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ORIGINAL ARTICLE

Gastrointestinal parasites of different avian species in Ilorin, North Central Nigeria

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ABSTRACT

Objective: The current study aimed to determine the prevalence, infection burden, and risk factors associated with the occurrence of gastrointestinal (GI) parasites in different avian species in Ilorin, Nigeria.

Materials and Methods: This study was conducted in Ilorin, involving 597 fecal samples and GI tracts from a variety of sold and slaughtered avian species. The study was conducted between September 2017 and February 2018. Fecal samples were examined using floatation technique, while the GI tracts were examined for gross helminths and its content were subjected to the direct wet mount examination. Data were analyzed using percentages (descriptive) and the *Chi*-square (χ^2) test (inferential). $p < 0.05$ was considered significant for all analysis.

Results: Ten GI parasites were detected with *Eimeria* species (32.83%), *Ascaridia galli* (30.15%) and *Heterakis gallinarum* (24.79%) as the most prevalent ones. Multiple parasites co-infection was recorded in all the avian species: broilers (77.78%), layers (33.33%), cockerels (45.16%), indigenous chickens (17.91%), ducks (69.70%), pigeons (94.12%), turkeys (47.83%), and guinea fowls (77.36%). Pigeons (100.00%) and turkeys (95.65%) were the most infected avian species. Age, sex, and avian types were significantly ($p < 0.05$) associated with the occurrence of GI parasites infection.

Conclusion: This study gives a reflection of the GI parasites fauna of avian species in Nigeria. The GI parasites are endemic among different avian species in Ilorin, North Central Nigeria. Knowledge on the epidemiology of these parasites is important in instituting a good preventive and control measures against GI parasites, so as to have maximum production and reproduction effects in the poultry industry.

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Introduction

Avian species refers basically to domestic birds such as chickens (including indigenous breed, broilers, layers, and cockerels), turkeys, ducks, guinea fowls, peasants, pigeons, and more recently ostriches that are kept for meat or egg production [1].

Gastrointestinal (GI) parasites are considered as major problems for efficient production of avian species, which lead to economic losses due to reduced productivity, decreased feed conversion ratio and poor weight gain, reduced egg production, catarrh, anorexia, diarrhea, intestinal obstruction, emaciation, anemia, weakness, paralysis, poor feathering, and even death [2–4].

Parasites that commonly invade the GI tract of avian species in the broad sense are helminths and protozoans [5]. Helminth parasites of poultry are generally cestodes, nematodes, and trematodes, of which the nematodes are regarded as the most important group considering both number of species and the harms they cause. Only few numbers of cestodes and trematodes are known to parasitize poultry [6,7]. *Eimeria* is the major GI protozoan affecting avian species in their intestinal tracts [8]. Multiple GI parasitic infection is a common phenomenon in poultry, affecting their normal activities which is manifested mainly by severe pains [9].

Poultry acts as an important source of animal protein (meat and egg) for man [7]. Due to the steady increase

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in the world human population, the demand for protein of animal origin as a vital component of nutrients is very important [10]. Poultry production is the most efficient and economical means of meeting this demand due to the relatively small capital required to start off, the ease of feed availability, the fast maturity of the birds, and the fewer social and religious taboos [9,11]. In most countries in the world, including Nigeria, poultry has become one of the most popular components of the livestock industry [11].

Among the African countries, Nigeria has the largest poultry population that estimates over 130–150 million [1,12]. Despite the enormous importance of poultry to the economy of Nigeria, there seems to be limited information on the epidemiology of GI parasites of different avian species in Ilorin. This study is aimed at determining the prevalence, infection burden, and risk factors associated with the occurrence of GI parasites in different avian species in Ilorin, North Central Nigeria.

Materials and Methods

Study area and duration

This study was conducted in Ilorin (comprising of Ilorin West, Ilorin East, and Ilorin South Local Government Areas) of Kwara State (Fig. 1). Kwara State is located in the North Central part of Nigeria. Kwara State is located within latitude 8° 30′N and longitude 5° 00′E and covers an area of 35,705 Km^2 (13,947.27 Sq. miles) [13]. Ilorin is situated almost at the middle of Nigeria, and hence, it is popularly referred to as the "connecting city of Nigeria." Simple random sampling technique was used for this study and it spanned between September 2017 and February 2018.

Sampling

A total of 597 fecal samples and GI tracts were collected from individual avian species from poultry markets (avian species were brought from all over Nigeria to be sold in Ilorin)

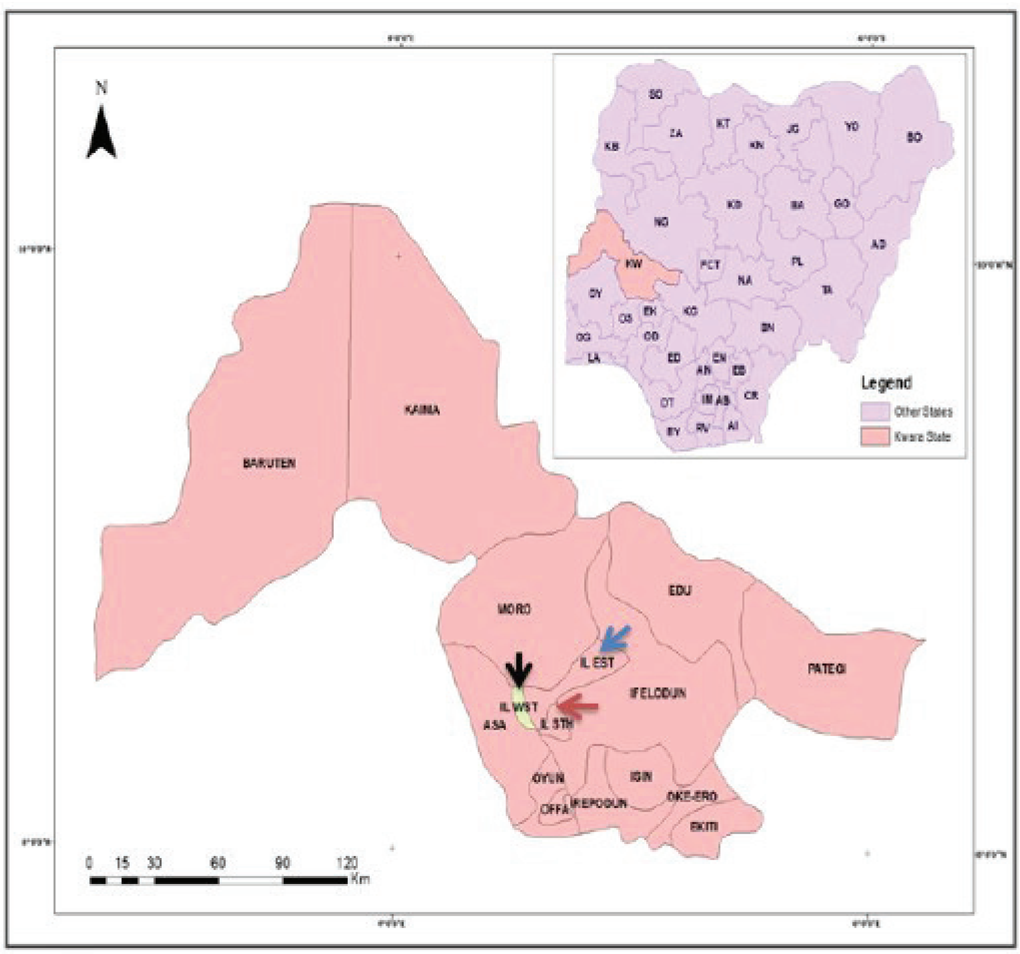

Figure 1. Map of Kwara State showing the location of Ilorin west, Ilorin east, and Ilorin south (sample areas). Insert map shows the location of Kwara State in Nigeria.

and poultry slaughterhouses. Fecal samples were collected immediately after defecation, while the intestinal tracts were collected after dressing of slaughtered avian species. The samples were collected into sterile and well-labeled polyethylene bags and then transported in a cool box to the Parasitology laboratory of the Department of Veterinary Parasitology and Entomology, Faculty of Veterinary Medicine, University of Ilorin for immediate parasitological analysis, and sometimes stored at 4°C when not analyzed immediately. Records on age, sex, and type of avian species of the sampled bird were documented at the time of sampling.

Processing of fecal samples and GI tracts

Fecal samples were processed using the simple floatation technique by using saturated salt solution. The GI tracts were opened longitudinally with the aid of sterile scissors and examined for the presence of helminth parasites [2]. The adult parasites removed from the GI tracts were preserved in 10% formalin for identification. Contents from the guts were microscopically examined by the direct wet mount method for the presence of helminth eggs and *Eimeria* oocysts. The simple flotation technique and the direct wet mount examination were carried out as described by Soulsby [5] and Taylor et al. [14].

Identification of helminth eggs, Eimeria oocysts, and adult helminths

Helminth eggs, *Eimeria* oocysts, and adult helminths from the processing methods mentioned above were identified using the morphological keys as earlier described [5,14].

Determination of positivity

Samples positive for one or more of the examinations carried out (the simple floatation technique, direct wet mount nor adult helminths examination) were considered positive for helminth(s) and *Eimeria*.

Data and statistical analysis

The data were analyzed using "Microsoft Excel 2010" and statistical package for social science; version 22.0, Chicago, USA. *Chi*-square (χ^2) test and odds ratios with 95% confidence interval (CI) were used to determine the association between each risk factor and the presence or absence of GI parasites. The odds ratios were calculated with respect to a reference category as indicated in the respective tables. $p < 0.05$ was considered significant.

Results

Total species prevalence of GI parasites

In this study, 10 GI parasites were detected overall, comprising of nine helminth species and one protozoan species. Of the 597 avian species sampled, 196 were infected with *Eimeria* species representing 32.83% (95% CI = 29.15–36.68) of the sampled population. *Ascaridia galli* (30.15%; 95% CI = 26.57–33.93) was the second most prevalent GI parasite, followed by *Heterakis gallinarum* (24.79%; 95% CI = 21.45–28.37). *Subulura brumpti*, *Raillietina echinobothrida,* and *A. columbae* were the least prevalent parasites representing 3.85% (95% CI = 2.52–5.64), 3.35% (95% CI = 2.1–5.04), and 2.51% (95% CI = 1.47–4.02), respectively (Fig. 2).

Prevalence of GI parasites among different avian species

Eimeria species were detected in all avian types. *Ascaridia galli* and *H. gallinarum* were also detected in all avian types, while other helminth species were not. *Eimeria* species was the most prevalent parasite recorded in broilers (77.78%; 95% CI = 65.28–87.36), layers (49.02%; 95% CI = 35.55–62.60), cockerels (45.16%; 95% CI = 28.47–62.72), indigenous chickens (23.88%; 95% CI = 19.54–28.67), and turkeys (52.17%; 95% CI = 32.13–71.70). The most prevalent parasite detected in ducks was *A. galli* (72.73%; 95% CI = 55.81–85.80), in pigeons was *A. columbae* (88.24%; 95% CI = 66.27–97.98), and in guinea fowls was *H. gallinarum* (73.58%; 95% CI = 60.55–84.11). Four GI parasites (*Eimeria* species, *A. galli*, *H. gallinarum,* and *Syngamus trachea*) were detected in layers, five parasites in broilers (*Eimeria* species, *A. galli*, *R. tetragona*, *H. gallinarum*, and *S. trachea*), pigeons (*Eimeria* species, *A. galli*, *R. tetragona*, *H. gallinarum*, and *A. columbae*), and turkeys (*Eimeria* species, *A. galli*, *H. gallinarum*, *S. brumpti,* and *Capillaria annulata*). Six GI parasites were detected in cockerels (*Eimeria* species, *A. galli*, *R. tetragona*, *Strongyloides avium*, *H. gallinarum* and *S. trachea*) and ducks (*Eimeria* species, *A. galli*, *H. gallinarum*, *S. brumpti*, *C. annulata,* and *R. echinobothrida*), while nine parasites were detected in the indigenous chickens (*Eimeria* species, *A. galli*, *R. tetragona*, *S. avium*, *H. gallinarum*, *S. trachea*, *S. brumpti*, *C. annulata,* and *R. echinobothrida*) (Table 1).

GI parasite(s) infection load (%) of different avian species

All the avian species were infected with single, double, and triple GI parasites. Indigenous chickens and ducks had five GI parasites co-infections with only indigenous chickens recording six GI parasites co-infections. Pigeons were the most infected avian species with 100.0% prevalence; this is followed by turkeys with 95.65% prevalence. Indigenous chickens and ducks recorded the lowest infection rate of 41.79% and 72.73%, respectively. Broilers, cockerels, guinea fowls, and layers recorded the prevalence of 88.89%, 83.87%, 81.13%, and 74.51%, respectively (Table 2).

Risk factors associated with GI helminths infection of avian species

Age, sex, and avian species were significantly ($p < 0.05$) associated with the prevalence of GI helminths. Young birds were

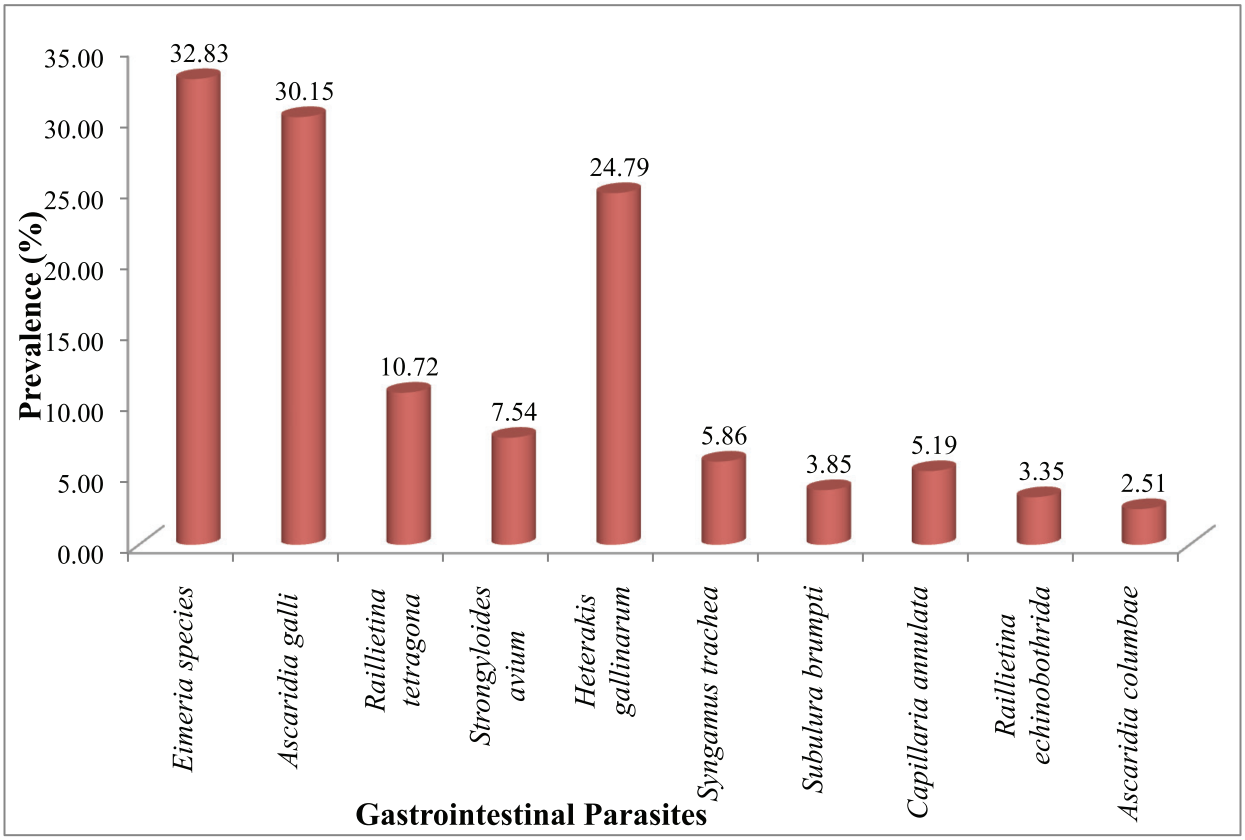

Figure 2. Total species-wise prevalence (%) of GI parasites of avian species in Ilorin, North Central Nigeria.

2.30 times more prone to GI helminths infection than adult birds, while females were 1.42 times more likely to be infected compared to males. All the studied avian species were more prone to GI helminths infection compared to guinea fowls (Table 3).

Risk factors associated with Eimeria infection of avian species

Young birds were 2.52 times more likely to be infected with *Eimeria* species compared to adult birds. Females were 2.18 times more prone to *Eimeria* infection than their male counterpart. The association between age and sex of poultry with the prevalence of *Eimeria* infection was significant ($p < 0.05$). Layers and indigenous chickens were significantly ($p < 0.05$) less susceptible to *Eimeria* infection compared to guinea fowls (Table 4).

Discussion

GI parasites infection plays an important role in causing hidden and devastating economic losses in the overall production and reproduction of poultry [10]. The results of our study showed that avian species in Ilorin, North Central Nigeria are commonly infected with a variety of GI parasites as 10 parasites were detected. This body of evidence differs from previous studies conducted in Nigeria by Jegede et al. [2], Udoh et al. [11], and Afolabi et al. [15], who reported nine, eight, and six species of GI parasites in poultry of Kaduna State, Ondo State, and the Federal Capital Territory, respectively. The higher number of GI parasites recorded in this study may be attributed to seasonal and climatic differences and the large range of avian species we studied. Similar to our finding, Lawal et al. [8] reported a 31.8% prevalence of *Eimeria* infection in poultry from Maiduguri, Borno State of Nigeria. *Eimeria* prevalence ranging from 7.7% [15] to 77.0% [16] has been reported among poultry in Nigeria, suggesting that *Eimeria* infection in poultry is endemic in Nigeria [10,17].

Eimeria species, *A. galli*, and *H. gallinarum* were the most prevalent GI parasites diagnosed among chickens (broilers, layers, cockerels, and indigenous chickens) in our study. This may be attributed to the fact that *Eimeria* species are ubiquitous anywhere poultry are reared [18] and that *A. galli* and *H. gallinarum* are helminths that affect a wide range of avians species [14]. Also, the direct type of life cycle of *A. galli* and *H. gallinarum* may facilitate its infections among avian species. Similarly, Jegede et al. [2] and Afolabi et al. [15] documented that these parasites

Table 1. Prevalence of GI parasites among different avian species in Ilorin, North Central Nigeria.

Avian types (N)	GI Parasites	*n* (Prevalence (%))	95% CI
Broilers (54)	*Eimeria* species	42 (77.78)	65.28; 87.36
	Ascaridia galli	36 (66.67)	53.35; 78.23
	Raillietina tetragona	6 (11.11)	4.63; 21.68
	Heterakis gallinarum	24 (44.44)	31.65; 57.82
	Syngamus trachea	6 (11.11)	4.63; 21.68
Layers (51)	*Eimeria* species	25 (49.02)	35.55; 62.60
	Ascaridia galli	17 (33.33)	21.46; 47.05
	Heterakis gallinarum	10 (19.61)	10.41; 32.17
	Syngamus trachea	4 (7.84)	2.54; 17.84
Cockerels (31)	*Eimeria* species	14 (45.16)	28.47; 62.72
	Ascaridia galli	10 (32.26)	17.69; 50.01
	Raillietina tetragona	4 (12.90)	4.24; 28.25
	Strongyloides avium	3 (9.68)	2.52; 24.12
	Heterakis gallinarum	9 (29.03)	15.18; 46.64
	Syngamus trachea	5 (16.13)	6.16; 32.19
Indigenous chickens (335)	*Eimeria* species	80 (23.88)	19.54; 28.67
	Ascaridia galli	45 (13.43)	10.09; 17.41
	Raillietina tetragona	20 (5.97)	3.79; 8.91
	Strongyloides avium	20 (5.97)	3.79; 8.91
	Heterakis gallinarum	35 (10.45)	7.50; 14.08
	Syngamus trachea	10 (2.99)	1.53; 5.26
	Subulura brumpti	5 (1.49)	0.55; 3.28
	Capillaria annulata	10 (2.99)	1.53; 5.26
	Raillietina echinobothrida	15 (4.48)	2.62; 7.12
Ducks (33)	*Eimeria* species	8 (24.24)	11.94; 40.89
	Ascaridia galli	24 (72.73)	55.81; 85.80
	Heterakis gallinarum	17 (51.51)	34.70; 68.07
	Subulura brumpti	8 (24.24)	11.94; 40.89
	Capillaria annulata	14 (42.42)	26.55; 59.58
	Raillietina echinobothrida	5 (15.15)	5.77; 30.44
Pigeons (17)	*Eimeria* species	11 (64.71)	40.49; 84.27
	Ascaridia galli	5 (29.41)	11.66; 53.68
	Raillietina tetragona	7 (41.12)	20.11; 65.03
	Heterakis gallinarum	10 (58.82)	34.97;79.89
	Ascaridia columbae	15 (88.24)	66.27; 97.98
Turkeys (23)	*Eimeria* species	12 (52.17)	32.13; 71.70
	Ascaridia galli	9 (39.13)	21.05; 59.80
	Heterakis gallinarum	4 (17.39)	5.78; 36.80
	Subulura brumpti	6 (26.09)	11.31; 46.57
	Capillaria annulata	7 (30.43)	14.39; 51.14
Guinea fowls (53)	*Eimeria* species	4 (7.55)	2.44; 17.21
	Ascaridia galli	34 (64.15)	50.64; 76.16
	Raillietina tetragona	27 (50.94)	37.61; 64.17
	Strongyloides avium	22 (41.51)	28.87; 55.06
	Heterakis gallinarum	39 (73.58)	60.55; 84.11
	Syngamus trachea	10 (18.87)	10.00; 31.06
	Subulura brumpti	4 (7.55)	2.44; 17.21

N = Number of Avian type sampled; *n* = Number positive for GI parasite, CI = confidence interval.

were the most predominant species affecting chickens in Nigeria. The high prevalence rate of *Eimeria* species recorded in broilers may be associated with the fact that this chicken type is raised intensively and on a deep litter with a high level of water spillage in the litter in most cases.

We observed *A. galli* and *H. gallinarum* to be the most prevalent helminth among ducks. An earlier study carried out on ducks in Nigeria reported *A. galli* and *H. gallinarum* to be the most predominant helminths with *Eimeria* species been the most prevalent protozoan [19,20]. *A. galli* and *H. gallinarum* have been reported to be the most prevalent parasites of ducks in Tanzania [21]. *Eimeria* species, *A. galli*, *R. tetragona*, *H. gallinarum*, and *A. columbae* were the parasites detected among pigeons in this study with *A. columbae* been the most prevalent. These parasites have been detected among pigeons in Nigeria [17,22,23] with *A. columbae* been of high prevalence [17].

Table 2. GI parasite(s) infection load (%) of different avian species in Ilorin, North Central Nigeria.

Avian species (*N*)	1 GI Parasite infection	2 GI Parasites infection	3 GI Parasites infection	4 GI Parasites infection	5 GI Parasites infection	6 GI Parasites infection	Total Positive infections (%)	Negative infection (%)
Broilers (54)	6 (11.11)	18 (33.33)	24 (44.44)	0 (0.00)	0 (0.00)	0 (0.00)	48 (88.89)	6 (11.11)
Layers (51)	21 (41.18)	16 (31.37)	1 (1.96)	0 (0.00)	0 (0.00)	0 (0.00)	38 (74.51)	13 (25.49)
Cockerels (31)	12 (38.71)	10 (32.26)	3 (9.68)	1 (3.23)	0 (0.00)	0 (0.00)	26 (83.87)	5 (16.13)
Indigenous chickens (335)	80 (23.88)	45 (13.43)	5 (1.49)	0 (0.00)	5 (1.49)	5 (1.49)	140 (41.79)	195 (58.21)
Ducks (33)	1 (3.03)	6 (18.18)	9 (27.27)	4 (12.12)	4 (12.12)	0 (0.00)	24 (72.73)	9 (27.27)
Pigeons (17)	1 (5.88)	6 (35.29)	5 (29.41)	5 (29.41)	0 (0.00)	0 (0.00)	17 (100.00)	0 (0.00)
Turkeys (23)	11 (47.83)	7 (30.43)	3 (13.04)	1 (4.35)	0 (0.00)	0 (0.00)	22 (95.65)	1 (4.35)
Guinea fowls (53)	2 (3.77)	3 (5.66)	20 (37.74)	18 (33.96)	0 (0.00)	0 (0.00)	43 (81.13)	10 (18.87)

N = Number of Avian type sampled

Table 3. Risk factors associated with GI helminths infection of avian species in Ilorin, North Central Nigeria (*n* = 597).

Variables	N	Helminth +ve (%)	OR (95% Cl)	*P*
Age				
Young	170	79 (46.47)	2.30 (1.59; 3.33)	<0.01[b]
Adult [a]	427	117 (27.40)	1.00	
Sex				
Female	297	109 (36.70)	1.42 (1.01; 2.00)	0.04[b]
Male [a]	300	87 (29.00)	1.00	
Avian species				
Broilers	54	42 (77.78)	40.64(13.00; 156.00)	<0.01[b]
Layers	51	25 (49.02)	11.49 (3.82; 42.29)	<0.01[b]
Cockerels	31	14 (45.16)	9.76 (2.93; 38.68)	<0.01[b]
Indigenous chickens	335	80 (23.88)	3.83 (1.45; 12.83)	<0.01[b]
Ducks	33	8 (24.24)	3.85 (1.06; 15.95)	0.04[b]
Pigeons	17	11 (64.71)	20.83 (5.23; 98.51)	<0.01[b]
Turkeys	23	12 (52.17)	12.75 (3.57; 53.67)	<0.01[b]
Guinea fowls [a]	53	4 (7.55)	1.00	

N = Number in each category; [a] Reference category; [b] Statistically Significant; OR = odds ratio; CI = confidence interval.

High prevalence of *Eimeria* species and *A. galli*, and moderate prevalence of *C. annulata* and *S. brumpti* in turkeys were observed in this study. This corroborates with earlier reports by Udoh et al*.* [11] and Dauda et al*.* [10] who reported a similar finding in their study conducted in Kaduna and Plateau States of North Central Nigeria, respectively. Our finding in agreement with previous studies suggests that these are the parasites of concern affecting turkeys in the North Central part of Nigeria. Our study revealed that guinea fowls are majorly infected with *H. gallinarum* and *A. galli* with moderate to minimal infection rate of *R. tetragona*, *Strongyloides avium*, *S. trachea*, *S. brumpti*, and *Eimeria* species. This body of evidence supports previous studies conducted in Nigeria [24,25].

Common species of GI parasites were detected among the different studied avian species. This might be due to the fact that these avian species are raised in the same area with free access of wild birds. In some cases, avian species shared their habitation, food, and water with each other, through which parasitic infections may be transmitted among themselves [19].

The indigenous chickens were the only avian type infected with nine of the ten GI parasites recorded and were infected with six GI parasites co-infection. The indigenous chickens seek their food in the superficial layers of the soil contaminated with living organisms, insects and worms, and intermediate host of parasites, which may be a reason for our findings; thus, the chickens are infected with parasitic infections continuously [7,26,27]. The poor management practice in which this avian species are raised and the poor or no veterinary medical care given may also be another reason for our finding. The 100.0% and 95.7% infection rate recorded in pigeons and turkeys, respectively, cannot be readily explained, as it may be associated with

Table 4. Risk factors associated with *Eimeria* infection of avian species in Ilorin, North Central Nigeria (n = 597).

Variables	N	*Eimeria* +ve (%)	OR (95% CI)	*P*
Age				
Young	170	109 (64.12)	2.52 (1.75; 3.65)	<0.01[b]
Adult [a]	427	177 (41.45)	1.00	
Sex				
Female	297	171 (57.58)	2.18 (1.57; 3.03)	<0.01[b]
Male [a]	300	115 (38.33)	1.00	
Avian species				
Broilers	54	42 (77.78)	0.82 (0.31; 2.12)	0.68
Layers	51	30 (58.82)	0.34 (0.13; 0.81)	0.01[b]
Cockerels	31	22 (70.97)	0.57 (0.20; 1.66)	0.30
Indigenous chickens	335	90 (26.87)	0.09 (0.04; 0.17)	<0.01[b]
Ducks	33	24 (72.73)	0.62 (0.22; 1.80)	0.38
Pigeons	17	17 (100.00)	X	X
Turkeys	23	18 (78.26)	0.84 (0.25; 3.06)	0.77
Guinea fowls [a]	53	43 (81.13)	1.00	

N = Number in each category; [a] Reference category; [b] Statistically Significant; OR = odds ratio; CI = confidence interval; *X* = Not applicable.

genetic, behavioral, and husbandry conditions. The multiple GI parasites infections reported among avian species might be attributed to their feeding preference, favorable climatic conditions, and rate of environmental contamination with viable worm eggs and sporulated oocysts at a particular time, which to a great extent can determine the establishment of mixed infection [10,11].

Age, sex, and species diversity are established risk factors associated with the occurrence of GI parasites infections in avian species [1,7,8,10]. The high prevalence of GI helminths and *Eimeria* species documented in young avian species compared to adults suggests that GI parasites infections usually occur at early ages [28]. Similarly, Ola-Fadunsin [1], Radfar et al. [9], Dauda et al. [10], Balarabe et al. [22] and Attah et al. [29] reported a higher prevalence of GI parasites in the young than adult avian species, chickens, turkeys, pigeons and guinea fowls respectively. The higher prevalence recorded in the young birds could be attributed to the immature immune system in young avian species leaving them susceptible to infections [1]; also the poor acclimatization of young avian species to the immediate environment could have led to our findings. *Eimeria* infections appear to reach climax at over 7 weeks of age, and as age advances, most poultry species will develop immunity and increase resistance to the disease (coccidiosis) [14]. Biu et al. [30] postulated that young poultry are mostly affected by GI parasites and they show severe clinical manifestation in heavy parasite burden while adult may sustain parasitic infection but serve as reservoir to maintain the continuous contamination of the environment and circulation of infection among poultry species on free-range, which complicate adequate control measures.

Both male and female were infected with helminth parasites and *Eimeria* species as observed by Jegede et al. [2] and Lawal et al. [8]. Despite the fact that these parasitic conditions are not sex bias, we observed that females were more prone to helminths and *Eimeria* infections than male. In line with our findings, Matur et al. [6] reported a higher prevalence of GI helminths in female than male in their study on exotic and local chickens. Atsanda et al. [31] reported that female guinea fowls were more prone to GI helminths than male, and Pam et al. [32] reported a higher prevalence of *Eimeria* species in exotic female chickens than its male counterpart. Contrary, Dauda et al. [10] reported a higher prevalence of GI helminths in male turkeys than female. Attah et al. [29] documented a higher prevalence of GI helminths in male chickens and guinea fowls than female. The report from this study may be attributed to the feeding nature of female avian species that are known to be more voracious in their feeding habits, especially during egg production, than the males which remain largely selective [6]. The frequent scratching of the ground by female avian species as they find food for their chicks and in the process pick up helminth eggs, sporulated *Eimeria* oocysts, and infected intermediate hosts of helminths such as earthworms and beetles may have resulted to the higher prevalence recorded in the female. Earthworms, beetles, flies, grasshoppers, and cockroaches are intermediate hosts of some helminth parasites [9,14]. Physiological stress of brooding may also have resulted to the higher prevalence recorded in female as the development of parasites in the host is largely dependent on stress factors and the immune system of the host [14].

Management practice, husbandry, and species differences may be the reason for an undefined prevalence among the different avian types as we observed.

Conclusion

Since the studied avian species were brought from all over Nigeria to be sold in Ilorin, this study, therefore, gives a reflection of the GI parasites fauna of avian species in Nigeria. GI parasites are endemic among different avian species in Ilorin, North Central Nigeria with *Eimeria* species, *A. galli,* and *H. gallinarum* been the most prevalent. Age, sex, and avian types were factors associated with the prevalence of GI parasites infection. Knowledge on the epidemiology of these parasites is important for achieving fruitful preventive and control measures against GI parasites. There is a need for an improved veterinary medical attention and education of poultry farmers on the need to regularly and periodically treat their flock against GI parasites, as this will improve the economic value of the poultry industry in Nigeria.

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Conflict of Interest

The authors declared that there is no conflict of interest regarding the research, authorship, and publication of this article.

Authors' contribution

Shola D. Ola-Fadunsin designed the experimental study, involved in the sampling and laboratory work, analyzed the data, and prepared the manuscript. Isau A. Ganiyu, M. Rabiu, and K. Hussain were involved in the sampling and laboratory work. Idiat M. Sanda was involved in the laboratory work and Patricia I. Uwabujo and Nathan A. Furo were involved in the sampling. All authors read and approved the final manuscript.

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