Prevalence, risk factors, zoonotic significance, and infection patterns of gastrointestinal helminths in pigs in Ogbomoso, Nigeria

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Abstract

In regions with inadequate control measures and poor biosecurity, helminth infections constitute a significant threat to the swine industry and contribute to the transmission of zoonotic helminths. These infections result in substantial economic losses through reduced weight gain, poor feed efficiency, and condemnation of affected carcass parts at slaughter, among other impacts. A cross-sectional survey was conducted on commercial pig farms in Ogbomoso, Nigeria, to investigate the epidemiology of gastrointestinal helminths in intensively raised pigs. A total of 250 faecal samples were collected using a simple random sampling technique on the selected farms. The samples were examined for helminth eggs using coprological analysis, which included simple floatation and formalin-ethyl acetate concentration techniques. One hundred and twenty-two (48.8%) pigs were positive for one or more helminth species. Prevalence rates were 54.47% in females and 43.31% in males. Adults, growers, and piglets had prevalence rates of 49.38%, 49.68%, and 33.33%, respectively. There were no significant associations between age or sex and prevalence of infection ($p > 0.05$). Seven helminth species were identified, with *Oesophagostomum* spp. (20%, 95% CI = 14.45-24.95) being the most prevalent and *Trichostrongylus* spp. (2.4%, 95% CI = 0.48-4.29), the least prevalent. This study provides the first report of *Oesophagostomum* and *Trichostrongylus* spp. in pigs in Ogbomoso. These findings call for strengthened parasite control programs, improved farm hygiene, stricter meat inspection practices in slaughter facilities, and increased public awareness on safe pork handling and consumption.

Keywords: epidemiology, helminths, Nigeria, swine, zoonoses.

Prevalência, fatores de risco, importância zoonótica e padrões de infecção de helmintos gastrintestinais em suínos em Ogbomoso, Nigéria

Resumo

Em regiões com medidas de controle inadequadas e baixa biossegurança, as infecções por helmintos representam uma ameaça significativa para a suinocultura e contribuem para a transmissão de helmintos zoonóticos. Essas infecções resultam em perdas econômicas substanciais devido à redução do ganho de peso, baixa eficiência alimentar e condenação de partes das carcaças no abate, entre outros impactos. Foi realizado um estudo transversal em granjas comerciais de suínos em Ogbomoso, Nigéria, com o objetivo de investigar a epidemiologia de helmintos gastrointestinais em suínos criados em regime intensivo. Um total de 250 amostras

fecais foi coletado utilizando uma técnica de amostragem aleatória simples nas granjas selecionadas. As amostras foram examinadas para detecção de ovos de helmintos por meio de análise coproparasitológica, incluindo os métodos de flutuação simples e concentração por formalina–acetato de etila. Cento e vinte e dois (48,8%) suínos foram positivos para uma ou mais espécies de helmintos. As taxas de prevalência foram de 54,47% em fêmeas e 43,31% em machos. Adultos, recrias e leitões apresentaram prevalências de 49,38%, 49,68% e 33,33%, respectivamente. Não houve associações significativas entre idade ou sexo e prevalência de infecção ($p > 0,05$). Sete espécies de helmintos foram identificadas, sendo *Oesophagostomum* spp. (20%, IC 95% = 14,45–24,95) a mais prevalente e *Trichostrongylus* spp. (2,4%, IC 95% = 0,48–4,29) a menos prevalente. Este estudo apresenta o primeiro relato de *Oesophagostomum* e *Trichostrongylus* spp., em suínos em Ogbomoso. Os achados ressaltam a necessidade de fortalecer os programas de controle parasitário, melhorar a higiene nas granjas, intensificar as práticas de inspeção sanitária em abatedouros e ampliar a conscientização pública sobre o manejo seguro e o consumo de carne suína.

Palavras-chave: epidemiologia, helmintos, Nigéria, suínos, zoonoses.

1. Introduction

Gastrointestinal helminths are a diverse group of eukaryotic parasites classified into nematodes, trematodes, and cestodes affecting animals worldwide. Helminthosis remains one of the most underestimated threats to livestock health, particularly in swine production, where its silent devastation is often overshadowed by more conspicuous diseases such as African swine fever (Atawalna et al., 2016). These parasites cause damage by depleting essential nutrients, preventing efficient feed conversion, impairing growth, and causing emaciation, among other detrimental effects (Adenaike, 2020). The impact extends far beyond occasional weight loss- it affects productivity, delays market readiness, reduces carcass yield due to condemnation of affected parts at slaughter, and increases farm operational costs and cost of control measures, translating to significant economic losses (Kouam; Ngueguim, 2022).

Despite their impact, gastrointestinal helminths of pigs have generally received less attention than ruminant helminths (Roepstorff et al., 2011). The challenge is greater in developing countries, where suboptimal management practices such as substandard biosecurity measures and inadequate deworming practices promote infections (Abonyi; Njoga, 2019; Bernard et al., 2021). An additional concern is the neglected public health significance of these infections. Smallholder pig farms commonly located in residential areas increase the likelihood of cross-transmission between pigs and humans (Chaudhary et al., 2023). *Ascaris suum*, *Taenia solium cysticerci*, *Trichinella*, and *Trichuris* spp. are zoonotic species that can infect humans through the consumption of undercooked pork, direct contact with infected pigs, or exposure to contaminated environments (Bawm et al., 2024; Chukwudi et al., 2025). These infections cause diarrhoea, dysentery, abdominal pain, anorexia, general malaise, impaired cognitive development, and growth retardation, particularly in children and young adults with mild to heavy infections (Bernard et al., 2021). It makes pork unsafe for human consumption, particularly in areas where food safety regulations are poorly enforced.

Pigs are known to provide approximately 40% of animal protein (meat) worldwide (Karaye et al., 2016). Smallholder farms dominate Nigeria's livestock sector and supply most of the pork consumed locally. Furthermore, they are crucial to biomedical research, serving as models for human physiology. Nigeria's swine industry is a rapidly growing sector due to its potential to reduce food insecurity and generate income. With an estimated population of 7.5 million, pigs make a significant contribution to the nation's economy because of their high fecundity, short gestation period, and minimal housing space requirements (FAO, 2019).

Helminthosis remains a major challenge to optimal pig production (Bawm et al., 2024). Several studies have reported varying prevalence of gastrointestinal helminths in pigs across different regions of the world, particularly Nigeria (Ojo; Ojo, 2022; Chaudhary et al., 2023; Bawm et al., 2024; Okey-Anene et al., 2025). Climate, presence of intermediate hosts, number of infective eggs and larvae, age, health status, omnivorous nature, and gluttonous appetite of pigs are some established factors influencing parasitic burdens (Unigwe et al., 2022).

Current data on gastrointestinal helminths in pigs within Ogbomoso are limited, and understanding their epidemiology is crucial for developing effective parasite control strategies and guiding One Health policy decisions. Therefore, this study aimed to investigate the prevalence, species diversity, and infection patterns of gastrointestinal helminths and to evaluate risk factors associated with these infections in pigs within Ogbomoso, Nigeria.

2. Materials and Methods

2.1 Study area

The study was conducted in Ogbomoso, Oyo State. Ogbomoso is located between latitude 8.08°N and longitude 4.15°E of the Greenwich Meridian, within the derived Savannah region of Nigeria. It has an elevation of about 347 m and covers an area of 37,984 km². The town shares borders with Oyo to the Southwest, Ilorin to the North, and Iwo and Ede to the South and East, respectively. With a population of about 334,000 people, most of its inhabitants are from the Yoruba ethnic group (Shittu et al., 2018; Bolaji et al., 2023). Commercial pig farms within this town were visited for data collection. The sampled areas included the five local government areas (LGAs) in Ogbomoso: Ogbomoso South, Ogbomoso North, Orire, Ogo-Oluwa, and Surulere LGAs.

2.2 Study design and sample size determination

A cross-sectional survey was carried out to assess the prevalence of gastrointestinal helminths in pigs in Ogbomoso. Selection of the farms across the LGAs was based primarily on the farmers' willingness to participate. A simple random sampling technique was employed to select the pigs across various intensively managed pig farms. The total faecal sample collected was 250, determined using the Thrusfield formula at an estimated prevalence of 80% (Abonyi; Njoga, 2019).

Briefly,

$$\text{Sample Size} = Z^2 \times P(1-P)/d^2 \text{ (Thrusfield formula)}$$

Where: Z = Confidence level interval 95% (1.96); P = Estimated prevalence of exposure; d = Desired absolute precision at 5%.

The value obtained was 245.9, but was rounded up to 250.

2.3 Sample collection

The faecal samples were collected individually from the rectum using sterile gloves and then placed into well-labelled universal bottles. The samples were immediately transported in cool boxes packed with ice packs to the Veterinary Parasitology Laboratory for processing. The pigs were identified based on sex and age: piglet (< 2 months), grower (2-6 months), and adult (> 6 months).

2.4 Coprological examination

All samples were individually subjected to different coprological examinations, such as floatation and formalin-ethyl acetate concentration techniques, to demonstrate the presence of gastrointestinal helminth eggs as described by Taylor et al. (2015) and Ola-Fadunsin et al. (2019), respectively.

2.4.1 Floatation technique

Approximately 2 g of faecal sample was placed in a beaker, and 10 mL of saturated sodium chloride was added. The sample was then gently mixed and filtered into a test tube. Following that, a cover slip was carefully placed, and the mixture was allowed to stand for around 15 min. The cover slip was placed on a glass slide and observed under the microscope at 10× and 40× magnification for helminth eggs (Taylor et al., 2015).

2.4.2 Formalin-ethyl acetate concentration technique

About 2 g of the faecal sample was mixed with 7 mL of 10% formalin. The suspension was sieved into a test tube, and 3 mL of ethyl acetate was added. This was thoroughly shaken by hand for about a minute and then centrifuged at 3000 rpm for 5 min. The supernatant was decanted, and the sediment was smeared with iodine on a clean glass slide. Finally, the slide was examined under the microscope at 10× and 40× magnification for helminth eggs (Ola-Fadunsin et al., 2019). The eggs were identified based on helminthological keys according to Soulsby et al. (1982) and Taylor et al. (2015). To ensure accuracy of identification, representative slides were re-examined to verify consistency of results.

2.5 Data management

Data collected from each farm were recorded and stored in Microsoft Excel and coded for clarity. The data were collated, sorted, and cleaned in Excel before statistical analysis.

2.6 Statistical analysis

The prevalence was obtained with descriptive statistics. The association between helminth infections and risk factors such as sex and age was determined using the Chi-square test and logistic regression, given the categorical nature of the variables. The dataset met the assumptions of independence. The statistical analysis was carried out using the Jamovi Project (Version 2.6) (2024). The results were summarised and presented in tables and figures. Statistical significance was considered at $p < 0.05$.

3. Results

The coprological examination revealed seven different helminth species (nematodes), including *Strongyloides* spp., *Metastrongylus* spp., *Hyostrongylus* spp., *Oesophagostomum* spp., *Trichuris* spp., *Ascaris* spp., and *Trichostrongylus* spp. *Oesophagostomum* spp. (20%, 95% CI = 14.45-24.95) and *Trichostrongylus* spp. (2.4%, 95% CI = 0.48-4.29) were the most and least prevalent helminth species, respectively, as shown in Table 1. A total of 122 pigs out of the 250 sampled were infected with one or more gastrointestinal helminths, giving an overall prevalence of 48.8%.

Table 1. Prevalence and distribution of helminth species in pigs (*n = 250*) in Ogbomoso, Nigeria.

Species of Helminth	Number of Pigs Infected	Prevalence (%)	95% Confidence Interval
Strongyloides spp.	24	9.6	5.95-13.25
Metastrongylus spp.	18	7.2	3.99-10.40
Hyostrongylus spp.	30	12	7.97-16.03
Ascaris spp.	12	4.8	2.15-7.45
Trichuris spp.	43	17.2	12.52-21.88
Oesophagostomum spp.	50	20	14.45-24.95
Trichostrongylus spp.	6	2.4	0.48-4.29

Note: Spp.: Species. Source: Authors, 2025.

A total of 128 (51.20%) samples were free from helminth infections among the 250 pigs sampled. Among the 122 infected pigs, 25 distinct helminth infection patterns were identified. Single infections were observed in 70 (57.38%) pigs, while two and three coinfections were recorded in 43 (35.25%) and 9 (7.38%) pigs, respectively, as illustrated in (Figure 1).

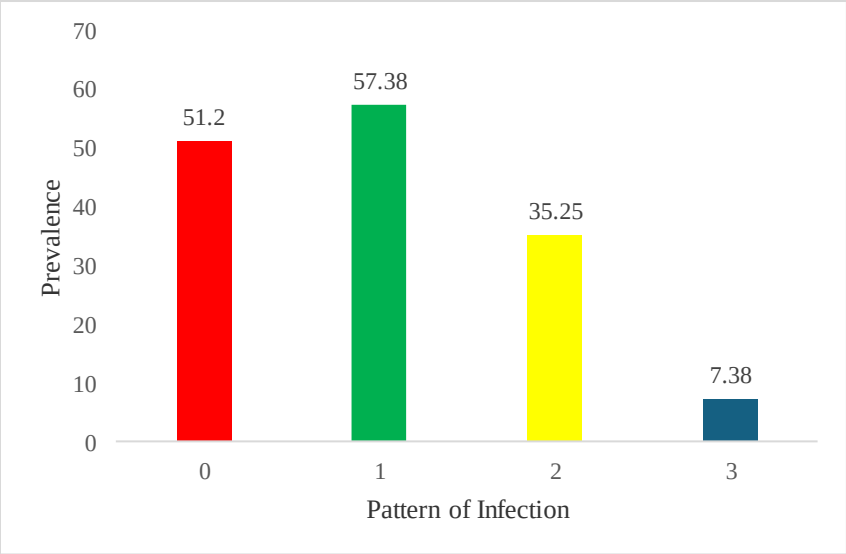

Figure 1. Patterns of helminth infections in pigs in Ogbomoso, Nigeria. Source: Authors, 2025

With respect to sex, female pigs (OR = 0.63, 95% CI = 0.38-1.06) had slightly higher odds of infection compared to males. But there was no significant association between the prevalence of GI helminths and sex ($\chi^2 = 3.12$, $P = 0.08$). Similarly, growers (OR = 1.13, 95% CI = 0.65-1.96) were 1.13 times more likely to be infected with GI helminths than adults, while piglets had lower odds (OR = 0.59, 95% CI = 0.16-2.15). In addition, the association between prevalence and age was not statistically significant ($\chi^2 = 1.21$, $P = 0.55$) as summarised in Table 2 below.

Table 2. Prevalence and risk analysis of helminth infections in pigs in Ogbomoso, Nigeria

Variable	Number Examined	Number Infected	Prevalence (%)	Odds Ratio (95% CI)	*P* Value	χ^2
Sex						
Female	123	67	54.47	0.63 (0.38-1.06)	0.08	3.12
Male*	127	55	43.31	1.00		
Age						
Piglet (< 2 months)	12	4	33.33	0.59 (0.16-2.15)	0.55	1.21
Grower (2-6 months)	157	78	49.68	1.13 (0.65-1.96)		
Adult* (> 6 months)	81	40	49.38	1.00		

Note: χ^2: Chi-square, CI: Confidence Interval, *Reference Category. Source: Authors, 2025.

Overall, 48.8% of the pigs sampled were infected with one or more gastrointestinal helminths. *Oesophagostomum* spp. had the highest prevalence, while *Trichostrongylus* spp. had the lowest. Of the twenty-five helminth infection patterns observed, single-species infections were the most common. Sex and age were not significantly associated with prevalence.

4. Discussion

In this study, 48.8% of the pigs sampled were infected with one or more gastrointestinal helminths. Seven nematode species were identified, with *Oesophagostomum* being the most prevalent and *Trichostrongylus* spp.

the least. Notably, this is the first report of *Oesophagostomum* and *Trichostrongylus* spp. infections in pigs within Ogbomoso. Twenty-five distinct helminth infection patterns were observed, with single-species infections being the most common. Infection odds were higher in female pigs and growers, but neither sex nor age was significantly associated with prevalence. Based on these findings, the implications extend beyond individual farm losses, as pigs have been established as a vital economic commodity in Nigeria (FAO, 2019). Shittu et al. (2018) and Amadi et al. (2018) recorded similar prevalence rates of 46% and 42.7% in Ogbomoso and Umuahia, respectively. Likewise, other studies have documented comparable rates ranging from 35.8-69.2% across different regions, including Ibadan (Unigwe et al., 2022), Enugu (Ejinaka; Onyali, 2020), Federal Capital Territory, Nigeria (Obeta; Adamu, 2025), and Myanmar (Bawm et al., 2024).

However, this study does not align with the findings of Bolaji et al. (2023) and Olusoji et al. (2018), who reported higher prevalence rates of 77.1% and 84.4% in Ogbomoso and Ibadan, respectively. The omnivorous, gluttonous, and coprophagic tendencies of pigs naturally predispose them to helminth infections. Furthermore, suboptimal biosecurity practices, such as feeding pigs untreated abattoir waste and poultry droppings, inconsistent daily dung removal, and inadequate cleaning of feeding and drinking troughs, further elevate the risk of infection (Bernard et al., 2021). In contrast, lower prevalence rates of 26.5% and 28% were reported by Adelakun et al. (2020) in Ibadan, Nigeria, and Atawalna et al. (2016) in Ghana, respectively. These differences may be attributed to sample size, diagnostic techniques, geographical and climatic conditions, deworming practices, the presence of intermediate hosts, husbandry systems, and other factors (Ejinaka; Onyali, 2020).

Additionally, seven helminth species (nematodes) were identified in this study, some of which have been previously reported in the same area (Shittu et al., 2018; Bolaji et al., 2023), with the exceptions of *Oesophagostomum* and *Trichostrongylus* spp., which appear to be first-time reports. *Oesophagostomum* spp. (20%) had the highest prevalence in this study, followed by *Hyostrongylus* spp. (12%). This finding contrasts with most studies within and outside Nigeria, where *Ascaris suum* have been reported to have the highest prevalence (Olusoji et al., 2018; Adenaike, 2020; Bernard et al., 2021).

The high prevalence of *Oesophagostomum* spp. observed in this study is comparable to the 25.7% recorded by Olusoji et al. (2018). This could be linked to the high egg excretion rate of *Oesophagostomum* in unhygienic and humid conditions, which facilitates its transmission. Furthermore, it is well established that dipteran flies can transport larvae on their legs, promoting pen-to-pen transmission (Urquhart et al., 1996). Coinfections involving two or three helminth species observed in this study have also been documented in previous studies in Nigeria and other parts of the world. This may be attributed to environmental contamination with a variety of eggs at a given time, and also the immunosuppression ability of some species, thus creating favourable conditions for coinfection (Bernard et al, 2021).

This study further revealed that the prevalence of helminth infections was higher in females (54.47%) than in males (43.31%), although the difference was not statistically significant. These results are consistent with those of Atawalna et al. (2016), Shittu et al. (2018), Amadi et al. (2018), Abonyi and Njoga (2019), Bernard et al. (2021), and Unigwe et al. (2022), who also reported higher prevalence rates in female pigs than males across various regions of Nigeria and Ghana. Progesterone has been shown to modulate immune responses, sometimes leading to increased susceptibility to infections.

Therefore, hormonal changes and stress in pregnant and lactating sows may lower their immunity and predispose them to helminth infections (Unigwe et al., 2022). Bernard et al. (2021) also suggest that the extended period of rearing sows, as well as male dominance, may result in sows feeding on contaminated leftovers, thus increasing their exposure to infections compared to males. However, this finding contradicts reports by Olusoji et al. (2018), Adenaike (2020), and Ejinaka and Onyali (2020), where males exhibited higher prevalence rates than females. In addition, growers (49.68%) had a higher prevalence of gastrointestinal helminths compared to adults or piglets. Although the difference was not statistically significant, it aligns with the findings of Olusoji et al. (2018), Abonyi and Njoga (2019), Ejinaka and Onyali (2020), and Bernard et al. (2021), who also confirmed higher prevalence in young or growing pigs. Young pigs have an underdeveloped immune system, making them more susceptible to infections.

Raising pigs of different age groups together, their exploratory behaviour, along with sudden dietary changes, and increased contact with contaminated soil, feed, and faeces, heightens their risk of encountering helminth eggs and larvae (Abonyi; Njoga, 2019; Bernard et al., 2021). However, the findings of this study differ from those of Shittu et al. (2018), Amadi et al. (2018), Adelakun et al. (2020), and Atawalna et al. (2016), who reported higher prevalence rates in some parts of Nigeria and Ghana, respectively, among adults.

This study utilised a cross-sectional design, which did not account for seasonal variations in helminth

transmission. In addition, the level of farm biosecurity and management practices was not assessed, which could have provided valuable insights into farm-level risk factors contributing to infection dynamics.

5. Conclusions

The findings from this study reveal a high prevalence of gastrointestinal helminths in pigs within Ogbomoso, Nigeria. Sex and age had no significant influence on the prevalence of infection. Notably, this study provides the first report of *Oesophagostomum* and *Trichostrongylus* spp. in pigs in Ogbomoso. The detection of zoonotic *Ascaris* spp. raises serious public health concerns. Effective prevention and control, therefore, require a comprehensive strategy that includes improved farm hygiene and management practices, a veterinarian-guided deworming plan, routine veterinary care, and public awareness of safe pork handling.

Furthermore, regular antemortem and postmortem inspections by veterinarians, along with stricter hygiene protocols in slaughter facilities, are crucial for reducing zoonotic risks. Future research should explore the molecular identification of helminths and conduct longitudinal assessments to capture seasonal and environmental influences on infection dynamics.

6. Authors' Contributions

Fiwasade Adejoke Rom-Kalilu: conceptualised, designed and supervised the study, collected, processed and analysed the data, and wrote the initial draft of the manuscript. *Esther Ayomide Daniel*: collected and processed the data. *Mujidat Titilope Tijani*: collected and processed the data. *Michael Olaoluwa Ogunyemi*: analysed and interpreted the data, critically reviewed the manuscript. *Blessing Abiola Oyetoro*: revised the manuscript. *Samuel Tobiloba Ogunbayode*: collected the data. *Saheed Olaide Ahmed*: critically reviewed the manuscript. *Besong Paul Nyenti*: designed the study and critically reviewed the manuscript. *Opeyemi Oladipupo Hammed*: critically reviewed the manuscript.

7. Conflicts of Interest

The authors declare that there are no conflicts of interest.

8. Ethics Approval

Yes. This study was approved by the Department of Animal Production and Health Animal Ethics Committee, Ladoke Akintola University of Technology (Approval number: APH/24/195045UG).

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