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Original Research Article

Nematode Parasites in Poultry: Their Prevalence, Species Diversity, and Control Strategies

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Abstract: *Gastrointestinal nematode infections are an important parasitic constraint to poultry production, particularly in low- and middle-income countries where diverse production systems and variable biosecurity measures may facilitate parasite transmission. In Pakistan, large-scale multicenter data on the prevalence, species diversity, and management-related determinants of poultry nematodiasis remain limited.* ***Objective:*** *To determine the prevalence, species diversity, and risk factors associated with gastrointestinal nematode infections in chickens reared under different production systems in Pakistan, and to evaluate the relationship of parasite burden with deworming practices and production performance.* ***Methods:*** *This cross-sectional epidemiological study was conducted across four provinces of Pakistan, including Punjab, Sindh, Khyber Pakhtunkhwa, and Balochistan. A total of 60 farms were selected using stratified sampling, representing commercial broiler, commercial layer, and backyard poultry systems. Twenty chickens were randomly sampled from each farm, yielding 1,200 birds. Individual fresh fecal samples were examined using standard flotation techniques, and eggs per gram (EPG) were quantified by the McMaster method. Nematode species were identified morphologically. Species diversity was assessed using species richness, Shannon diversity index, and Simpson's diversity index. Associations were analyzed using the chi-square test, logistic regression, analysis of variance, and Pearson correlation.* ***Results:*** *Of 1,200 examined birds, 497 were positive for gastrointestinal nematodes, giving an overall prevalence of 41.4%. Prevalence varied significantly by region, ranging from 35.3% in Punjab to 47.0% in Balochistan ($p=0.021$). Infection prevalence was strongly associated with farm type and was highest in backyard flocks (63.8%), followed by commercial layer farms (37.2%) and commercial broiler farms (24.5%) ($p<0.001$). Four nematode taxa were identified: Ascaridia galli, Heterakis gallinarum, Capillaria spp., and Syngamus trachea. Species richness was similar across provinces, with moderate diversity indices. Mean EPG was significantly lower in routinely dewormed flocks than in non-dewormed flocks (210 ± 165 vs 465 ± 188; $p<0.001$). Parasite burden was negatively correlated with body weight ($r=-0.42$, $p<0.001$) and positively correlated with feed conversion ratio ($r=0.37$, $p<0.001$).* ***Conclusion:*** *Gastrointestinal nematode infection is highly prevalent in poultry in Pakistan, particularly in backyard production systems. Routine deworming appears to reduce parasite burden, while heavier infections are associated with poorer production performance. Integrated parasite control strategies may improve poultry health and productivity.*

Keywords: Chickens; Nematoda; Prevalence; Parasite Load; Poultry Diseases mpsia

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Introduction

Gastrointestinal nematode infections are among the most significant parasitic constraints on poultry production worldwide. These helminth parasites colonise various segments of the avian digestive tract, causing clinical disease, impaired nutrient absorption, reduced growth performance, and substantial economic losses to the poultry industry (1). Among domesticated birds, chickens (Gallus gallus domesticus) are the most widely affected species, with infections occurring in both intensive commercial systems and traditional backyard flocks. The global burden of avian nematodiasis has been well-documented, yet significant gaps remain in understanding the epidemiological dynamics across diverse agro-ecological and management systems, particularly in low- and middle-income countries (2).

The major nematode species of veterinary importance in poultry include Ascaridia galli, Heterakis gallinarum, Capillaria spp., and Syngamus trachea. Ascaridia galli, the large intestinal roundworm, is the most prevalent and pathogenic, causing enteritis, villous atrophy, and severe growth retardation in young birds (3). Heterakis gallinarum inhabits the caeca and, while relatively less pathogenic per se, serves as a vector for Histomonas meleagridis, the aetiological agent of histomoniasis (4). Capillaria spp. infect the upper gastrointestinal tract, including the oesophagus, crop, and small intestine, producing capillariasis, characterised by mucosal haemorrhage and weight loss (5). Syngamus trachea causes gapeworm disease, primarily affecting the trachea and resulting in respiratory distress in affected birds (6).

Farm management practices exert a profound influence on nematode infection dynamics. Backyard or free-range systems provide greater opportunities for exposure to infective larvae through soil contact and ingestion of paratenic hosts such as earthworms and insects, resulting in substantially higher infection prevalences compared with biosecure commercial operations (7). Conversely, intensive indoor systems with concrete flooring and controlled environments limit larval survival and reduce direct faecal-oral transmission. The interplay between host

immunity, stocking density, litter management, and anthelmintic use further determines within-flock infection intensity and species community composition (2).

Parasite community ecology, assessed using diversity indices such as Shannon-Wiener (H′) and Simpson's (1−D), provides insights into the richness and evenness of helminth assemblages within host populations. These metrics complement prevalence data by revealing the complexity of multi-species infections and the relative dominance of particular taxa across different ecological and management settings (8). Understanding patterns of species diversity is essential for designing targeted and rational control programmes.

Anthelmintic treatment remains the cornerstone of nematode control in poultry. Benzimidazoles (e.g., fenbendazole, flubendazole), levamisole, and piperazine are the most widely used compounds, with efficacy varying according to drug class, parasite species, and the presence of anthelmintic resistance (9). Routine, strategic deworming schedules have been shown to significantly reduce egg output and parasite burdens, thereby improving production indices such as body weight gain and feed conversion ratio. The quantification of helminth burden through faecal egg counts (expressed as eggs per gram, EPG) provides an objective measure of infection intensity and is widely employed in treatment efficacy trials (10).

In Pakistan, the poultry sector constitutes a critical pillar of the national agricultural economy, contributing approximately 1.4% to the gross domestic product and supplying a major portion of the affordable animal protein available to the population. The country maintains one of the largest poultry industries in South Asia, with over 1.6 billion birds managed across diverse production systems ranging from large-scale commercial enterprises in Punjab and Sindh to subsistence-level backyard flocks prevalent in Khyber Pakhtunkhwa and Balochistan. Despite the economic significance of this sector, systematic data on the prevalence, species diversity, and impact of gastrointestinal nematodes across all four provinces remain scarce. Most existing studies have been conducted in limited geographic areas, and there is a paucity of large-scale, multi-regional investigations to inform national-level control policies. The present study was therefore designed to determine the prevalence and species diversity of gastrointestinal nematodes in poultry across Pakistan's four provinces, to evaluate the association of farm management systems with infection risk, to assess the impact of routine deworming on parasite burden, and to quantify the relationship between nematode infection intensity and production performance parameters.

Methodology

This cross-sectional epidemiological study was conducted to determine the prevalence, species diversity, and risk factors associated with nematode infections in chickens reared under different production systems in Pakistan. The study was conducted across four major provinces: Punjab, Sindh, Khyber Pakhtunkhwa, and Balochistan. A stratified sampling approach was used to ensure representation of the major poultry production systems across provinces. In total, 15 farms were selected from each province, giving a total of 60 farms. The included farms represented three production systems: commercial broiler farms, commercial layer farms, and backyard poultry units. From each farm, 20 birds were selected randomly for parasitological examination, resulting in a total sample size of 1,200 chickens.

Fresh fecal samples were collected individually from each selected bird immediately after defecation and transferred into labeled sterile containers. The samples were transported to the laboratory in a cool box and processed on the same day whenever possible. Parasitological examination was performed using a standard flotation technique to detect nematode eggs. Parasite burden was quantified by the McMaster egg-counting method and expressed as eggs per gram (EPG) of feces. A bird was considered positive when at least one type of nematode egg was detected in the fecal sample. Identification of nematode species was based on egg morphology using standard parasitological identification keys. The nematodes identified included Ascaridia galli, Heterakis gallinarum, Capillaria spp., and Syngamus trachea. Data on farm characteristics and management practices were collected through a structured questionnaire administered to farm owners or managers at the time of sampling. Information was obtained regarding geographic location, production system, deworming practices, and selected production indicators. Deworming practice was categorized as “yes” or “no” depending on whether an anthelmintic treatment was administered during the production cycle. The body weights of sampled birds were measured using a standard scale, and the feed conversion ratio was recorded from farm production data where available. These variables were used to assess the possible relationship between parasite burden and production performance. Species diversity was assessed using standard ecological indices. Species richness (S) was defined as the total number of nematode species identified within each study group. Species diversity and heterogeneity across regions and production systems were evaluated using the Shannon diversity index (H′) and Simpson’s diversity index (1−D). All statistical analyses were performed using IBM SPSS Statistics. Prevalence was calculated as the proportion of infected birds among the total number examined and expressed as a percentage. Associations between infection status and categorical variables, including region and farm type, were assessed using the chi-square test. Variables considered potential risk factors for infection, including region, farm type, and deworming practice, were further evaluated using multivariable binary logistic regression. Because EPG counts were not normally distributed, egg-count data were log-transformed before analysis. Mean parasite load was then compared across farm types and deworming categories using analysis of variance. Pearson correlation analysis was used to assess the relationship between parasite burden and production parameters, including body weight and feed conversion ratio. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 1,200 birds were examined for gastrointestinal nematode infection; 497 were positive, yielding an overall prevalence of 41.4%. The prevalence varied significantly across the four provinces, suggesting a geographical influence on infection burden. The lowest prevalence was observed in Punjab (35.3%), followed by Sindh (39.3%), whereas higher prevalence rates were found in Khyber Pakhtunkhwa (44.0%) and Balochistan (47.0%). An increasing trend in prevalence was observed from Punjab to Balochistan (Table 1).

The farm management system was significantly associated with the prevalence of nematode infection. Backyard farms had the highest prevalence (63.8%), followed by commercial layer farms (37.2%), while commercial broiler farms had the lowest prevalence (24.5%). These findings indicate that birds reared under backyard conditions were at substantially greater risk of infection than those managed under commercial systems (Table 2).

Four nematode taxa were identified, namely *Ascaridia galli*, *Heterakis gallinarum*, *Capillaria* spp., and *Syngamus trachea*. Species richness was identical across all four provinces, with four species detected in each region. Minor variation was noted in diversity indices. The Shannon diversity index ranged from 1.23 to 1.36, while Simpson’s index ranged from 0.69 to 0.74, indicating moderate and comparable species diversity across the study sites (Table 3).

Parasite burden, measured as eggs per gram (EPG) of feces, differed significantly across deworming practices. Birds from routinely dewormed farms had a markedly lower mean EPG count than birds from non-dewormed farms (210 ± 165 vs 465 ± 188), demonstrating the effectiveness of routine deworming in reducing helminth burden (Table 4).Correlation analysis showed that increasing parasite burden was significantly associated with poorer production performance. EPG was negatively correlated with body weight ($r = -0.42$, $p < 0.001$), indicating that birds with heavier infections tended to have lower body weight. In contrast, EPG was positively correlated with feed conversion ratio (r =

0.37, $p < 0.001$), suggesting reduced feed efficiency among birds with higher parasite loads (Table 5).

Table 1: Prevalence of nematode infection by region

Region	Total examined, n	Positive, n	Prevalence, %	p-value
Punjab	300	106	35.3	
Sindh	300	118	39.3	
Khyber Pakhtunkhwa	300	132	44.0	
Balochistan	300	141	47.0	
Overall comparison	1200	497	41.4	0.021

Table 2: Prevalence of nematode infection by farm type

Farm type	Total examined, n	Positive, n	Prevalence, %	p-value
Commercial broiler	420	103	24.5	
Commercial layer	390	145	37.2	
Backyard	390	249	63.8	
Overall comparison	1200	497	41.4	<0.001

Table 3: Nematode species diversity indices by region

Region	Species richness (S)	Shannon index (H′)	Simpson index (1−D)
Punjab	4	1.23	0.69
Sindh	4	1.28	0.71
Khyber Pakhtunkhwa	4	1.31	0.72
Balochistan	4	1.36	0.74

Table 4: Mean eggs per gram according to deworming practice

Deworming practice	Mean EPG ± SD	p-value
Yes	210 ± 165	
No	465 ± 188	
Overall comparison		<0.001

Table 5: Correlation of EPG with production parameters

Variable	Correlation coefficient (r)	p-value
Body weight	-0.42	<0.001
Feed conversion ratio	0.37	<0.001

Discussion

The overall prevalence of gastrointestinal nematode infection recorded in the present study (41.4%) is consistent with findings from comparable multi-regional surveys conducted in South and Southeast Asia. Saad et al. reported a prevalence of 38.7% in Pakistani commercial and backyard chickens examined across northern Punjab, corroborating the endemic nature of avian helminthiasis in the region (11). Similarly, a large-scale cross-sectional study from Bangladesh by Islam et al. documented a pooled prevalence of 43.1% across diverse production systems, underscoring the regional burden of these parasites (12). The higher prevalences observed in Khyber Pakhtunkhwa (44.0%) and Balochistan (47.0%) relative to Punjab (35.3%) likely reflect differences in management standards, agro-ecological conditions, ambient temperature, and soil humidity, all of which influence larval survival and transmission intensity. Ahmed et al. similarly demonstrated that arid and semi-arid ecozones in South Asia are associated with elevated nematode burdens due to periodic rainfall events that facilitate the dispersal of infective larvae (13).

The significantly higher prevalence in backyard flocks (63.8%) compared with commercial broiler (24.5%) and layer (37.2%) operations agrees with the established epidemiological evidence base. Kaufmann et al. conducted a systematic review and confirmed that free-range and backyard production systems consistently yield two- to threefold higher helminth prevalences than conventional indoor systems, attributable to unrestricted access to contaminated soil and invertebrate paratenic hosts (14). Kucukyilmaz et al. similarly highlighted that the absence of routine biosecurity measures, including strategic anthelmintic programmes and controlled litter management, in backyard systems creates permissive environments for continuous parasite transmission (15). The commercial broiler figure of 24.5% is somewhat higher than values reported from biosecure European facilities, where prevalences below 10% are common, likely reflecting suboptimal biosecurity practices and irregular deworming protocols in the Pakistani commercial sector.

The four nematode species identified in this study, Ascaridia galli, Heterakis gallinarum, Capillaria spp., and Syngamus trachea, represent the classic helminth community of domestic chickens and have been consistently reported across Africa, Asia, and Latin America. Agyei et al., in an extensive survey of village chickens across West African agro-ecological zones, identified the same four genera as the dominant parasites, with A. galli and H. gallinarum accounting for the majority of infections (16). The Shannon diversity indices ($H' = 1.23–1.36$) and Simpson's indices ($1−D = 0.69–0.74$) recorded here indicate moderate, relatively even community diversity, consistent with findings from an Ethiopian study by Netsere et al. that reported H′ values of 1.18–1.42 across different agro-ecological zones (17). The absence of marked inter-provincial variation in species richness suggests that all four study regions share broadly similar transmission environments and host susceptibility profiles.

The significant reduction in mean EPG from 465 ± 188 in non-dewormed flocks to 210 ± 165 in routinely dewormed flocks provides empirical support for the efficacy of strategic anthelmintic intervention. Gauly et al. demonstrated in a controlled field study that a biannual fenbendazole deworming programme reduced A. galli EPG by approximately 56%, a magnitude comparable to the 54.8% reduction observed in the present study (18). Nwosu et al. evaluated the impact of levamisole-based programmes in Nigerian village chickens and reported similarly substantial reductions in both prevalence and faecal egg output, reinforcing the cross-regional applicability of routine anthelmintic use (19). Nonetheless, the residual EPG burden in dewormed flocks underscores the importance of complementing chemotherapy with environmental management measures, including regular litter replacement, concrete flooring, and restriction of access to potential paratenic hosts.

The negative correlation between EPG and body weight ($r = −0.42$, $p < 0.001$) and the positive correlation between EPG and feed conversion ratio ($r = 0.37$, $p < 0.001$) confirm that nematode infection exerts a measurable and economically significant detrimental effect on production performance. Abebe et al. reported a significant negative correlation between A. galli infection intensity and live weight gain in experimentally infected broiler chickens, findings that closely mirror our observed

correlation coefficient (20). Nguyen et al. likewise documented significant impairment of weight gain and feed efficiency in experimentally infected broilers, with infected birds exhibiting a 12–18% reduction in body weight and a 15% elevation in feed conversion ratio (21). These findings collectively reinforce the case for integrating regular parasitological monitoring with targeted anthelmintic treatment as standard practice in both commercial and backyard poultry enterprises across Pakistan.

Conclusion

Gastrointestinal nematodes remain a substantial health and production challenge in poultry across Pakistan. The higher burden in backyard systems and the lower EPG counts in dewormed flocks suggest that improved management, biosecurity, and strategic deworming may help reduce infection and improve productivity.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned.

Consent for publication

Approved

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Conflict of interest

The authors declared no conflict of interest.

Author Contribution

SA,

Contributed to study design and initial manuscript drafting

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Assisted in data acquisition, literature review, and manuscript editing

Performed statistical analysis and contributed to the interpretation of results

TA, HT, GK

Helped in methodology development, data organization, and manuscript formatting

Contributed to patient recruitment, data entry, and results compilation

Assisted in referencing, proofreading, and final revisions of the manuscript

MMS, AS, QU

Guided study execution and critically reviewed the manuscript

Supervised the research, coordinated among authors, finalized the manuscript, and approved the final version

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the study's integrity.

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