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Gastrointestinal helminths of Chickens and associated risk factors: A cross-sectional study in live bird markets in Maiduguri, Borno State, Nigeria.

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Abstract

Gastrointestinal helminth infections are a constraint to poultry production, particularly in extensive and backyard systems where chickens are exposed to infective stages in the environment. This cross-sectional study estimated the prevalence of gastrointestinal helminth infection and examined associated host factors among chickens sold in selected live bird markets in Maiduguri, Borno State, Nigeria. A total of 300 gastrointestinal tracts were examined using standard parasitological techniques for helminth recovery and identification. Descriptive statistics were used to summarize infection prevalence and parasite composition. Chi-square tests were used to assess associations between infection status and host characteristics. Overall, 52.3% of sampled chickens had gastrointestinal helminths. Single and mixed infections were recorded in 30.7% and 21.7% of sampled birds, respectively. Nematodes were the predominant helminth group, with a reported proportion of 64.3%, compared with 19.0% for cestodes. *Ascaridia galli* was the most frequently reported taxon (33.7%), followed by *Heterakis* spp. (23.8%) and *Capillaria* spp. (14.5%). Infection status was significantly associated with sex, age, and breed. Infection prevalence was higher in female chickens, younger birds, and village breeds than in their respective comparison groups. More than half of the chickens sampled at the selected markets were infected, and roughly one in five carried mixed infections. The observed associations identify groups with higher infection prevalence at sampling. Because the study was cross-sectional and the chi-square tests assessed individual associations, the findings cannot establish whether host characteristics independently influenced infection risk. The prevalence estimate applies to the sampled market chickens and provides a baseline for local surveillance.

Keywords

Gastrointestinal Helminths;
Poultry;
Live Bird Markets;
Risk Factors;
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Introduction

Poultry production plays an important role in global food security and economic development, particularly in low- and middle-income countries where backyards and semi-intensive systems contribute significantly to the animal protein supply (Gueye, 2000; Mottet *et al.*, 2017). However, infectious diseases remain a major challenge to sustainable poultry production, with gastrointestinal parasitic infections amongst the most prevalent health challenges (Abd El-Ghany, 2022). Gastrointestinal helminths negatively affect poultry production through reduced growth performance, impaired egg production and increased susceptibility to secondary infections, leading to economic losses (Makouloutou-Nzassi *et al.*, 2024; Nemathaga *et al.*, 2023).

Helminths affecting poultry are generally classified into nematodes, cestodes, and trematodes, with nematodes being the most frequently reported group due to their direct life cycles and environmental resilience. Among these, *Ascaridia galli*, *Heterakis gallinarum*, and *Capillaria* species are widely distributed and are associated with intestinal damage, impaired nutrient absorption, and compromised immune responses (Permin and Hansen, 1998; Ali *et al.*, 2023). In addition, some helminths can serve as carriers or facilitators of other pathogens, such as *Histomonas meleagridis*, thereby increasing disease burden and mortality in affected flocks (McDougald, 2005).

The epidemiology of gastrointestinal parasites is influenced by multiple factors, including management practices, environmental conditions, and host characteristics such as age, sex, and breed. Free-range and backyard production systems, which are common in many African countries, often expose birds to infective stages present in soil, water, and intermediate hosts, resulting in a higher prevalence than intensive systems (Leeson and Summers, 2009; Cantin-Rosas *et al.*, 2025). Live bird markets represent an important epidemiological interface where birds originating from different production systems are aggregated, potentially facilitating parasite transmission and dissemination across regions. Therefore, this study aimed to determine the prevalence, species distribution, and risk factors associated with gastrointestinal helminth infections in chickens sold in selected live bird markets in Maiduguri, Northeast Nigeria.

MATERIALS AND METHODS

Study Area

The study was conducted in Maiduguri Metropolis, which comprises Maiduguri Metropolitan Council and parts of Jere, Konduga, and Mafa Local Government Areas. Maiduguri, the administrative hub of Borno State, is in North-eastern Nigeria. Specifically, it lies between latitudes 11° 46´ 18"N and 11° 53´ 21"N, and longitudes 13° 02´ 23" E and 13° 14´ 19"E. As the economic and cultural centre of North-eastern Nigeria, Maiduguri boasts a vast land area of 137,356 square kilometres (Abatcha et al., 2024). The city is rapidly
urbanizing, with a population of 822,000 as of 2022 (Abatcha et al., 2024).

Sample size determination

The sample size was determined using the formula described by Thrusfield and Christley (2018) for cross-sectional studies:

$$n = \frac{Z^2 \times P_{exp}(1 - P_{exp})}{d^2}$$

where *n* is the minimum required sample size, *Z* is the standard normal deviation at the 95% confidence level (1.96), *Pexp* is the expected prevalence, and *d* is the desired precision (0.05).
An expected prevalence of 16.9% (Bello *et al.*, 2025) resulted in a minimum sample size of 216 chickens. However, a total of 300 samples were collected to increase precision.

Study Design

A cross-sectional study was conducted in Maiduguri metropolis, Borno State, northeastern Nigeria. Sampling was carried out in six major live bird markets within the metropolis, namely Monday Market, Custom Market, Milk Shop, Moromti, Mafa, and the University of Maiduguri poultry slaughter slabs. Fifty fresh gastrointestinal tracts were collected from slaughtered chickens per location

Sample Collection

The samples were collected immediately after evisceration in a polythene bag and labelled based on their sex, age category and breed. After a day's

collections samples were immediately transported in an ice packed box to the Veterinary Parasitology and Entomology Laboratory, Faculty of Veterinary Medicine, University of Maiduguri, Nigeria, for parasitological examination.

Parasitological examination and identification

The recovery and morphological characterization of gastrointestinal helminths were performed using an adapted protocol based on the procedures reported by Elijah *et al*. (2022). The gastrointestinal tract was cut with the aid of a sharp pair of scissors, and different sections, viz., proventriculus, small and large intestines were cut open and placed in a Petri dish containing normal saline. The open part was then drawn firmly several times between the fingers to slip off all the intestinal contents and parasites. Each Petri dish was examined for adult worms visible to the naked eye, which were further isolated and washed by shaking in normal saline. Thereafter, they were picked with forceps and placed in 10% formalin solution for preservation. Afterwards, the sample (adult helminth) was soaked in borax carmine solution for 48 hours.

The samples were then passed through increasing concentrations of alcohol (25%, 50%, 75%, 100%) to clear the stain. For each concentration (%) of alcohol, the sample was allowed to incubate for 2 hours. Finally, the helminths were cleared using clove oil for 30 minutes. The cleared sample was then removed and placed on a cleaned glass slide, and a drop of DPX mountant was added to each slide and covered with a cover slip. The mounted slides were then allowed to air dry and viewed under a stereoscopic microscope. Cestodes were identified under a stereomicroscope using the size and disposition of suckers, testes, and ovaries, using the via keys as described by Taylor *et al*. (2016), whereas nematodes were similarly identified using features such as intestines, reproductive organs and teeth as described by Zajac *et al*. (2021).

The flotation method of Soulsby (1982) was used to examine parasitic eggs with saturated sodium chloride (NaCl) as the flotation medium. The procedure was conducted by placing the intestinal contents in a universal bottle containing 10 ml of flotation medium. The mixture was filtered through a double-layer sieve into a universal bottle, and more medium was added until the meniscus formed. A cover slip was placed gently on the universal bottle and allowed to stand for 10 minutes. The cover slip was then carefully removed, placed on a grease-free glass slide and examined immediately for parasite eggs under ×10 and ×40 objectives.

Statistical analysis

The data were analysed using GraphPad InStat 3.10 software (GraphPad Software, Inc., San Diego, CA, USA). Descriptive statistics were used to calculate the prevalence rates of gastrointestinal parasites. Associations between infection status and potential risk factors (sex, age, breed and location) were assessed using chi-square tests. Odds ratios (OR) with 95% confidence intervals (CI) were calculated to evaluate the strength of associations. Statistical significance was set at $p \leq 0.05$.

RESULTS

Overall prevalence of gastrointestinal parasites

Among the 300 chickens examined, 157 were positive for gastrointestinal parasites, resulting in an overall prevalence of 52.3% (157/300). Single infections were detected in 92 birds (30.7%), whereas mixed infections were detected in 65 birds (21.7%) (Table 1).

Table 1. Overall prevalence of gastrointestinal parasites in the chickens examined

Infection type	No. examined	No. positive (%)	95% CI
Single infection	300	92 (30.7)	25.7–36.1
Mixed infection	300	65 (21.7)	17.4–26.7
Total prevalence	**300**	**157 (52.3)**	46.7–58.0

Species-specific prevalence of gastrointestinal parasites

Nematodes were the predominant parasite group, identified in 193 birds (64.3%), whereas cestodes were detected in 57 birds (19.0%) (Table 2). Among the nematodes, *Ascaridia galli* had the highest prevalence (33.7%), followed by *Heterakis* spp. (23.8%) and *Capillaria* spp. (14.5%). Other nematodes detected included *Strongyloides avium* (11.9%), *Acuaria spiralis* (8.8%), and *Subulura brumpti* (7.3%). Among cestodes, *Raillietina tetragona* was the most prevalent species (49.1%), followed by *R. echinobothridia* (28.1%) and *Davainea proglottina* (22.8%) (Table 2).

Table 2. Species-specific prevalence of gastrointestinal parasites

Parasite species	No. positive (%)	95% CI
Nematodes		
Ascaridia galli	65 (33.7)	27.0–40.3
***Capillaria* spp.**	28 (14.5)	9.6–19.5
***Heterakis* spp.**	46 (23.8)	17.6–29.8
Strongyloides avium	23 (11.9)	7.33–16.5
Acuaria spiralis	17 (8.8)	4.8–12.8
Subulura brumpti	14 (7.3)	3.6–10.9
Subtotal	193 (64.3)	58.9–69.7
Cestodes		
Raillietina tetragona	28 (49.1)	36.1–62.1
R. echinobothridia	16 (28.1)	16.4–39.7
Davainea proglottina	13 (22.8)	12.0–33.7
Subtotal	57 (19.0)	14.6–23.4

Risk factors associated with gastrointestinal parasite infection based on sex, age, breed and sample location

Statistical analysis revealed significant associations between gastrointestinal parasite infection and host-related factors. Compared with male chickens, female chickens were significantly more likely to be infected (p = 0.0003; OR = 2.38; 95% CI: 1.50–3.79). Young birds had higher infection rates than did adults (p < 0.001; OR = 4.08; 95% CI: 2.39–6.97). Additionally, village chickens were significantly more prevalent than exotic breeds were (p < 0.001; OR = 7.113; 95% CI: **4.23–11.97**) (Table 3).

Table 3. Risk factors associated with gastrointestinal parasite infection based on sex, age, breed and sample location

Variable	Category	No. examined	No. positive (%)	p value	OR	95% CI
Sex	Female	151	**95**	0.0003	2.38	1.50–3.79
	Male	149	62			
Age	Young	210	131	<0.001	4.08	2.39–6.97
	Adult	90	26			
Breed	Village	178	126	<0.001	7.113	**4.23 -11.97**
	Exotic	122	31			

Discussion

The present study reported a high prevalence (52.3%) of gastrointestinal helminth infections amongst chickens sold in live bird markets in Maiduguri, highlighting the substantial parasite burden within poultry production systems in Borno State. Comparable prevalence rates have been reported in recent studies from the same region, including the 54.8% reported in Borno State (Lawal *et al.*, 2023) and the 56% reported by Gambo *et al.* (2024) in Maiduguri, Borno State. Lower prevalence rates of 16.9% and 44.8% have been reported in chickens slaughtered at Maiduguri Monday Market and Biu Main Market, Borno State (Bello *et al.*, 2025; Usman *et al.* (2026). The difference between our findings and those of Usman *et al.* (2026) at Biu (44.8%) may reflect methodology, as their study relied on faecal flotation alone, whereas this study combined gross recovery of adult worms with flotation of intestinal contents, which detects other infections that egg-based methods cannot identify. Gastrointestinal helminths negatively affect growth performance, feed conversion efficiency, and egg production, resulting in significant economic losses in poultry systems (Makouloutou-Nzassi *et al.*, 2024; Nemathaga *et al.*, 2023).

Nematodes were identified as the predominant class of gastrointestinal parasites, which is consistent with previous epidemiological studies reporting their dominance in indigenous chicken populations (Maina *et al.*, 2017). The high prevalence of nematodes may be attributed to their direct life cycles, which facilitate rapid transmission through contaminated environments without requiring intermediate hosts. Similar findings have been reported in recent epidemiological studies, highlighting the environmental resilience and efficient transmission dynamics of nematodes such as *Ascaridia galli* and *Capillaria* species (Ali *et al.*, 2023; Cantin-Rosas *et al.*, 2025).

Among the identified species, *Ascaridia galli* presented the highest prevalence, followed by *Heterakis* spp., confirming its role as one of the most widespread and economically important helminths in poultry production systems. This parasite has been associated with intestinal pathology, impaired nutrient absorption, and reduced productivity, particularly in extensive production systems where environmental exposure is increased (Ali *et al.*, 2023). Furthermore, these findings also support a review on poultry parasites in Nigeria, where *Ascaridia galli* and *Heterakis* spp. were reported to be widely distributed across all the geopolitical zones of Nigeria (Midala *et al.*, 2025).

This study reported that *Raillietina tetragona* and *Raillietina echinobothridia* had the highest prevalence in the study area. This finding supports a review on poultry parasites in Nigeria by Midala *et al.* (2025), who reported *Raillietina tetragona* and *Raillietina echinobothridia* as the most diagnosed cestodes in Nigeria. The lower prevalence of other helminths relative to Raillietina species may reflect differences in transmission efficiency. Nematodes with direct life cycles, such as Ascaridia galli and Heterakis gallinarum, depend on eggs that develop in litter and soil, where heat, desiccation and exposure to sunlight can reduce their survival, and they are also readily removed by commonly used dewormers such as piperazine and albendazole. Species that depend on earthworms as intermediate or paratenic hosts, such as Capillaria annulata and Syngamus trachea, are likely to be limited by the lower availability of these hosts and their lower consumption by chickens than ants. Cestodes such as Choanotaenia infundibulum depend on houseflies and beetles, whose abundance fluctuates seasonally. In contrast, Raillietina cysticercoids develop within ants, which are abundant throughout the year and are actively eaten by scavenging chickens. The infection is also less effectively controlled by the anthelmintics routinely used by farmers.

Infection was significantly higher in female chickens (62.9%) than in male chickens (41.6%) (OR = 2.38, 95% CI 1.50–3.79, p = 0.0003). Several factors may explain this. Laying hens face greater physiological demands, and egg production is associated with stress, nutritional drain and immune suppression, which may increase susceptibility to helminths. Females also tend to be kept for longer periods in backyard poultry systems, giving them more time to accumulate infections. This finding agreed with the earlier studies of Lawal *et al.* (2023) and Usman *et al.* (2026), both in Borno state, who reported a

significant association between helminth infection in chickens and sex.

The significantly higher prevalence observed in village chickens compared to exotic breeds, with the odds of infection being 7 times higher highlights the strong influence of management systems on parasite epidemiology. Village chickens are typically reared under extensive or scavenging systems, increasing their exposure to infective stages present in soil, water, and intermediate hosts. Recent studies have shown that free-range production systems are associated with higher parasite prevalence due to increased environmental exposure and limited biosecurity practices (Cantin-Rosas *et al.*, 2025). In contrast, exotic breeds raised under more controlled conditions may benefit from improved hygiene practices and routine deworming programs. This finding agrees with previous reports by Agbolade *et al.* (2014), Idika *et al.* (2016), Usman *et al.* (2022) and Usman *et al.* (2026).

Age was also identified as a significant risk factor, with younger birds showing higher infection rates than adults. This might be because of the immature immune systems of young chickens and their lack of acquired immunity, thereby increasing their susceptibility (Nemathaga *et al.*, 2023). Overall, the findings highlight the need for improved biosecurity measures, routine parasite monitoring, and strategic anthelmintic interventions to reduce the gastrointestinal helminth burden and improve poultry productivity in the study region.

Conclusion

This study revealed a high (52.3%) prevalence of gastrointestinal helminth infections among chickens in live bird markets in Maiduguri, with nematodes (64.3%) being the dominant parasite group. Age and breed were significant factors associated with risk of infection, with village chickens and younger birds showing greater susceptibility. Future studies including longitudinal designs and molecular diagnosis are recommended.

Authors' Contributions

SHM conceived and designed the study, collected the samples and data, and analysed the samples. SBB analysed, interpreted the data, drafted the manuscript and edited the manuscript. CAM Interpreted the results and edited the manuscript.. AGB, LJ and IAM supervised the study and critically reviewed the manuscript. All authors read and approved the final manuscript.

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