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Prevalence of parasitic gastrointestinal diseases of poultry diagnosed in the Veterinary Teaching Hospital, University of Jos, Nigeria

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Abstract

The adverse effects of parasitic gastrointestinal diseases on poultry production are enormous, especially where birds are kept under extensive or semi-intensive systems, but the diseases are rarely recognized as primary problems except during necropsy examinations. A two-year longitudinal cohort prospective study was conducted from October 2018 to September 2020 to determine the prevalence and diagnostic features of parasitic gastrointestinal diseases of poultry in the Veterinary Teaching Hospital, University of Jos, Plateau State, Nigeria. A total of 2,989 cases were diagnosed over the study period, out of which 749 (25.1%) were parasitic gastrointestinal diseases. Protozoan gastrointestinal diseases were more prevalent among cases of parasitic gastrointestinal diseases with a total of 610 (81.4%), while gastrointestinal helminths had 139 (18.6%) cases. The prevalence of helminthiasis was more in the months of August, September, December, January and February, while gastrointestinal protozoan diseases were more in the months of April, May, June, July, October and November. Helminths species commonly diagnosed were *Ascaridia galli* (8.3%); *Heterakis gallinarum* (4.7%); *Capillaria* spp (1.9%); *Tetramere* spp. (0.5%), *Gongylonema* spp. (0.1%), *Strongyloides avium* (0.1%), *Raillietina* spp (1.5%), *Hymenolepis carioca* (1.1%) and *Davainea* spp. (0.4%). The intestinal protozoan parasites of poultry predominantly diagnosed were *Eimeria* spp. (78.0%) but *Histomonas meleagridis* (2.7%), *Trichomonas* spp (0.7%) and *Hexamita* spp. (0.1%) were also seen. It is concluded that the prevalence of parasitic gastrointestinal diseases of poultry was high and could be some of the leading causes of low productivity and mortality in the study area even in commercial poultry farms under intensive production systems. It is recommended that attention should be given to good litter management where birds are reared on the floor to prevent the multiplication of the developmental stages of the gastrointestinal parasites in the environment, as well as the adoption of other control strategies against parasitic gastrointestinal diseases of poultry.

Keywords: Cohort Study, Gastrointestinal Parasites, Helminthiasis, Jos, Nigeria, Poultry, Protozoan Diseases

Introduction

There is a global increase in poultry production, with its population currently estimated to be about 23 billion, kept under different types of management systems for meat, eggs and manure for crop farming (Mottet & Tempio, 2017). The rapid growth is due largely to the short production cycle with low start-up capital as well as the wide acceptance of poultry meat and eggs as sources of animal protein among diverse cultures, traditions, religions and social strata to provide nutrition and food security (Mottet & Tempio, 2017).

However, the impact of diseases on the poultry industry is enormous and often hinders productivity depending on the type of production. Mottet & Tempio (2017) grouped the production types into layers and broilers, which can either be backyard scale production under semi-intensive and or large-scale commercial production under intensive management systems in developed parts of the world. This classification is in contrast to what is obtained in developing countries of Africa where the greater part of poultry production irrespectful of type is mostly done under the traditional, semi-intensive and extensive systems (Permins & Hansen, 1998). Disease burdens in the backyard or semi-intensive and extensive production systems are much higher than in the intensive system (Adene & Oguntade, 2006; Mottet & Tempio, 2017).

Hence, the incidence or prevalence of viral, bacterial and parasitic diseases are higher in developing countries where poultry production is mostly backyard under traditional, semi-intensive, and extensive systems than those in the developed countries reared under large scale commercial and intensive systems. Nonetheless, the prevalence of parasitic infections is close to 100% not only in developing countries but even in developed countries where poultry are kept on free-range production akin to the traditional or extensive system (Permins & Hansen, 1998; Opara *et al.*, 2014; Tomza-Marciniak *et al.*, 2014).

However, even under the intensive system, the economic impacts of parasitic gastrointestinal diseases can be more in deep litter flocks due to poor management and environmental factors that may favour their perpetuations once established (Tomza-Marciniak *et al.*, 2014; Mottet & Tempio, 2017). Poultry flocks infected with internal parasites show stunted growth, reduced egg production, reduced weight gain, marked anaemia, enteritis, poor response to vaccination, susceptibility to secondary infections and high mortality (Permins & Hansen, 1998). Ekpo *et al.* (2010) also reported that parasitic gastrointestinal diseases or their concurrent infections with other diseases could cause immunosuppression and poor responses to vaccination against some poultry diseases.

In Nigeria, the most common diseases of poultry are Newcastle disease, Gumboro disease, coccidiosis, fowlpox as well as other internal and external parasites (Abdu, 2002; Ameji *et al.*, 2012). In another report, mortality due to parasitic diseases was said to be higher than that of Newcastle disease that was thought to be the most endemic and fatal disease of poultry (Nnadi & George, 2010; Opara *et al.*, 2014). Elsewhere, Tomza-Marciniak *et al.* (2014) reported the most common poultry diseases to be coccidiosis and helminthiasis, with higher mortality among free-ranging flocks than chickens kept in confined poultry houses. Hence, parasitism can be a problem anywhere under poor management and ranks high among factors that threaten chicken production globally (Nnadi & George, 2010; Tomza-Marciniak *et al.*, 2014).

Gastrointestinal parasites, which consist of helminths (worms) and GIT protozoans (mainly coccidia) are, however the most prevalent and most devastating parasites affecting chicken productivity (Nnadi & George, 2010). In Nigeria, there is no comprehensive and nationwide study on the prevalence and impact of parasitic gastrointestinal diseases in poultry but there are a few reports which give localized prevalence in some states. Junaidu *et al.* (2014) reported a prevalence of 81.5% of gastrointestinal helminths in chickens in Giwa, Kaduna state, while a prevalence of 32% was reported for gastrointestinal helminths in chickens and turkeys in Owerri, Imo state (Opara *et al.*, 2014). Also, a general prevalence of 42.5% of gastrointestinal parasites was reported for local and exotic breeds of chickens in Gwagwalada, Abuja-FCT, with a specific prevalence of 14.6% for *Eimeria* spp. and 15.4% for *Ascaridia* spp. (Jegede *et al.*, 2015).

On the basis of class, helminths of poultry are grouped as nematodes (roundworms), cestodes (tapeworms) and trematodes (flukes). Most of the roundworms of poultry have direct and short life cycles, with the common roundworms of poultry being *Ascaridia* spp., *Heterakis* spp. and *Capillaria* spp. (Permins & Hansen, 1998). The other classes of worms have indirect and complicated life cycles requiring intermediate hosts in their developmental stages before infecting poultry. Common tapeworms found in poultry are *Rallietina* spp., *Choanotaenia* spp., *Hymenolepis* spp., *Amoebotaenia* spp. while the common trematodes of poultry are *Echinostoma* spp. and *Prosthogonimus* spp. (Permins & Hansen, 1998). Coccidia is protozoans that cause coccidiosis in poultry and other animals. The class coccidia is differentiated into four orders. The most important order for poultry is the *Eucoccidiorida* having the monoxenous coccidia, which is an enteric parasite, infecting one specific host with short life cycles and are grouped under the family *Eimeridae*. The *Eimeridae* has four genera of coccidia, namely *Eimeria*, *Tyzzeria, Isospora* and *Wenyonella* that can cause coccidiosis in poultry and other animals (Permins and Hansen, 1998).

Eimeria parasites are host specific, but multiple species may infect the same host concurrently with no cross-protection (Permins and Hansen, 1998; Chapman *et al.*, 2013). The severity of lesions depends on the species of *Eimeria*, poultry affected and the predilection site within the gastrointestinal tract (GIT). The pathogenic *Eimeria* species associated with chickens are *Eimeria tenella, E. necatrix, E. burnetti, E. acervulina, E. mitis, E. praecox* and *E. maxima* (Chapman *et al.*, 2013).

Coccidiosis may be self-limiting but the presence of immunocompromising diseases such as Gumboro disease, reticuloendotheliosis and Marek's disease in concurrent infections may exacerbate the severity of the disease (Ekpo *et al.*, 2010). Similarly, tissue damage and changes in intestinal mucosa permeability and function may enhance colonization by pathogenic bacteria such as *Clostridium perfringens, Salmonella* spp and *Escherichia coli* to cause necrotic enteritis, Salmonellosis or colisepticemia (Ekpo *et al.*, 2010; Dieter & Michael, 2020). Also, caecal coccidiosis caused by *E. tenella* may increase the severity of blackhead disease caused by *Histomonas meleagridis* in chickens and turkeys (Dieter & Michael, 2020).

Generally, GIT parasitic diseases are often not recognized by most farmers despite their huge effects on productivity with the attending economic losses. Severally, birds or many other animals are presented for a different disease problem before the parasitic gastrointestinal disease could be diagnosed clinically, and this has led to under-reporting, increased disease burdens, adverse impacts on production, as well as huge economic losses to farmers. In this study, we assessed the prevalence and diagnostic features of GIT parasitic diseases of poultry in the Veterinary Teaching Hospital, University of Jos, Nigeria.

Materials and Methods

Study location

The study was conducted at the Veterinary Teaching Hospital (VTH; on Lat. 9.9312620 and Long. 8.8759490), University of Jos, Nigeria, with follow-up field investigations to some poultry farms in Jos metropolis, Plateau State, Nigeria (Figure 1).

The State is bounded by Kaduna State on the west, Bauchi State on the north, Taraba State on the east, Nasarawa State on the south, and falls within the Guinea Savannah zone with Lat. 9.810230 and Long. 8.913280 on the northeastern part of Nigeria. The VTH, the University of Jos, because of its location and accessibility, enjoys patronage by clients not only in Plateau State but from neighbouring locations such as Saminaka in Kaduna State; Tilden Fulani in Toro LG of Bauchi State; Akwanga and Wamba in Nasarawa State and from Kano State.

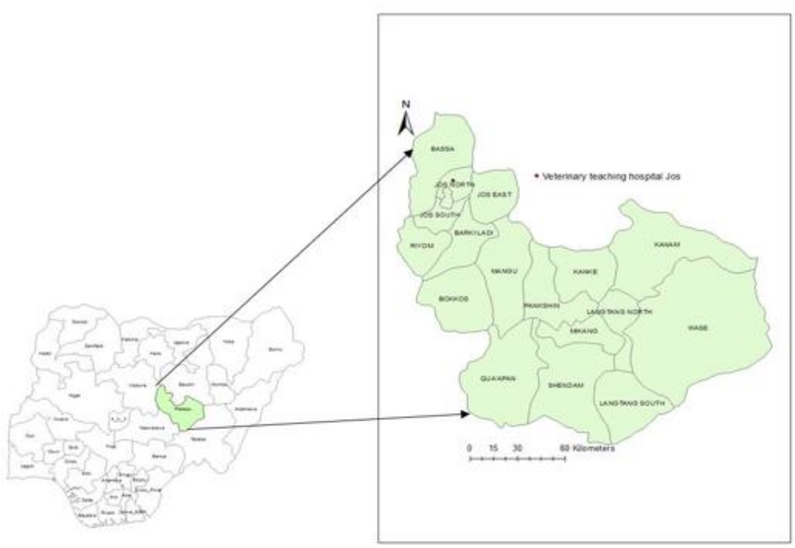

Figure 1: Map of Nigeria with Plateau State insert showing the location of the Veterinary Teaching Hospital, University of Jos, Nigeria

Study design

A longitudinal cohort prospective study was designed to investigate the prevalence and diagnostic features of cases of GIT parasitic diseases of poultry in the Poultry and Fish Clinic of the VTH, University of Jos, Nigeria, with follow-up of cases to some poultry farms in Jos metropolis over a 2-year period (October 2018 – September 2020).

Case inclusion criteria included all

cases presented to the VTH within the period of study with specific emphasis on complaints of unthriftiness in the flock, diarrhoea and wet litter as well as lingering mortality in the face of antibiotic treatment, among others.

Diagnosis

Investigation of GIT parasitic diseases of poultry was carried out based on clinical findings during presentation and farm visits; post-mortem (necropsy) lesions as well as light microscopy of faecal and intestinal scrapings with the photomicrographs of the parasites taken using a microscope camera (AmscopeR). Confirmatory diagnoses of protozoan parasites were made by the direct wet mount of intestinal scrapings with some slide stained with Giemsa for proper visualization, while GIT helminths were diagnosed by gross visualization, faecal floatation and sedimentation tests with microscopy.

Data Analyses

Data of cases were tabulated based on year, months, age group, poultry species and type of parasites detected with the specific rates, odds ratio (OR) and prevalence calculated using SPSS version 20 (SPSS Inc., Chicago, IL, USA) to see the patterns of the distribution of GIT parasitic diseases and other diseases of poultry within the period. A 95% confidence interval (CI) was determined using Fisher's test with a $p < 0.05$ to establish the level of significance of the diseases over the other. Descriptive statistics were also used to present the data graphically to visualize the frequency and prevalence of cases over the given period.

Results

A total of 2,989 cases were investigated in the Poultry and Fish Clinic of the VTH, the University of Jos, Nigeria, over the study period, out of which 749 (25.1%) were found to be GIT parasitic diseases with a yearly prevalence of 26.5% in 2018, 27.3% in 2019 and 23.1% in 2020 respectively (Table 1). Protozoan parasitic diseases had a specific prevalence of 81.4% among cases of GIT parasitic diseases, while GIT helminths were 18.6% (Table 2). On the other hand, the prevalence of GIT parasitic diseases was lowest in the months of March and December, with higher prevalence in May (29.9%), August (29.8%), September (36.7%) and October (31.6%), respectively (Table 2).

The prevalence of GIT parasitic diseases on a yearly cycle showed the prevalence of helminthiasis and

Table 1: Prevalence of gastrointestinal diseases of poultry diagnosed on yearly basis over the two year period (2018 – 2020) in the Veterinary Teaching Hospital, University of Jos, Nigeria

Year	GIT parasitic diseases (%)	Other diseases (%)	Total
2018	30 (26.5)	83 (73.5)	113
2019	349 (27.3)	934 (73.0)	1279
2020	370 (23.1)	1232 (77.1)	1597
Total	749 (25.1)	2,249 (75.2)	2,989

Table 2: Prevalence and group specific rates of GIT parasitic diseases diagnosed on a monthly basis over a two year period (2018 – 2020) in the Veterinary Teaching Hospital, University of Jos, Nigeria

Month	Helminthiasis (%)	GIT protozoan diseases (%)	Total GIT parasitic diseases (%)	Other diseases (%)	Total
January	14 (26.4)	39 (73.6)	53 (22.2)	186 (77.8)	239
February	12 (25.5)	35 (74.4)	47 (22.2)	165 (77.8)	212
March	8 (19.5)	33 (80.5)	41 (14.9)	235 (85.1)	276
April	4 (8.9)	41 (91.1)	45 (21.4)	165 (78.6)	210
May	11 (13.1)	73 (86.9)	84 (29.9)	197 (70.1)	281
June	9 (14.1)	55 (85.9)	64 (22.9)	215 (77.1)	279
July	13 (16.5)	66 (83.5)	79 (23.8)	253 (76.2)	332
August	22 (23.9)	70 (76.1)	92 (29.8)	217 (70.2)	309
September	29 (26.4)	81 (73.6)	110 (36.7)	190 (63.3)	300
October	4 (8.5)	43 (91.5)	47 (31.6)	101 (68.4)	148
November	1 (2.1)	46 (97.9)	47 (23.0)	157 (77.0)	204
December	12 (30.0)	28 (70.0)	40 (19.2)	168 (80.8)	208
Total	139 (18.6)	610 (81.4)	749 (25.1)	2249 (74.9)	2979

GIT protozoan diseases to be more within the 2019 – 2020 yearly cycle with 469 cases than in the 2018 – 2019 yearly cycle with 271cases (Figure 2). The monthly specific prevalence of helminthiasis compared to GIT protozoan diseases were low, but there was an increased prevalence of helminthiasis in the months of August (23.9%), September (26.4%), December (30.0%), January (26.4%) and February (25.5%) while GIT protozoan diseases though high throughout the year, were more in April (91.1%), October (91.5%) and November (97.9%) respectively (Table 2; Figure 3). In addition, the total monthly prevalence of GIT parasitic diseases was high for all the months except for March and December. However, a relatively higher prevalence was seen in the months of May (29.9%), August (29.8%), September (36.7%) and October with 31.6% (Table 2 and Figure 4). The prevalence of helminthiasis based on poultry species was more in pigeons (100.0%), turkeys (38.5%), local chicken (27.3%), Guinea fowl (25.0%) and chicken layers (23.5%), while GIT protozoan diseases were more in chicken broilers (98.0%), chicken cockerels (90.9%), peacock (83.3%) and chicken layers (76.5%) than in any species of poultry (Table 3). The prevalence of GIT parasitic diseases based on age group showed the

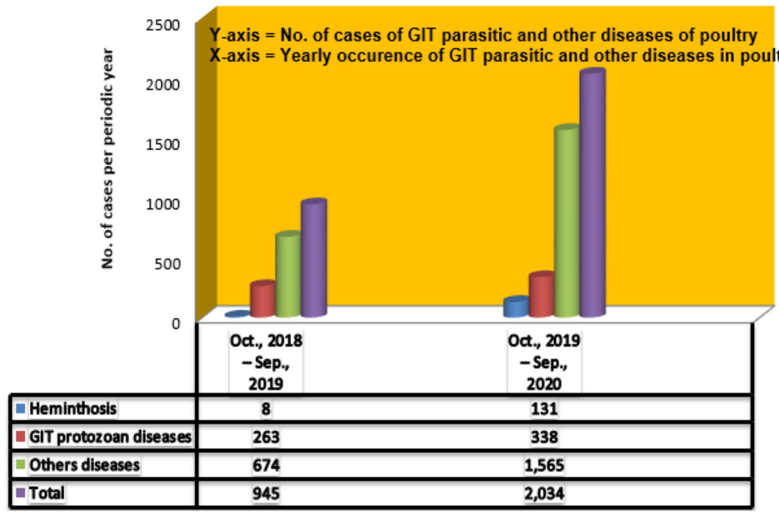

Figure 2: Burden of gastrointestinal parasitic diseases of poultry diagnosed on a yearly cycle basis over two years (2018 – 2019) in the Veterinary Teaching Hospital, University of Jos, Nigeria

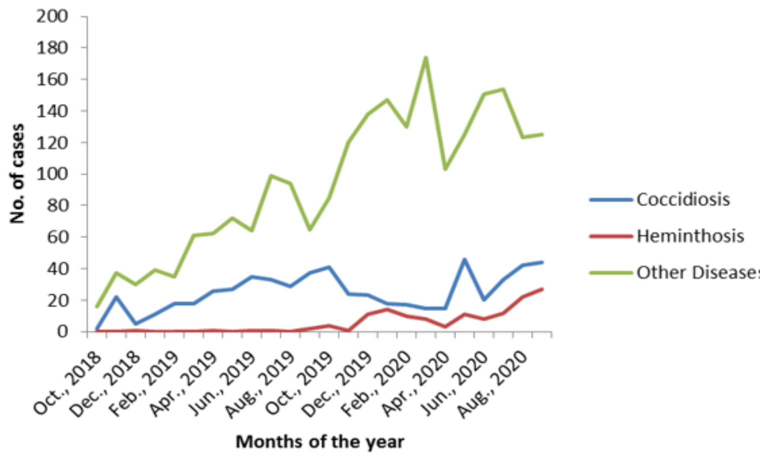

Figure 3: Monthly case isolated index of helminthiasis, GIT protozoan and other diseases in poultry over two years (2018 – 2020) in the Veterinary Teaching Hospital, University of Jos, Nigeria

Table 3: Prevalence and relative risk of helminthiasis to GIT protozoan diseases based on poultry species over two years (2018 – 2020) diagnosed in the Veterinary Teaching Hospital, University of Jos, Nigeria

Bird Species	Helminthiasis (%)	GIT protozoan diseases	Total GIT parasitic diseases	O.R	95% CI
Chicken broilers	4 (2.0)	197 (98.0)	201	0.0090*	0.0002 - 0.0048
Chicken layers	105 (23.5)	341 (76.5)	446	0.0620	0.0306 - 0.1259
Chicken cockerels	2 (9.1)	20 (90.9)	22	0.0816	0.0185 - 0.3599
Local chicken	3 (27.3)	8 (72.7)	11	0.3557	0.0915 - 1.3820
Turkey	20 (38.5)	32 (61.5)	52	0.5313	0.2786 - 1.0130
Guinea fowl	1 (25.0)	3 (75.0)	4	0.3266	0.0334 - 3.1960
Peacock	1 (16.7)	5 (83.3)	6	0.1919	0.0220 - 1.6740
Pigeon	3 (100.0)	0 (0.0)	3	7.2150	0.3676 - 141.63
Mixed	0 (0.0)	4 (100.0)	4	0.1067	0.0057 - 2.0100
Total	139 (18.6)	610 (81.4)	749		

*significant value at $p < 0.05$

Table 4: Prevalence and relative risk of helminthiasis to GIT protozoan diseases based on age group over two year period (2018 – 2020) in the Veterinary Teaching Hospital, University of Jos, Nigeria

Age (weeks)	Helminthiasis (%)	GIT protozoan diseases (%)	Total GIT parasitic diseases	O.R.	95% C.I.
≤2	0 (0.0)	58 (100.0)	58	0.003614*	0.00022 - 0.0599
3 – 6	3 (1.6)	182 (98.4)	185	0.002018*	0.00043 - 0.0096
7 – 10	12 (10.8)	99 (89.2)	111	0.001380*	0.00018 - 0.01081
11 – 20	22 (16.2)	114 (83.8)	136	0.093240	0.04443 - 0.1957
≥21	103 (39.6)	157 (60.4)	260	0.28800	0.15480 - 0.5359
Total	139 (18.6)	610 (81.4)	749		

*significant value at $p < 0.05$

prevalence of helminthiasis to be more in poultry 21 weeks or more (39.6%) while the prevalence of GIT protozoan diseases was more in poultry ≤ 2 weeks (100.0%), 3 – 6 weeks (98.4%) and 7 - 10 weeks (89.2%), age groups respectively (Table 4). Helminths species commonly diagnosed were *Ascaridia galli* (8.3%); *Heterakis gallinarum* (4.7%); *Capillaria* spp (1.9%); *Tetramere* spp. (0.5%), *Gongylonema* spp. (0.1%), *Strongyloides avium* (0.1%), *Raillietina* spp (1.5%), *Hymenolepis carioca* (1.1%) and *Davainea* spp. (0.4%) (Plates I and II and Table 5). The intestinal protozoan parasites of poultry predominantly diagnosed was *Eimeria* spp. (78.0%) but *Histomonas meleagridis* (2.7%), *Trichomonas* spp (0.7%) and *Hexamita* spp. (0.1%) were also seen (Plate III and Table 5). The clinical signs observed in most of the cases were pale comb; soiled or pasty vent; chilling or huddling of birds; droopy wings; retarded growth; loss of weight as well as hock sitting and sometimes, leg paralysis; drop in egg production; persistent low grade or rising mortality; persistent wet litter due to diarrhoea which could be blood-tinged or brownish colouration as well as worms in faeces; The post-mortem findings in most of the cases were pallor of the comb; pale breast muscles; ascites (mostly broilers); hydropericardium (in layers). Striking lesions were ballooning of the intestines; brownish/creamy mucoid or haemorrhagic enteritis with severe necrosis and haemorrhages in the intestinal mucosa; haemorrhagic and white necrotic foci on the intestinal serosa with a “salt and pepper” appearance; massive worms in intestines with blockage of the lumen (Plates I and IV).

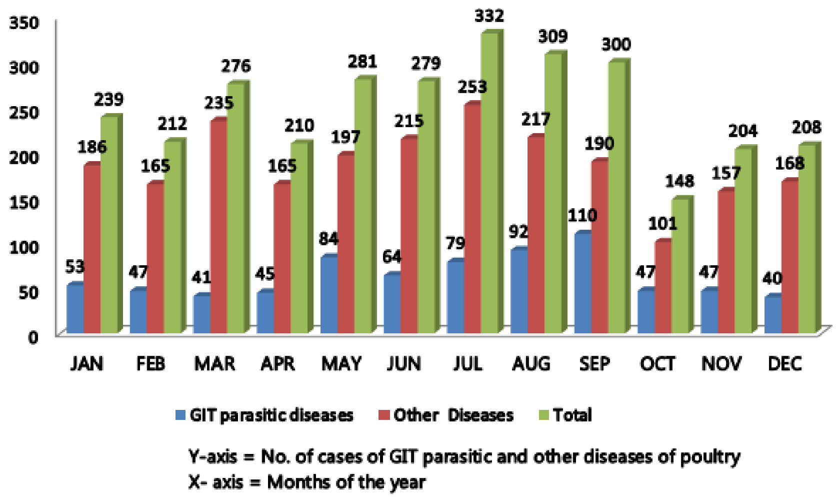

Figure 4: Monthly cases and burdens of GIT parasitic and other diseases in poultry over a two-year period (2018 – 2020) in the Veterinary Teaching Hospital, University of Jos, Nigeria

There were also severe necrohaemorrhagic proventricular and duodenal mucosae, intestinal rupture and loss of muscular integrity due to sloughing of mucosa or severe typhlitis (Plate IV). Microscopically, oocysts, schizonts and merozoites of coccidian as well as the amoeboid or flagellated forms of histomonad and *Hexamita* (protozoan) parasites were seen by direct wet mount and also with stained smears of intestinal scrapings (Plate III). Also, larvae (L2 and L3) of nematodes were seen by the direct wet mount of intestinal scrapings while several eggs of round and tapeworms were seen after faecal flotation and sedimentation tests (Plate II).

Discussion

The prevalence of 25.1% for GIT parasitic diseases reported in this study is much lower than previous reports in Nigeria by Opara *et al.* (2014) and Jegede

Table 5: Types and different species of Gastro – intestinal parasites detected from 2018 to 2020 study period in the Veterinary Teaching Hospital, University of Jos, Nigeria

GIT Parasites	Type of GIT parasite detected	Number of parasites detected (%)
Protozoan parasites	*Eimeria spp.*	584 (78.0)
	Histomonas meleagridis	20 (2.7)
	Hexamita spp	1 (0.1)
	Trichomonas spp.	5 (0.7)
Helminths parasites	*Ascaridia galli*	62 (8.3)
	Capillaria spp	14 (1.9)
	Heterakis gallinarum	35 (4.7)
	Strongyloides avium	1 (0.1)
	Tetramere spp	4 (0.5)
	Gongylonema spp	1 (0.1)
	Daveinea spp	3 (0.4)
	Hymenolepsis carioca	8 (1.1)
	Rallietina spp	11 (1.5)
The overall prevalence of GIT parasites (n/N)		749 (25.1)

n = Total GIT parasites detected during the study period; N = Total cases of poultry diseases within the study period

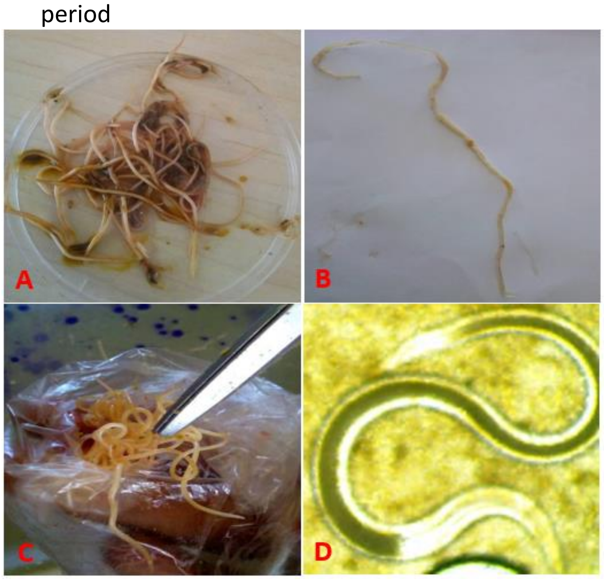

Plate I: GIT helminths of poultry visualized with the naked eye (A – C) and under the light microscope (D). *Ascaridia galli* (A); *Capillaria* spp (B); *Heterakis gallinarum*/*Ascaridia galli* (C); and *Strongyloides avium* ×40 (D)

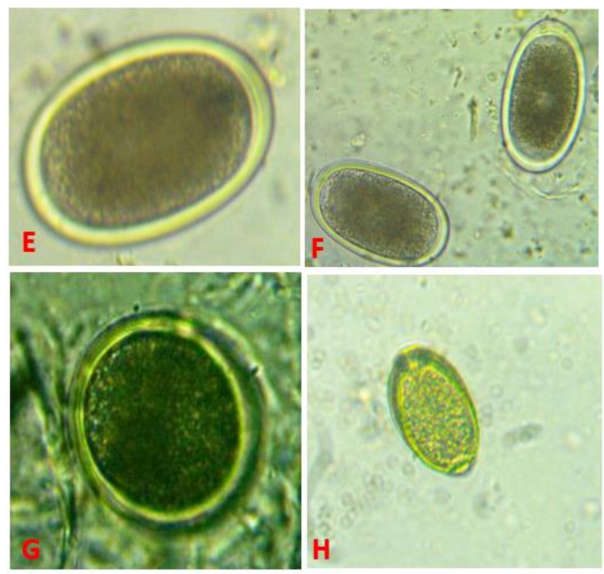

Plate II: Eggs of GIT helminths of poultry visualized after faecal flotation and wet mount of intestinal scrapings under the light microscope. *Ascaridia galli* ×40 (E); *Heterakis gallinarum* ×40 (F); *Rallietina* spp ×40 (G); and *Capillaria rectus* ×40 (H)

et al. (2015) who reported a prevalence of 32% and 42.5% respectively as well as the prevalence of 90% reported by Tomza-Marciniak *et al.* (2014) in free-range chicken in Poland. However, the prevalence is higher than that of Hassan *et al.* (2020), who reported a prevalence of 5.7% in Kaduna state, Nigeria. The difference may be due to the variations in the different study designs as well as improved management and preventive measures of intensively reared poultry compared to extensively managed or free-range poultry.

Protozoan diseases, mainly coccidiosis was the predominant GIT parasitic diseases diagnosed even when most of the poultry were intensively raised. This may be attributed to the fact that most of the poultry produced in the study area were on deep litter or reared on the floor, which could support rapid sporulation of oocysts of *Eimeria* spp in wet and humid conditions, as reported by (Tomza-Marciniak *et al.* 2014). On the other hand, apart from *Eimeria* spp, other protozoan parasites such as *Histomonas meleagridis*, *Hexamita* spp and *Trichomonas* spp were seen at necropsy in some cases. These parasites were initially thought to be more pathogenic in turkeys and, to a lesser extent in chickens. However, morbidity, marked mortality and immunosuppression have been reported by some researchers in chickens and other birds infected with these protozoan parasites making them economically important in all species of poultry (Dolka *et al.*, 2015; Dieter & Michael, 2020). Among bird species, pigeons, turkeys, chickens and guinea fowls suffer from helminthiasis more than any bird species. Among bird types, the layers suffer more from helminthiasis. This may be due to the fact that chicken layers and turkeys are the most reared commercial poultry and are kept over long periods which may lead to their being infected with helminth parasites after reaching the infective stage of their life cycles. In addition, it is important to note that chickens and turkeys are often reared together or in close proximity both in the backyard and commercial farming system with susceptibility to the same helminth species.

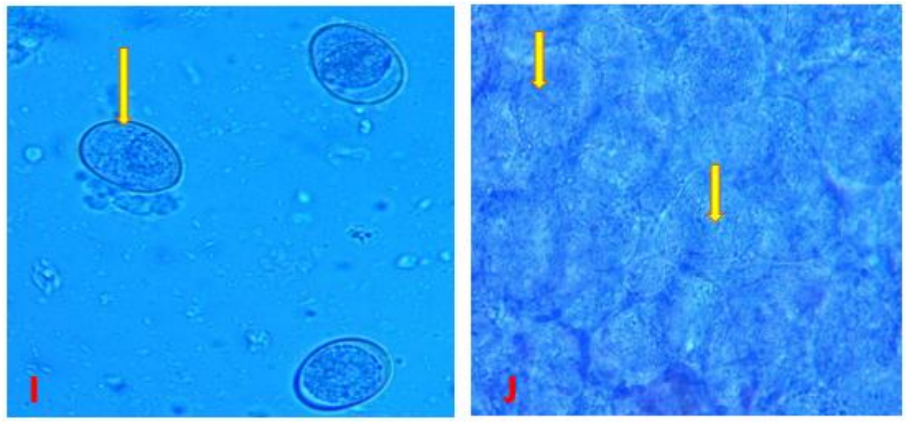

Plate III: Coccidian parasites of poultry visualized from the direct wet mount of intestinal scrapings and faecal flotation stained with field stain under the light microscope. Oocysts (yellow arrow) of *Eimeria* parasite ×40 (I) and Schizonts (yellow arrows) of *Eimeria* parasite ×40 (J)

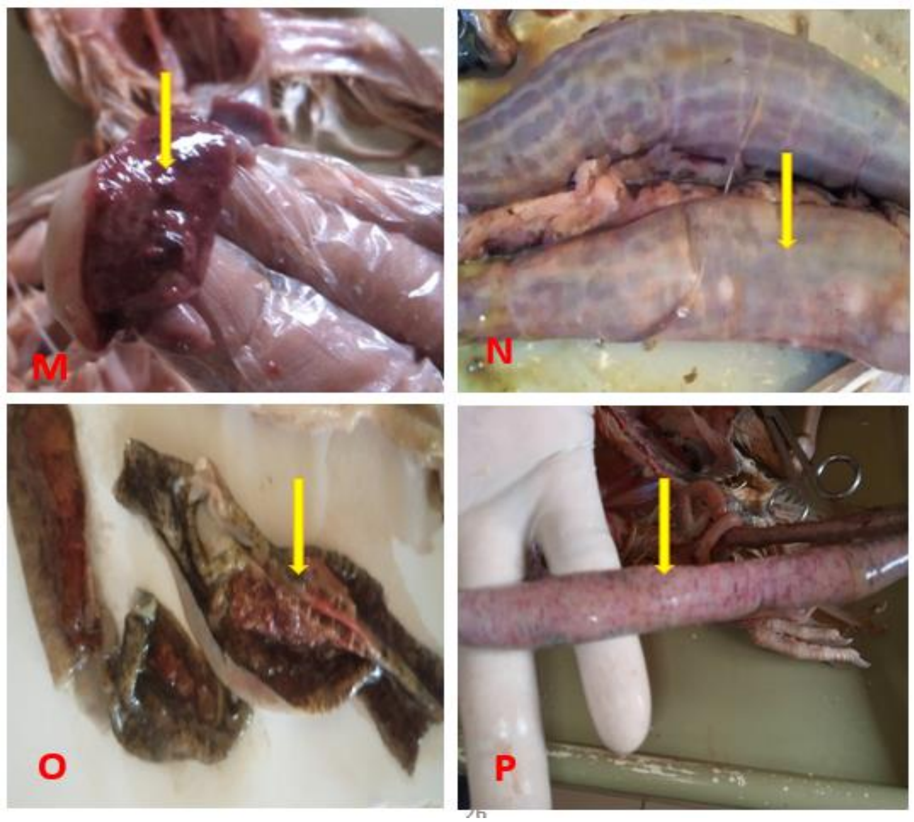

Plate IV: Gross lesions of coccidiosis and histomoniasis of poultry seen at necropsy with severe damages to the GIT. Caecal coccidiosis with the caecum filled with frank blood (arrow) (M); dilated caeca (arrow) in histomoniasis with the caecum filled with blood clots and mucosal debris (N); severe typhlitis (arrow) with sloughing of the intestinal mucosa due to intestinal coccidiosis (O); and intestinal coccidiosis with haemorrhagic and necrotic foci (arrow) on the intestinal serosa (P)

In this study, *Strongyloides avium* as well as other nematodes and cestodes of chickens, were isolated from turkey flocks which agreed with the report of Sa'idu *et al.* (1994).

The only GIT parasitic disease diagnosed in pigeons was helminthiasis as three cases of *Ascaridia columbae* were recorded but none for coccidiosis or any other GIT protozoan diseases over the study period. This may be attributable to the type of husbandry practice where domestic pigeons are sporulation of *Eimeria* oocysts before infection can occur. This finding agreed with other studies in Nigeria by Muhammed *et al.* (2019) and in Brazil by Vaz *et al.* (2017), which showed helminth parasites to be a problem in domestic and feral pigeons more than GIT protozoan parasites.

The rates of occurrence of helminthiasis in other types of poultry are lower than that of GIT protozoan diseases. This is in contrast to the work of Abdu (1986) that reported helminthiasis to be the major parasitic disease of local chickens in Zaria, Kaduna State, Nigeria. The difference can be explained by the variation in study design and the fact that though most poultry productions are done on deep litter systems, the generation time of coccidian parasites is shorter with a high rate of turnover compared to the relatively long-life cycles of helminths which could be direct or indirect.

However, the monthly prevalence of helminthiasis showed increased cases at periods corresponding to intense rainfall and cold months just before the intense dry and windy months. This finding has implications for the control of helminthiasis, which should be targeted towards these periods. The trend showed the surge in cases of helminthiasis to correspond to the period of the beginning and ending of rain which makes most farmers to initiate chemotherapy and other control measures within this period with favourable outcomes leading to a decline of cases thereafter.

Among the poultry age group, birds of 21 weeks and older are more likely to suffer from helminthiasis than any other age group, while birds of 3 – 6 weeks are more likely to suffer from coccidiosis alone than any other age group. These findings are similar to the reports of other workers such as Oparah *et al.* (2014), which may be related to the exposure of older birds to the helminth parasites after completion of their life cycles over a long period with the high turnover of the parasites in contrast to young birds whose age is not up to the prepatent period of helminth parasites but their naïve immune status makes them more susceptible to coccidiosis.

The composite monthly prevalence of GIT parasitic diseases over the period of the study showed a steep rise from the month of May steadily to peak around August and September. These months mark the beginning and end of the rainy season in the Jos, Plateau state, which corresponds to the spring and summer rise in parasites multiplication and housed in lofts or nestling cages and not reared on the floor, which may enhance infections as previously reported (Dube *et al.*, 2010; Hassan *et al.*, 2020).

In conclusion, GIT parasitic diseases are still a problem in poultry production in our environment in spite of the rapid change from traditional or extensive system to the intensive system of poultry production largely because most birds are raised on the floor with poor litter management and relatively high humidity of the environment in Jos, Plateau state. It is recommended that proper attention should be given to good litter management and rational use of drugs to control GIT parasitic diseases of poultry in Jos, Plateau State, Nigeria.

Conflict of Interest

The authors declare that there is no conflict of interest.

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