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Research Article

Prevalence and Morphometric Characterization of Fasciolosis in Cattle Slaughtered at Zaria Abattoir, Kaduna State, Nigeria

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ABSTRACT
Fasciolosis is an important food-borne zoonotic helminth disease caused by liver flukes of the genus *Fasciola*. The disease affects the liver and bile ducts of ruminants, resulting in substantial economic losses through reduced productivity and condemnation of infected livers at slaughter. This study determined the prevalence of fasciolosis among different breeds of cattle slaughtered at Zangon Shanu Abattoir, Zaria, Kaduna State, Nigeria, and characterized the recovered flukes using morphological and morphometric techniques. Bile samples were examined for *Fasciola* eggs using the formalin–ether sedimentation technique. An overall prevalence of 50.5% (101/200) was recorded. Infection was more frequent among female (54.81%; 57/104) than in male cattle (45.83%; 44/96). Breed-specific prevalence was 56.52% (13/23) in Sokoto Gudali, 50.34% (75/149) in White Fulani (Bunaji), 46.67% (7/15) in Red Bororo, and 46.15% (6/13) in Crosses. Age-related prevalence increased from 6.82% (3/44) in cattle aged 1.0–1.5 years to 52.17% (36/69), 66.67% (40/60), and 81.48% (22/27) in the 2.0–2.5, 3.0–3.5, and 4.0–5.0 years age groups, respectively. Morphometric analysis showed a mean cone length of 3.68 ± 0.08 mm and a body length-to-body width ratio of 3.83 ± 0.21, with measurements largely comparable to published reference values for *F. gigantica* while exhibiting intermediate characteristics between *F. hepatica* and *F. gigantica*. The findings indicate that fasciolosis remains highly prevalent among cattle slaughtered in Zaria and provide baseline epidemiological and morphometric data to support surveillance and control programmes in northwestern Nigeria.

Keywords: Cattle; *Fasciola gigantica*; Kaduna State; Morphometric analysis; Prevalence: Zaria Abattoir

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INTRODUCTION
Fasciolosis is one of the most important food-borne zoonotic helminth diseases affecting both livestock and humans worldwide. The disease is caused by liver flukes of the genus *Fasciola*, principally *Fasciola hepatica* and *Fasciola gigantica*, which parasitize the liver and bile ducts of a wide range of domestic and wild mammals (Mas-Coma *et al*., 2019; Caravedo and Cabada, 2020). Owing to its widespread distribution, economic significance, and impact on public health, fasciolosis has been recognized by the World Health Organization (WHO) as a Neglected Tropical Disease (NTD) (WHO, 2020). Although traditionally regarded as a disease of livestock, human infections have increasingly been reported from many endemic countries, highlighting its importance as a zoonosis which requires integrated veterinary and public health interventions (Caravedo and Cabada, 2020). Recent evidence further suggests that environmental changes, climate variability, irrigation practices, and

expansion of suitable snail habitats are contributing to the persistence and spread of fasciolosis in both animals and humans (Nyagura *et al*., 2022; Tanabe *et al*., 2024).

The two recognized species of *Fasciola* differ primarily in their geographical distribution and epidemiology. *Fasciola hepatica* predominates in temperate regions of Europe, the Americas, Oceania, and parts of Asia, whereas *F. gigantica* is mainly distributed throughout tropical and subtropical regions, including Africa, the Middle East, and South and Southeast Asia (Mas-Coma *et al*., 2019; Caravedo and Cabada, 2020). In sub-Saharan Africa, particularly Nigeria, *F. gigantica* is the predominant species infecting livestock because climatic conditions favour the survival of its lymnaeid snail intermediate hosts (Nyagura *et al*., 2022). Adult flukes inhabit the bile ducts, where they induce chronic cholangitis, biliary hyperplasia, fibrosis, hepatic dysfunction, and progressive loss of body condition. Heavy infections may predispose affected animals to secondary bacterial infections, reduced immunity, and occasionally death (Tanabe *et al*., 2024).

The life cycle of *Fasciola* species is indirect and involves freshwater lymnaeid snails as intermediate hosts. Eggs passed in the faeces of infected animals hatch in water to release miracidia, which infect suitable snail hosts. Within the snail, the parasite undergoes several developmental stages before cercariae emerge and encyst on aquatic vegetation as metacercariae, the infective stage for the definitive host (Mas-Coma *et al*., 2019). Grazing cattle become infected through ingestion of contaminated pasture or water. Consequently, environmental conditions such as rainfall, flooding, irrigation, marshy grazing fields, and the presence of stagnant water bodies strongly influence transmission dynamics and the epidemiology of fasciolosis (Nyagura *et al*., 2022; Tanabe *et al*., 2024). Seasonal abundance of intermediate host snails therefore plays a major role in determining infection rates in endemic regions (Mas-Coma *et al*., 2019).

Bovine fasciolosis remains a major constraint to livestock production because of the considerable economic losses associated with infection. These losses arise from decreased feed conversion efficiency, reduced weight gain, lower milk yield, impaired reproductive performance, poor carcass quality, increased susceptibility to other diseases, treatment costs, and condemnation of infected livers during meat inspection (Vassilev and Jooste, 1991; Tanabe *et al*., 2024). Globally, fasciolosis is estimated to cause annual economic losses amounting to billions of United States dollars, making it one of the most economically important helminth infections of ruminants (Flores-Velázquez *et al*., 2023). Beyond its economic consequences, the disease compromises animal welfare and poses an important challenge to food security in many low- and middle-income countries (Flores-Velázquez *et al*., 2023).

In Nigeria, livestock production constitutes an important component of the agricultural sector and provides meat, milk, hides, employment, and income for millions of households. However, parasitic diseases such as fasciolosis continue to undermine productivity (Nyagura *et al*., 2022; Tanabe *et al*., 2024). Several abattoir- and field-based studies conducted across different ecological zones of the country have reported varying prevalence rates of bovine fasciolosis, reflecting differences in climate, husbandry systems, grazing practices, diagnostic methods, season, and geographical location (Nyagura *et al*., 2022). Northern Nigeria, characterized by extensive cattle production and seasonal wetlands, provides favourable ecological conditions for the maintenance of *Fasciola* transmission (Nyagura *et al*., 2022). Consequently, regular epidemiological surveillance remains essential for understanding disease distribution, identifying high-risk populations, and designing effective control strategies (Caravedo and Cabada, 2020).

Recent advances in parasitology have also demonstrated that the epidemiology of fasciolosis is more complex than previously recognized. In areas where *F. hepatica* and *F. gigantica* occur sympatrically, intermediate or hybrid forms have been reported based on morphological, morphometric, and molecular evidence (Mas-Coma *et al*., 2019; Flores-Velázquez *et al*., 2023). Such hybrids may exhibit altered biological characteristics, including differences in host adaptation, fecundity, pathogenicity, geographical expansion, and possibly susceptibility to anthelmintic drugs (Flores-Velázquez *et al*., 2023). While molecular markers provide the most reliable means of confirming hybridization, morphometric analysis remains a valuable and cost-effective preliminary approach for species differentiation, particularly in resource-limited settings where molecular facilities are not readily available (Periago *et al*., 2008; Mas-Coma *et al.*, 2019).

Abattoir-based surveillance provides an important opportunity to estimate the burden of fasciolosis in slaughtered livestock and to generate epidemiological information relevant to disease control (Phiri *et al*., 2005). In addition to estimating prevalence, post-mortem examination enables direct recovery of adult flukes for detailed morphological and morphometric characterization, thereby providing valuable information on species distribution (Periago *et al*., 2008). Such studies also facilitate assessment of host-related factors, including breed, age, and sex, that may influence susceptibility to infection (Shinggu *et al*., 2019).

Despite the economic importance of cattle production in Kaduna State, information on the prevalence of fasciolosis among different cattle breeds slaughtered at Zaria Abattoir remains limited. Furthermore, few studies have combined prevalence estimation with detailed morphometric characterization of recovered *Fasciola* specimens to assess the possible occurrence of intermediate forms in the study area. Such information is important for understanding the epidemiology of fasciolosis and for guiding effective surveillance and control programmes (Flores-Velázquez *et al*., 2023).

Therefore, the present study was undertaken to determine the prevalence of fasciolosis among different breeds of cattle slaughtered at Zaria Abattoir, Kaduna State, Nigeria, and to characterize the recovered liver flukes using morphological and morphometric techniques. The findings are expected to provide baseline epidemiological data that will contribute to improved disease surveillance, meat inspection practices, and strategic control of bovine fasciolosis in northwestern Nigeria.

MATERIALS AND METHODS

Study Area

The study was conducted at Zango Shanu Abattoir, located in Zaria, Kaduna State, North-western Nigeria. The abattoir is situated in Zango Shanu area at approximately latitude 11°11′N and longitude 7°42′45″E (Abbas and Arigbede, 2012). Zaria is located about 250 km from Abuja, the Federal Capital Territory of Nigeria, and approximately 150 km from Kano, a major commercial city in northern Nigeria. The city lies on the Northern Guinea Savannah at an altitude of approximately 670 m above sea level (Aminu and Jaiyeoba, 2015). Agriculture, particularly crop cultivation and livestock production, constitutes the principal occupation of the inhabitants.

Study Design

This study employed a cross-sectional abattoir-based study design to determine the prevalence of fasciolosis among cattle slaughtered at Zango Shanu Abattoir, Zaria, Kaduna State, Nigeria. Bile samples and adult *Fasciola* specimens were collected from slaughtered cattle during the study period and examined for the presence of *Fasciola* eggs and adult flukes. Data on selected animal characteristics, including sex, age, and breed, were recorded to evaluate their association with *Fasciola* infection.

Sample Size Determination

The minimum sample size was determined using the formula described by Thrusfield (2018):

$n = Z^2Pq/d^2$

Where;

q = complementary probability (1-p)

n = minimum sample size

P = Assumed prevalence of fasciolosis

d = desired absolute precision (0.05).

Z = appropriate value for the standard normal deviate set at 95% confidence interval (1.96).

P = 13.67% (Liba *et al.,* 2018)

$$n = \frac{(1.96)^2 \ x\ 0.1367\ x\ (1 - 0.1367)}{0.05^2}$$

$$n = \frac{3.84\ x\ 0.12}{0.0025}$$

$$n = \frac{0.46}{0.0025}$$

$$n = 184$$

The calculated minimum sample size was 184. To improve the precision of the study and compensate for possible sample losses, the sample size was increased by approximately 10%, giving a total of 200 cattle.

Ethical Approval

Ethical approval for the study was obtained from the Kaduna State Ministry of Health, which granted ethical clearance (Approval No. PG8/LSC/2023/2073) before commencement of the research. The approval served as the official authorization to conduct the study within Zaria Local Government Area, Kaduna State. All sample collection procedures were carried out in accordance with established ethical guidelines for research involving animal-derived materials collected from slaughterhouses.

Age Determination

The age of each animal was estimated using dentition, following the standard method based on the eruption and wear pattern of the permanent incisors. The estimated ages were subsequently grouped into four categories: 1.0–1.5 years, 2.0–2.5 years, 3.0–3.5 years, and 4.0–5.0 years for statistical analysis.

Breed Identification

The breeds of cattle examined were identified based on their phenotypic characteristics, including coat colour, horn conformation, body size, and other distinguishing morphological features. Information obtained from abattoir personnel was also used to confirm breed identity. The breeds encountered during the study included White Fulani (Bunaji), Sokoto Gudali, Red Bororo, and Crosses.

Collection and Transportation of Samples

Bile samples and adult *Fasciola* spp. were collected from cattle slaughtered at Zango Shanu Abattoir between August and December 2025. Approximately, 15 mL of bile was aseptically collected directly from the gall bladder into sterile universal sample bottles. Each sample was appropriately labelled, and relevant information, including the animal's sex, breed, estimated age, date of collection, and location, was recorded.

The samples were transported to the Department of Veterinary Parasitology and Entomology, Ahmadu Bello University, Zaria, in insulated cold boxes containing ice packs. Samples that could not be processed immediately were preserved in 10% buffered formalin until analysis.

Adult *Fasciola* specimens were carefully recovered from the bile ducts of slaughtered cattle, washed thoroughly in several changes of physiological saline to remove adherent debris, and transported to the laboratory in 70% ethanol for preservation. Specimens intended for morphometric analysis were transported in physiological saline.

Processing of Bile Samples

Bile samples were processed using a modified formalin–ether sedimentation technique adapted from the World Health Organization (WHO, 2024). Briefly, 4 mL of bile was transferred into a labelled centrifuge tube, followed by the addition of 1 mL of 10% formalin. The mixture was allowed to stand for 5 minutes, after which 1 mL of diethyl ether was added. The tube was securely stoppered, vigorously shaken, and centrifuged at 2,000 × g for 10 minutes. Following centrifugation, the supernatant was carefully discarded, leaving a small quantity of fluid with the sediment. A portion of the sediment was transferred onto a clean glass slide, stained with a drop of methylene blue, covered with a coverslip, and examined microscopically using the ×10 objective for the detection of *Fasciola* eggs until the entire sediment had been examined (WHO, 2024).

The prevalence of fasciolosis was calculated as the percentage of positive samples relative to the total number of samples examined. Egg counts were expressed as the number of eggs per millilitre (eggs/mL) of bile examined (Ortiz *et al*., 2000).

Morphological and Morphometric Characterization of *Fasciola* species

Adult *Fasciola* specimens intended for morphometric analysis were transported to the laboratory in physiological saline and incubated at 37°C for 2 hours to facilitate the expulsion of gut contents. Each specimen was gently flattened between two microscope slides secured with rubber bands and examined under a stereomicroscope (Olympus, Japan) following the procedure described by Biu *et al*. (2013). Morphological landmarks were identified and marked before measurements were taken. Linear morphometric measurements were obtained to the nearest millimetre, while the corresponding ratios were subsequently calculated.

Morphological identification and morphometric characterization of the recovered flukes were carried out following the methods of Ashrafi *et al*. (2006), Biu *et al*. (2013), and Shaldoum *et al*. (2015), with slight modifications. The parameters measured included body length (BL), body width (BW), cone length (CL), cone width (CW), distance from the ventral sucker to the posterior end of the body (VS–P), distance from the ventral sucker to the junction of the vitelline glands (VS–Vit), and the calculated body length-to-body width (BL/BW) and cone length-to-cone width (CL/CW) ratios.

Data Analysis

Data generated from the study were entered into Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) and analysed using GraphPad Prism (GraphPad Software Inc., San Diego, CA, USA). Descriptive statistics were used to summarize the prevalence of *Fasciola* infection. Associations between infection status and categorical variables (sex, age, and breed) were assessed using the Pearson chi-square (χ^2) test. Statistical significance was established at $P < 0.05$.

RESULTS

Microscopic examination of bile samples collected from cattle slaughtered at Zango Shanu Abattoir revealed an overall prevalence of 50.50% for *Fasciola* infection, with 101 out of 200 cattle testing positive for *Fasciola* eggs (Table 1). Sex-wise distribution showed a prevalence of 54.81% among females and 45.83% among males. Among the cattle breeds examined, Sokoto Gudali recorded the highest prevalence (56.52%), followed by White Fulani (Bunaji) (50.34%), Red Bororo (46.67%), and Crosses (46.15%). Age-specific prevalence increased from 6.82% in cattle aged 1.0–1.5 years to 52.17% in those aged 2.0–2.5 years, 66.67% in cattle aged 3.0–3.5

years, and 81.48% in the 4.0–5.0 years age group (Table 1).

Analysis of the association between *Fasciola* infection and sex showed that 44 males and 57 females were positive for infection. Although the prevalence was higher among females (54.81%) than males (45.83%), there was no statistically significant association between sex and infection status (Pearson $\chi^2 = 1.608$, df = 1, P = 0.205) (Table 2).

The association between age and *Fasciola* infection was statistically significant (Pearson $\chi^2 = 50.304$, df = 3, P < 0.001). The prevalence of infection increased across the age groups from 6.82% in cattle aged 1.0–1.5 years to 52.17%, 66.67%, and 81.48% in cattle aged 2.0–2.5 years, 3.0–3.5 years, and 4.0–5.0 years, respectively (Table 3).

There was no statistically significant association between cattle breed and *Fasciola* infection (Pearson $\chi^2 = 0.522$, df = 3, P = 0.914). The prevalence recorded among the breeds was 56.52% in Sokoto Gudali, 50.34% in White Fulani (Bunaji), 46.67% in Red Bororo, and 46.15% in Crosses (Table 4).

The comparative morphometric measurements of *Fasciola* isolates recovered from cattle slaughtered at Zango Shanu Abattoir are presented in Table 5. The mean body length of the recovered flukes was 39.14 ± 1.92 mm, while the mean body width was 10.20 ± 1.92 mm. The mean body length-to-body width (BL/BW) ratio was 3.83 ± 0.21, and the mean cone length was 3.68 ± 0.08 mm.

Comparison of the morphometric measurements of the Zaria isolates with published international reference values showed that the mean body length and cone length were within the reported range for *Fasciola gigantica*, whereas the body width overlapped the reported ranges for both *F. hepatica* and *F. gigantica*. The mean body length-to-body width ratio (3.83 ± 0.21) was intermediate between the published reference ranges for the two species, as presented in Table 5

Table 1: Overall prevalence of *Fasciola* infection in cattle slaughtered at Zangon Shanu Abattoir according to sex, breed, and age, based on bile examination

Characteristic	Category	Total Examined (N)	Positive Cases (n)	Prevalence (%)
Overall Study		200	101	50.50
By Sex	Male	96	44	45.83
	Female	104	57	54.81
By Breed	White Fulani	149	75	50.34
	Red Bororo	23	13	56.52
	Sokoto Gudali	15	7	46.67
	Crosses	13	6	46.15
By Age (Years)	1.0 to 1.5	44	3	6.82
	2.0 to 2.5	69	36	52.17
	3.0 to 3.5	60	40	66.67
	4.0 to 5.0	27	22	81.48

Table 2: Association between *Fasciola* infection and sex of cattle slaughtered at Zangon Shanu Abattoir

Sex	Positive (Infected)	Negative (Non-Infected)	Total	Percentage Positive	dF	Pearson Chi-Square	P- value
Male	44	52	96	45.83	1	1.608	0.205
Female	57	47	104	54.81			
Total	101	99	200	50.50			

Table 3: Association between *Fasciola* infection and age group of cattle slaughtered at Zango Shanu Abattoir

Age Group (Years)	Positive (Count)	Negative (Count)	Total	Percentage Positive (%)	dF	Pearson Chi-Square	P-value
1.0 to 1.5	3	41	44	6.82	3	50.304	0.000
2.0 to 2.5	36	33	69	52.17			
3.0 to 3.5	40	20	60	66.67			
4.0 to 5.0	22	5	27	81.48			
Total	101	99	200	50.50			

Table 4: Association between *Fasciola* infection and breed of cattle slaughtered at Zangon Shanu Abattoir

Breed	Positive (Infected)	Negative (Non-Infected)	Total	Percentage Positive	dF	Pearson Chi-Square	P-value
White Fulani	75	74	149	50.34	3	0.522	0.914
Sokoto Gudali	13	10	23	56.52			
Red Bororo	7	8	15	46.67			
Crosses	6	7	13	46.15			
Total	101	99	200	50.50			

Table 5: Morphometric comparison of *Fasciola* isolates recovered from cattle slaughtered at Zangon Shanu Abattoir with published reference values for *F. hepatica* and *F. gigantica*

Morphometric Parameter	Host Species	Zaria Isolates Overall Mean±SD (mm)	International Standard Range: *F. hepatica* (mm)	International Standard Range: *F. gigantica* (mm)	Inference/Likely Species
Body Length (BL)	Cattle	39.14±1.92	20.0–30.0	40.0–70.0	Comparable with *F. gigantica* size
Body Width (BW)	Cattle	10.20±1.92	8.0–15.0	5.0–12.0	Comparable with *F. gigantica* size
BL/BW Ratio	Cattle	3.83±0.21	2.0–3.5 (Broad)	4.0–7.0 (Slender)	Intermediate (Hybrid/High *F. gigantica*)
Cone Length (CL)	Cattle	3.68±0.08	1.0 (Short)	~3.0–5.0 (Long)	Consistent with *F. gigantica*'s long cone

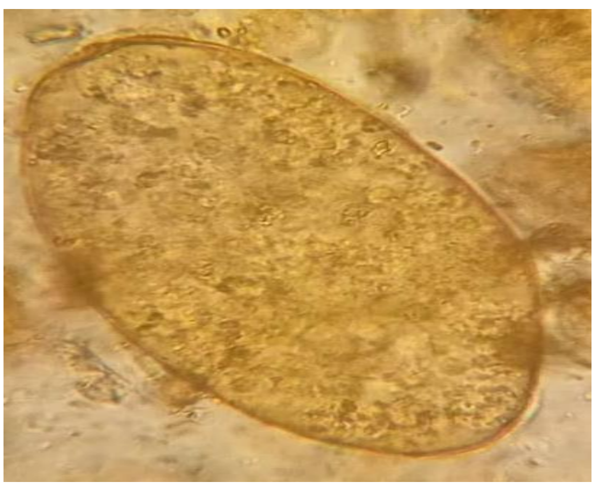

Plate 1: *Fasciola* egg recovered from the bile specimen of an infected cow slaughtered at Zangon Shanu Abattoir, Zaria. (×40 magnification)

Plate 2: Adult *Fasciola* spp. recovered from the bile duct of an infected cow slaughtered at Zangon Shanu Abattoir, Zaria

Plate 3: Morphometric measurements of an adult *Fasciola* specimen recovered from cattle slaughtered at Zangon Shanu abattoir, Zaria

DISCUSSION

The present study investigated the prevalence of fasciolosis among cattle slaughtered at Zangon Shanu Abattoir, Zaria, Kaduna State, and characterized the recovered *Fasciola* isolates using morphological and morphometric techniques. An overall prevalence of 50.5% was recorded, indicating that bovine fasciolosis remains endemic in the study area. This prevalence is higher than the pooled national prevalence of 29.0% recently reported in a systematic review and meta-analysis of bovine fasciolosis in Nigeria (Agbajelola and Agbajelola, 2025) but is comparable to findings reported in some abattoir-based studies conducted in northern Nigeria (Dada and Jegede, 2019; Yaro *et al*., 2022). Variations in prevalence among studies may be attributed to differences in geographical location, climatic conditions, season of sampling, grazing practices, sources of slaughter animals, and diagnostic methods employed (Mas-Coma *et al*., 2019; Nyagura *et al*., 2022). Zaria serves as a major livestock marketing centre receiving cattle from different parts of northern Nigeria, where extensive pastoral production systems and communal grazing increase the likelihood of exposure to infective metacercariae.

Although a higher prevalence of infection was observed among female cattle (54.81%) than males (45.83%), the association between sex and infection was not statistically significant (P > 0.05). The higher prevalence among females may be associated with their longer retention within herds for breeding and milk production, thereby increasing the duration of exposure to contaminated pastures. Similar observations have been reported in previous studies (Phiri *et al*., 2005; Ieren *et al*., 2016), although several authors have suggested that management practices and duration of exposure exert a greater influence on infection than sex alone (Nyagura *et al*., 2022).

Age had a significant influence on the occurrence of fasciolosis (P < 0.001), with prevalence increasing progressively from younger to older cattle. This finding supports the cumulative exposure hypothesis, whereby animals grazing over longer periods are more likely to ingest infective metacercariae and accumulate chronic infections (Urquhart *et al*., 1996). Older cattle also tend to remain longer within extensive production systems, increasing opportunities for repeated exposure. Similar age-related trends have been reported in Nigeria and other endemic regions of Africa (Mas-Coma *et al*., 2019; Nyagura *et al*., 2022; Yaro *et al*., 2022).

Breed-specific prevalence varied slightly, with Sokoto Gudali recording the highest prevalence, followed by White Fulani (Bunaji), Red Bororo, and Crosses. However, these differences were not statistically significant (P > 0.05), suggesting that breed was not an important determinant of infection in the present study. This observation indicates that cattle reared under similar grazing systems and environmental conditions are likely to experience comparable exposure to *Fasciola* infection irrespective of breed. Similar findings have been reported by Ieren *et al*. (2016) and Dada and Jegede (2019), who observed that environmental factors and husbandry practices play a more important role in disease transmission than breed differences.

Morphological and morphometric examination showed that the recovered flukes were predominantly consistent with *Fasciola gigantica*. The mean body length, cone length, and other morphometric parameters closely corresponded with published reference values for *F. gigantica* (Periago *et al*., 2008). However, the body length-to-body width ratio occupied an intermediate position between the reported ranges for *F. hepatica* and *F. gigantica*. Although this observation may suggest the occurrence of intermediate morphotypes, morphometric characteristics alone are insufficient to confirm hybridization because parasite age, host species, environmental conditions, and specimen preparation may influence body measurements (Periago *et al*., 2008; Mas-Coma *et al*., 2019). Molecular characterization using appropriate genetic markers would therefore be required to confirm the occurrence of hybrid forms.

Overall, the findings of this study demonstrate that bovine fasciolosis remains an important parasitic disease among cattle slaughtered at Zangon Shanu Abattoir, Zaria. The significant association between infection and age highlights the role of prolonged environmental exposure in disease transmission, while the absence of significant associations with sex and breed suggests that management practices and grazing systems are likely to exert greater influence than host-related factors. The predominance of morphometric characteristics consistent with *F. gigantica* agrees with the recognised distribution of this species in tropical Africa and provides baseline epidemiological information for future molecular investigations and strategic fasciolosis control programmes in northwestern Nigeria.

CONCLUSION

This study demonstrated that fasciolosis is highly prevalent among ruminants slaughtered in Zaria metropolis, affecting approximately half of all cattle examined. The infection was strongly influenced by age and sex, with older animals and females being more commonly infected. The morphometric analysis conclusively identified the endemic species as predominantly *Fasciola gigantica*, with possible intermediate forms between *F. hepatica* and *F. gigantica*. The near-universal infection among adult ruminants, coupled with the presence of intermediate morphotypes, underscores the parasite's high adaptability and endemic stability in the study area. Overall, the findings reveal that fasciolosis remains an economically significant and epidemiologically stable parasitic disease in Zaria's livestock sector.

REFERENCES

Abbas, I. I., & Arigbede, Y. A. (2012), Green area mapping of Ahmadu Bello University Main Campus, Zaria, Nigeria using remote sensing (Rs) and geographic information system (Gis) techniques. *Journal of Geography and Regional Planning*, 5(10), 287-292.

Agbajelola, V.I., & Agbajelola, B.S. (2025). A systematic review and meta-analysis on the prevalence of bovine fascioliasis in Nigeria. *Acta Parasit.* 70, 57. https://doi.org/10.1007/s11686-025-00991-7.

Aminu, Z., & Jaiyeoba, I. A. (2015). An assessment of soil degradation in Zaria area, Kaduna state, Nigeria. *Ife Research Publications in Geography,* 13, 26 – 36.

Ashrafi, K., Valero, M. A., Panova, M. V., Massoud, J., & Mass– Coma, S. (2006). Phenotypic analysis of adult of Fasciola hepatica, Fasciola gigantica and intermediate forms from the endemic region of Gilan, Iran. *Parasitology International*, 55, 249 – 260.

Biu, A. A., Paul, B. T., Konto, M., & Yauba, A. M. (2013). Cross- sectional and phenotypic studies on fascioliasis in slaughter cattle in Maiduguri, Nigeria. *Journal of Agriculture and Veterinary Sciences*, 2, 155-162.

Caravedo, M. A., & Cabada, M. M. (2020). Human fascioliasis: Current epidemiological status and strategies for diagnosis, treatment, and control. *Research and Reports in Tropical Medicine,* 11, 149–158. https://doi.org/10.2147/RRTM.S237461

Dada, E. O., & Jegede, S. O. (2019). Prevalence of fascioliasis and dicrocoeliasis in cattle slaughtered in some abattoirs in Akure metropolis, Ondo state, Nigeria. *International Journal of Pathogen Research*, 3 (2), 1-7. ⟨hal-05353788⟩

Flores-Velázquez, L. M., Ruiz-Campillo, M. T., Herrera-Torres, G., & Martínez-Moreno, Á. M. (2023). Fasciolosis: Pathogenesis, host–parasite interactions, and implication in vaccine development. *Frontiers in Veterinary Science, 10*, Article 1270064. https://doi.org/10.3389/fvets.2023.1270064

Ieren, I. I., Ajanusi, O. J., & Mbaya P. Y. (2016). Prevalence of liver flukes in cattle, and small ruminants at slaughter in Zaria, Nigeria. *Research in Zoology*, 6(3): 33-36. DOI: 10.5923/j.zoology.20160603.01

Liba, J. W., Atsanda, N. N., & Francis, M. I. (2018). Prevalence of fascioliasis in cattle slaughtered at Maiduguri Municipal Abattoir, Borno State, Nigeria. *Nigerian Journal of Parasitology*, 39(2), 242. doi. 10.4314/njpar.v39i2.22

Mas-Coma, S., Bargues, M. D., & Valero, M. A. (2019). Fascioliasis and other plant-borne trematode zoonoses. *International Journal for Parasitology, 49*(10–11), 743–759. https://doi.org/10.1016/j.ijpara.2019.04.009

Nyagura, I., Malatji, M. P., & Mukaratirwa, S. (2022). Occurrence of *Fasciola* species in livestock, wildlife and humans, and the geographical distribution of their intermediate hosts in South Africa: A scoping review. *Frontiers in Veterinary Science, 9*, 935428. https://doi.org/10.3389/fvets.2022.935428

Ortiz, P., Cabrera, M., Jave, J., Claxton, J., & Williams, D. (2000). Human fascioliasis: Prevalence and treatment in a rural area of Peru. *The infectious Disease Review – Microbes of man, animals and the environment,* 2(1), 42-46.

Periago, M. V., Valero, M. A., Panova, M., & Mas-Coma, S. (2008). Phenotypic comparisoof allopatric and sympatric *Fasciola hepatica* and *Fasciola gigantica* adults from European and African bovines using a computer image analysis system. *Parasitology Research, 102*(3), 545–555. https://doi.org/10.1007/s00436-007-0794-7

Phiri, A. M., Phiri, I. K., Sikasunge, C. S., & Monrad, J. (2005). Prevalence of fasciolosis in Zambian cattle observed at selected abattoirs with emphasis on age, sex and origin. *Journal of Veterinary Medicine B, 52*(9), 414–416. https://doi.org/10.1111/j.1439-0450.2005.00894.x

Shaldoum, F. M., Muhammad, A. A., Sadek, A. G., Yassin, M. K., Elmadawy, A. O. & Gobaara, I. M. (2015). Advance and classical diagnosis of *Fasciola* spp. in Egypt. *Journal of American Science*. 11(5), 111-120.

Shinggu, P. A., Olufemi, O. T., Nwuku, J. A., Baba-Onoja, E. B. T., & Iyawa P. D. (2019). Liver flukes egg infection and associated risk factors in white fulani cattle slaughtered in Wukari, southern Taraba state, Nigeria. *Advances in Preventive Medicine*, Volume 2019, 5. https://doi.org/10.1155/2019/2671620

Tanabe, M. B., Caravedo, M. A., White, A. C., Jr., & Cabada, M. M. (2024). An update on the pathogenesis of fascioliasis: What do we know? *Research and Reports in Tropical Medicine, 15*, 13–24. https://doi.org/10.2147/RRTM.S397138

Thrusfield, M. (2018). Veterinary Epidemiology, 4th ed., Wiley-Blackwell, Oxford.

Urquhart, G. M., Armour, J., Duncan, J. L., Dunn, A. M., & Jennings, F. W. (1996). *Veterinary parasitology* (2nd ed.). Blackwell Science.

Vassilev, G. D., & Jooste, R. (1991). Production losses and economic impact of fasciolosis in cattle: A review. *Tropical Animal Health and Production, 23*, 193–200.

World Health Organization (2020). *Ending the neglect to attain the Sustainable Development Goals: A road map for neglected tropical diseases 2021–2030*.

World Health Organization (2024). *Bench aids for the diagnosis of intestinal parasites* (2nd ed.).

Yaro, A. H., Mohammed, B. R., Abdullahi, U. S., & Ibrahim, M. (2022). Prevalence of bovine fasciolosis among cattle slaughtered in Kano metropolitan abattoirs, Nigeria. *Sokoto Journal of Veterinary Sciences, 20*(3), 170–177.