2022) that reported a high prevalence of gastrointestinal parasites among those with no education/informal education but differs from other studies conducted in Ethiopia and Cameroon by Alemu & Mama (2017), Alemu et al. (2019). In both studies, the highest prevalence of intestinal parasites was recorded among those with primary school levels, followed by those with secondary and secondary levels of education, while those with informal levels of education had the least prevalent rate. Similarly, Mohammed et al. (2019) also recorded the least prevalence of intestinal parasites among people with informal education in Sokoto State, Nigeria.

In this study, the source of drinking water and housing type were significantly associated with a parasitic gastrointestinal infection. This agrees with previous studies by Ben et al. (2018) and Mohammed et al. (2019). In this study, the risk factors identified included the source of drinking water, toilet types and nature of the house used by the participants. Although there was no significant difference in infection levels among those that used different sources of water, the rate of infection was high among those that used boreholes and sachet water as sources of drinking water. This result is variant from the record of Mohammed et al. (2019), who recorded a higher prevalence among people that use streams as well as a source of drinking water and the least among participants that use sachet water as a source of drinking water in Sokoto. Cedric et al. (2020) also reported streams and rivers as the highest source of parasitic infection in Cameroun. The high prevalence of infection from boreholes and sachets in this study could be attributed to the depth of the boreholes and the sachet water not being certified by the country's national regulatory agency as fit for consumption. This present study also recorded higher prevalence from those that lived in 1-bedroom and 2-bedroom apartments, and this was statistically significant, while those that lived in 3-bedrooms and above had lower infection rates. This is in line with the work of (Cedric et al., 2020).

This study recorded a higher prevalence rate of parasitic gastrointestinal infection during the wet season across the three locations studied as against the dry season. This is in line with other researchers in Nigeria, such as Akinbo et al. (2011) in Benin city that recorded a higher prevalence of parasitic intestinal infections in the wet season (17.6%) than in the dry season (12.3%)

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among the HIV-infected persons. Raining season promotes conditions and risk factors that encourage parasitic gastrointestinal infections. Increased parasitic infections during this season are associated with agricultural activities being at their peak during this time (Akinbo et al., 2011). Consumption of raw fruits and vegetables, especially during the wet season, increases the risk of parasitic gastrointestinal infections, particularly in susceptible individuals like tuberculosis patients that are immunodeficient (Taghipour et al., 2019). This study recorded a significant relationship in the occurrence of parasitic gastrointestinal infection between TB and Non-TB patients. This was obvious in all the study locations; this is in line with other researchers (Mhimbira et al., 2017; Alemu et al., 2019; Alemu et al., 2020) but contrary to the study of Idu et al. (2016), that had a slightly higher prevalence of infection among the non-TB patient than TB-patients.

CONCLUSION

The study showed a high prevention rate of gastrointestinal parasite infection among tuberculosis patients attending designated clinics in Rivers State: Chest clinic, Rumuigbo; General hospital, Ahoada and Meridian hospital, Port Harcourt. The study showed that tuberculosis patients were more vulnerable than non-tuberculosis patients. It was also observed that a higher number of gastrointestinal parasites were detected using the ELISA technique than the non-ELISA technique.

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