



Disease patterns of ruminants from Sokoto: A retrospective study of illness duration, systemic involvement and demographics

A Umar, N Abdullahi, H Tukur, MU Ibrahim, A Arzika, A Usman, FA Tukur, LB Yahaya & A Abdulrasheed*

Ministry of Livestock and Fisheries Development, Sokoto, Nigeria

*Correspondence: Tel.: +234; E-mail: rasheedabdulrauf@gmail.com

Copyright: © 2026

Umar *et al.* This is an open-access article published under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Publication History:

Received: 11-01-2026

Revised: 07-05-2026

Accepted: 18-05-2026

Abstract

Ruminants play an essential socio-economic role in Nigeria, yet their productivity is affected by a wide range of infectious and non-infectious diseases. This study examined the pattern of disease occurrence in cattle, sheep and goats presented to the Veterinary Clinic Sokoto, Aliyu Jodi Road, between 2021 and 2023, with emphasis on illness duration, body system involvement and demographic influences. Data from 298 cattle, 7,145 sheep and 4,797 goats were analysed using descriptive statistics and chi-square tests to determine the associations between disease patterns and age, sex and breed. Helminthosis emerged as the most frequently diagnosed disease across all illness durations, accounting for the majority of peracute, acute, subacute and chronic cases in cattle, sheep and goats. Contagious bovine pleuropneumonia (CBPP) was the leading cause of chronic disease in cattle. Across all species, the gastrointestinal system was the most affected body system, followed by musculoskeletal, cutaneous, reproductive and respiratory systems, with notable respiratory–gastrointestinal comorbidities in goats. Demographic analysis revealed that age significantly ($p < 0.05$) influenced disease distribution across body systems in all species. In sheep and goats, sex and breed are associated ($p < 0.05$) with affected body systems, whereas these factors were not significant in cattle. The predominance of gastrointestinal disorders highlights the ongoing burden of parasitic and nutritional diseases under various management systems. These findings emphasise the need for targeted preventive strategies, parasite control programs and strengthened herd health management to reduce disease burden and enhance ruminant productivity in semi-arid regions of Nigeria.

Keywords: Demographics, Disease, Duration, Illness, Ruminants

Introduction

Ruminants such as cattle, sheep and goats play a vital social and economic role in Nigeria and globally by providing meat, milk, hide and livelihoods to many

families and societies (Fakoya & Oloruntoba, 2009). In Nigeria, ruminants contribute about 85% of the national meat supply, with small ruminants (sheep

and goats) accounting for 35% of this figure, and supporting numerous value chains from farming to marketing to butchery and hide or skin production (Mustapha *et al.*, 2024). Socially, ruminants feature in sacrificial offerings, ceremonies and festivals, and are often projected as a symbol of status (Ocheja *et al.*, 2025). Despite the socio-economic significance of ruminants in many parts of the world, the productivity and sustainability of ruminants' production system is threatened by numerous health challenges (Armson *et al.*, 2020). Disease outbreaks often lead to lower productivity, increased mortality and higher treatment costs (Tsouloufi *et al.*, 2023). Thus, understanding the nature and impact of diseases affecting ruminants is essential for developing prevention strategies that will safeguard livestock production (Nuvey *et al.*, 2023).

Acute diseases in ruminants usually last hours to a few days and are associated with highly contagious bacterial and viral infections. Such diseases may include foot-and-mouth disease, with clinical and infectious phases averaging 8.5 days (Yadav *et al.*, 2019), and *Clostridium perfringens* type C/D, which manifests as bloody diarrhoea and sudden death in lambs (Hussain *et al.*, 2022). Sub-acute diseases usually last between 1-4 weeks and can manifest as ruminal acidosis in high-grain-fed cattle or sheep, characterized by low ruminal pH, reduced feed intake and diarrhoea (Christodouloupoulos, 2025). Another sub-acute condition in ruminants includes the migratory phase of fasciolosis with manifestations of anaemia, jaundice and potential liver failure (Tsega *et al.*, 2015). Chronic illness lasts months to years and is predominantly seen in helminthic cases such as gastrointestinal nematodiasis and lungworm infections, which often result in progressive emaciation (Kebede *et al.*, 2025).

The digestive system is the most affected body system in ruminants due to its vital role in microbial fermentation of fibrous feed, making it prone to disorders such as ruminal acidosis, bloat and displacement (Bayne & Edmondson, 2021). These conditions often result from sudden dietary change, nutritional imbalances and hypomotility (Wang *et al.*, 2023). The respiratory system is affected by diseases such as bovine respiratory disease complex, contagious caprine pleuropneumonia and pneumonic pasteurellosis, manifesting clinically as pneumonia, fever, coughing and dyspnea (Kamel *et al.*, 2024). The reproductive system is affected by diseases such as bovine viral diarrhoea, brucellosis and leptospirosis, with clinical manifestations of abortion, stillbirth,

infertility and reduced milk yield (Ibrahim *et al.*, 2021).

Demographic factors, including age, sex and breed, influence the susceptibility, transmission and impact of infectious and non-infectious diseases in ruminants (Underwood *et al.*, 2015). Young ruminants under six months of age are often vulnerable to respiratory and enteric diseases due to suboptimal rumen function and incomplete passive immunity transfer, while resistance to these diseases may increase with age (Colditz *et al.*, 1996). Female ruminants are often more affected by diseases such as PPR and toxoplasmosis due to the stress of lactation, while males are often affected by circulatory diseases such as anaplasmosis (Torsson *et al.*, 2017). *Bos indicus* cattle are more resistant to *Anaplasma marginale* infection than the *Bos taurus* breed. Some breeds of sheep, such as *Corriedale*, are more prone to certain inherited hepatic disorders compared to others, while goats show breed-specific vulnerabilities to lysosomal storage diseases that affect the nervous and musculoskeletal system (Underwood *et al.*, 2015; Tabor, 2022; Crane, 2024).

There is a critical gap in knowledge on illness duration, systemic involvement and demographic influences as it relates to diseases affecting ruminants in Sokoto metropolis, where livestock production is a key economic activity despite challenges such as limited diagnostic facilities and inadequate disease surveillance (Bolajoko *et al.*, 2020). This study seeks to establish an epidemiological baseline of ruminant diseases in the Sokoto metropolis, with emphasis on illness duration, systemic involvement and demographic influences.

Materials and Methods

Study area and data collection

This study was conducted at the Veterinary Clinic Sokoto, Aliyu Jodi Road, situated within the Sokoto metropolis in the semi-arid region of north-western Nigeria. Geographically, Sokoto State is located between longitudes 4°8'E and 6°54'E and latitudes 12°N and 13°58'N, encompassing an area of approximately 32,000 square kilometres. As of 2019, the state had an estimated human population of 5.8 million (NBS, 2020) and a livestock population comprising approximately 1.8 million cattle, 2.6 million sheep and 2.9 million goats (MAHF, 2012).

Data on cattle, sheep, and goat cases were collected from the clinical case files of the Veterinary Clinic Sokoto from 2021 to 2023. These data were analysed to assess the illness duration, systemic involvement and demographic influences.

Data collection and analysis

Data were collected using Google Forms and exported to Microsoft Excel for analysis. A chi-square test was conducted using the Statistical Package for the Social Sciences (SPSS, Version 29.0.2.0, Chicago, IL, USA) to determine the frequency of illness duration (per acute, acute, subacute and chronic), systemic involvement and demographics for infectious and non-infectious diseases. The analysis also examines the statistical significance between these variables and disease occurrence.

Results

A total of 298 bovine, 7,145 ovine and 4,797 caprine cases were recorded during the study period. In bovines, 48 (16.11%) of the cases were helminthosis, followed by 26 (8.73%) Contagious Bovine Pleuropneumonia, 19 (6.38%) hypoglycemia, 14 (4.698%) mange and 11 (3.70%) prophylaxis and atresia ani each. Other notable conditions included 10 (3.36%) nutritional diarrhoea and bloat each, 9 (3.02%) fractures and traumatic injuries each, and 8 (2.69%) nutritional deficiency and dystocia each. Conditions such as omphalitis, urolithiasis and abscesses occurred with moderate frequency of 6 (2.01%), while brucellosis, dermatophytosis and downer cow syndrome were less common, with frequencies of five or fewer. Rare conditions, such as cranium bifidum, were recorded only once.

In ovine, 1360 (19.03%) cases of helminthosis were diagnosed, followed by 596 (8.34%) pneumonic pasteurellosis, 431 (6.03%) lousiness, 387 (5.41%) traumatic injury and 341 (4.77%) nutritional diarrhoea. Other common conditions included 316 (4.42%) bloat, 224 (3.13%) foot rot, 217 (3.03%) PPR, 130 (1.81%) listeriosis and 112 (1.56%) rumen impaction. Less frequent conditions were 55 (0.77%) coccidiosis, 47 (0.65%) grain overload, 43 (0.60%) pregnancy toxemia, and 39 (0.54%) mastitis. Eighteen disease conditions, such as omphalitis, hydrocele, evisceration, haematoma and cryptosporidiosis, were diagnosed only once.

In caprines, 782 (16.30%) cases of helminthosis were diagnosed, followed by 566 (11.80%) PPR, 249 (5.19%) lousiness, 247 (5.15%) bloat, and 231 (4.82%) pneumonic pasteurellosis. Other common conditions included 192 (4.00%) dystocia, 186 (3.88%) nutritional diarrhoea, 174 (3.63%) traumatic injury, 158 (3.29%) mastitis and 142 (2.96%) mange. Less frequent conditions were 77 (1.61%) retained placenta, 67 (1.40%) abortion, 65 (1.36%) infectious diarrhoea and 52 (1.08%) foot rot. Fourteen disease conditions, such as intestinal evisceration,

staphiloma, uveitis, pharyngitis and polioencephalomalacia, were diagnosed only once.

Most frequent diseases by duration

In bovine, helminthosis was the most frequently recorded disease during the peracute, acute and subacute durations, accounting for 33 (19.08%) of 173 peracute cases, 7 (13.21%) of 53 acute cases and 4 (14.81%) of 27 subacute cases. During the chronic duration, CBPP was the most frequent disease, accounting for 7 (15.56%) of 45 chronic cases. In ovine, helminthosis was the most frequently recorded disease across all durations. It accounted for 919 (20.20%) of 4,550 peracute cases, 134 (9.44%) of 1,420 acute cases, 120 (24.24%) of 495 subacute cases and 163 (23.97%) of 680 chronic cases. Similarly, in caprines, helminthosis was the most frequently recorded disease in all durations. It accounted for 493 (16.91%) of 2,915 peracute cases, 192 (13.24%) of 1,450 acute cases, 44 (18.33%) of 240 subacute cases and 58 (30.21%) of 192 chronic cases (Table 1).

Disease occurrence according to body systems

The gastrointestinal system was the most frequently affected body system in both infectious and non-infectious diseases across all species. In bovine, gastrointestinal involvement accounted for 71 (47.97%) infectious and 72 (48.00%) non-infectious cases. Similarly, in ovine, gastrointestinal conditions accounted for 1,645 (41.21%) infectious and 1,300 (41.23%) non-infectious cases, while in caprine, they accounted for 1,024 (36.28%) infectious and 716 (36.27%) non-infectious cases. Musculoskeletal conditions were the second most affected system in ovine, accounting for 631 (15.81%) infectious and 497 (15.76%) non-infectious cases, while in bovine they accounted for 16 (10.81%) infectious and 16 (10.67%) non-infectious cases, and in caprine for 283 (10.02%) infectious and 197 (9.98%) non-infectious cases. Cutaneous conditions were also common, accounting for 15 (10.14%) infectious and 17 (11.33%) non-infectious cases in bovine, 550 (13.78%) infectious and 433 (13.73%) non-infectious cases in ovine, and 350 (12.40%) infectious and 245 (12.41%) non-infectious cases in caprine.

Respiratory conditions accounted for 13 (8.78%) infectious and 13 (8.67%) non-infectious cases in bovine, 395 (9.89%) infectious and 309 (9.80%) non-infectious cases in ovine, and 144 (5.10%) infectious and 101 (5.12%) non-infectious cases in caprine. Reproductive system involvement accounted for 9 (6.08%) infectious and 11 (7.33%) non-infectious

cases in bovine, 324 (8.12%) infectious and 257 (8.15%) non-infectious cases in ovine, and 364 (12.89%) infectious and 257 (13.02%) non-infectious cases in caprine. Unspecific conditions accounted for 6 (4.05%) infectious and 7 (4.67%) non-infectious cases in bovine, 193 (4.83%) infectious and 152 (4.82%) non-infectious cases in ovine, and 87 (3.08%) infectious and 62 (3.14%) non-infectious cases in caprine. Nervous system involvement accounted for 5 (3.38%) infectious and 6 (4.00%) non-infectious cases in bovine, 118 (2.96%) infectious and 93 (2.95%) non-infectious cases in ovine, and 52 (1.84%) infectious and 37 (1.87%) non-infectious cases in caprine. Urinary conditions accounted for 3 (2.03%) infectious and 4 (2.67%) non-infectious cases in bovine, 47 (1.18%) infectious and 37 (1.17%) non-infectious cases in ovine, and 39 (1.38%) infectious and 27 (1.37%) non-infectious cases in caprine. Respiratory-gastrointestinal involvement accounted for a notable proportion in caprine, with 332 (11.76%) infectious and 232 (11.75%) non-infectious cases (Table 2).

Influence of demographic factors on body systems

The distribution of body systems affected by diseases in bovines varied significantly with age (Table 3a). Among young animals, the gastrointestinal system was the most frequently affected, accounting for 102 (53.13%) cases, followed by cutaneous (22; 11.46%), musculoskeletal (19; 9.90%) and respiratory systems (14; 7.29%). Nervous system involvement accounted for 11 (5.73%) cases, while unspecific conditions accounted for 7 (3.65%) cases. Other systems, including urinary, nervous–reproductive, ocular and gastrointestinal–musculoskeletal, accounted for

smaller proportions. In adult animals, the gastrointestinal system remained the most affected, accounting for 41 (38.68%) cases, followed by reproductive (16; 15.09%), musculoskeletal (13; 12.26%) and respiratory systems (12; 11.32%). The association between age and body system affected was statistically significant ($\chi^2 = 44.452$, $df = 11$, $p < 0.001$).

Based on sex, the gastrointestinal system was also the most frequently affected in both males and females, accounting for 69 (46.62%) and 74 (49.33%) cases, respectively. In males, respiratory and reproductive systems accounted for 16 (10.81%) and 14 (9.46%) cases, respectively, while cutaneous conditions accounted for 12 (8.11%) cases. In females, cutaneous conditions accounted for 20 (13.33%) cases, followed by musculoskeletal (15; 10.00%) and respiratory (10; 6.67%) conditions. Other body systems accounted for smaller proportions in both sexes. There was no statistically significant association between sex and body system affected ($\chi^2 = 17.276$, $df = 11$, $p = 0.068$). Across breeds, the gastrointestinal system was the most frequently affected body system in all bovine breeds, accounting for 95 (49.22%) cases in Sokoto Gudali, 21 (47.73%) in Rahaji, 6 (42.86%) in Bunaji, 2 (40.00%) in Holstein Friesian, and 19 (45.24%) in cross-breeds.

Musculoskeletal and cutaneous systems were also commonly affected across breeds, while respiratory and reproductive conditions accounted for moderate proportions. Other body systems accounted for relatively smaller proportions across all breeds. There was no statistically significant association between breed and body system affected in bovine ($\chi^2 = 14.556$, $df = 44$, $P = 0.999$) (Table 3a).

Table 1: Frequent cases associated with each duration of illness in ruminants

Species	Duration	Most Frequent Disease	Disease frequency (%)	Total cases in duration
Bovine	Peracute	Helminthosis	33 (19.08)	173
	Acute	Helminthosis	7 (13.21)	53
	Subacute	Helminthosis	4 (14.81)	27
	Chronic	CBPP	7 (15.56)	45
Ovine	Peracute	Helminthosis	919 (20.20)	4550
	Acute	Helminthosis	134 (9.44)	1420
	Subacute	Helminthosis	120 (24.24)	495
	Chronic	Helminthosis	163 (23.97)	680
Caprine	Peracute	Helminthosis	493 (16.91)	2915
	Acute	Helminthosis	192 (13.24)	1450
	Subacute	Helminthosis	44 (18.33)	240
	Chronic	Helminthosis	58 (30.21)	192

CBPP = Contagious Bovine Pleuropneumonia

Table 2: Frequent body system affected by infectious and non-infectious diseases in ruminants

Body System	Bovine infectious (%)	Bovine non-infectious (%)	Ovine infectious (%)	Ovine non-infectious (%)	Caprine infectious (%)	Caprine Non-infectious (%)
Gastrointestinal	71 (47.97)	72 (48.00)	1645 (41.21)	1300 (41.23)	1024 (36.28)	716 (36.27)
Musculoskeletal	16 (10.81)	16 (10.67)	631 (15.81)	497 (15.76)	283 (10.02)	197 (9.98)
Cutaneous	15 (10.14)	17 (11.33)	550 (13.78)	433 (13.73)	350 (12.40)	245 (12.41)
Respiratory	13 (8.78)	13 (8.67)	395 (9.89)	309 (9.80)	144 (5.10)	101 (5.12)
Reproductive	9 (6.08)	11 (7.33)	324 (8.12)	257 (8.15)	364 (12.89)	257 (13.02)
Unspecific	6 (4.05)	7 (4.67)	193 (4.83)	152 (4.82)	87 (3.08)	62 (3.14)
Nervous	5 (3.38)	6 (4.00)	118 (2.96)	93 (2.95)	52 (1.84)	37 (1.87)
Urinary	3 (2.03)	4 (2.67)	47 (1.18)	37 (1.17)	39 (1.38)	27 (1.37)
Nervous-Reproductive	3 (2.03)	2 (1.33)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Ocular	2 (1.35)	3 (2.00)	33 (0.83)	26 (0.82)	35 (1.24)	27 (1.37)
Gastrointestinal-Musculoskeletal	2 (1.35)	1 (0.67)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Circulatory	1 (0.68)	0 (0.00)	1 (0.03)	1 (0.03)	0 (0.00)	0 (0.00)
Mammary	0 (0.00)	0 (0.00)	35 (0.88)	27 (0.86)	100 (3.54)	70 (3.55)
Auditory	0 (0.00)	0 (0.00)	1 (0.03)	1 (0.03)	1 (0.04)	1 (0.05)
Thermoregulatory	0 (0.00)	0 (0.00)	5 (0.13)	4 (0.13)	3 (0.11)	2 (0.10)
Respiratory-Gastrointestinal	0 (0.00)	0 (0.00)	14 (0.35)	11 (0.35)	332 (11.76)	234 (11.75)
Cutaneous-Musculoskeletal	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	3 (0.11)	2 (0.10)
Lymphatic	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.04)	0 (0.00)
Total	148 (100)	150 (100)	3992 (100)	3153 (100)	2823 (100)	1974 (100)

The distribution of body systems affected by diseases in ovine varied significantly with age. Among young animals, the gastrointestinal system was the most frequently affected, accounting for 648 (41.20%) cases, followed by musculoskeletal (248; 15.77%), cutaneous (217; 13.80%) and respiratory systems (155; 9.85%). Nervous system involvement accounted for 44 (2.80%) cases, while reproductive and unspecific conditions accounted for 78 (4.96%) and 77 (4.90%) cases, respectively. Other systems, including urinary, mammary, ocular, respiratory-gastrointestinal, thermoregulatory, circulatory and auditory systems, accounted for smaller proportions. In adult animals, the gastrointestinal system also accounted for the highest proportion of cases (2,297; 41.23%), followed by musculoskeletal (880; 15.80%), cutaneous (766; 13.75%), respiratory (549; 9.85%) and reproductive systems (503; 9.03%). The association between age and body system affected was statistically significant ($\chi^2 = 66.274$, $df = 13$, $p < 0.001$) (Table 3b).

Based on sex, the gastrointestinal system was the most frequently affected in both males and females, accounting for 1,391 (40.97%) and 1,554 (41.44%)

cases, respectively. In males, musculoskeletal and cutaneous systems accounted for 536 (15.79%) and 457 (13.46%) cases, respectively, while reproductive system involvement accounted for 298 (8.78%) cases. In females, musculoskeletal and cutaneous systems accounted for 592 (15.79%) and 526 (14.03%) cases, respectively, while respiratory and reproductive systems accounted for 369 (9.84%) and 283 (7.55%) cases, respectively. Other systems accounted for relatively smaller proportions in both sexes. There was no statistically significant association between sex and body system affected ($\chi^2 = 6.102$, $df = 13$, $p = 0.942$). Across breeds, the gastrointestinal system was the most frequently affected in all ovine breeds and was also commonly affected across all breeds, while respiratory and reproductive systems accounted for moderate proportions. Other systems accounting for 1,805 (41.24%) cases in Ouda, 395 (41.28%) in Yankasa, 259 (41.24%) in Balami, 26 (41.94%) in Sudanese and 460 (41.03%) in cross-breeds. Musculoskeletal and cutaneous systems were including nervous, urinary, mammary, ocular and combined system conditions, accounted for smaller proportions across all breeds. There was no

Table 3a: Cross tabulation for the influence of demographic factors on systems affected by infectious and non-infectious diseases for bovine

Bovine	GIT	MSK	CUT	RES	REP	UNS	NER	URI	NER-REP	OCU	GIT-MSK	CIR	X ²	df	p value
Young	102 (53.13)	19 (9.90)	22 (11.46)	14 (7.29)	4 (2.08)	7 (3.65)	11 (5.73)	5 (2.60)	2 (1.04)	4 (2.08)	2 (1.04)	0 (0.00)	44.452	11	< 0.001
Adult	41 (38.68)	13 (12.26)	10 (9.43)	12 (11.32)	16 (15.09)	6 (5.66)	0 (0.00)	2 (1.89)	3 (2.83)	1 (0.94)	1 (0.94)	1 (0.94)			
Male	69 (46.62)	17 (11.49)	12 (8.11)	16 (10.81)	14 (9.46)	8 (5.41)	5 (3.38)	2 (1.35)	3 (2.03)	2 (1.35)	0 (0.00)	0 (0.00)	17.276	11	0.068
Female	74 (49.33)	15 (10.00)	20 (13.33)	10 (6.67)	6 (4.00)	5 (3.33)	6 (4.00)	5 (3.33)	2 (1.33)	3 (2.00)	3 (2.00)	1 (0.67)			
S/Gudali	95 (49.22)	22 (11.40)	19 (9.84)	16 (8.29)	12 (6.22)	9 (4.66)	6 (3.11)	4 (2.07)	3 (1.55)	3 (1.55)	2 (1.04)	2 (1.04)	14.556	44	0.999
Rahaji	21 (47.73)	5 (11.36)	5 (11.36)	4 (9.09)	3 (6.82)	2 (4.55)	1 (2.27)	1 (2.27)	1 (2.27)	1 (2.27)	0 (0.00)	0 (0.00)			
Bunaji	6 (42.86)	2 (14.29)	2 (14.29)	1 (7.14)	1 (7.14)	1 (7.14)	1 (7.14)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)			
H/Friesian	2 (40.00)	1 (20.00)	1 (20.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (20.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)			
Cross-Breed	19 (45.24)	2 (4.76)	5 (11.90)	5 (11.90)	4 (9.52)	1 (2.38)	2 (4.76)	1 (2.38)	1 (2.38)	1 (2.38)	1 (2.38)	0 (0.00)			

Key: S/Gudali: Sokoto Gudali, H/Friesian: Holstein Friesian, CIR: Circulatory, CUT: Cutaneous, GIT: Gastrointestinal, GIT-MSK: Gastrointestinal-Musculoskeletal, MSK: Musculoskeletal, NER: Nervous, NER-REP: Nervous-Reproductive, OCU: Ocular, REP: Reproductive, RES: Respiratory, UNS: Unspecific, URI: Urinary, X²: Chi-square, DF: Degree of freedom, p-value: Probability value, Spp.: Species, *Significantly different at $p < 0.05$.

statistically significant association between breed and body system affected in ovine ($\chi^2 = 8.706$, $df = 52$, $p = 0.999$) (Table 3b).

The distribution of body systems affected in caprines did not vary significantly with age. Among young animals, the gastrointestinal system was the most frequently affected, accounting for 414 (36.22%) cases, followed by cutaneous (142; 12.42%), reproductive (148; 12.95%), musculoskeletal (115; 10.06%) and respiratory-gastrointestinal systems (134; 11.72%).

Other systems, including respiratory, mammary, nervous, urinary, ocular, unspecific and thermoregulatory systems, accounted for smaller proportions. Similarly, in adult animals, the gastrointestinal system was the most frequently affected, accounting for 1,326 (36.29%) cases, followed by cutaneous (453; 12.40%), reproductive (473; 12.95%), musculoskeletal (365; 9.99%), and respiratory-gastrointestinal systems (432; 11.82%). There was no statistically significant association between age and body system affected in caprine ($\chi^2 = 0.793$, $df = 11$, $p = 0.999$).

Based on sex, the gastrointestinal system was also the most frequently affected in both males and females, accounting for 507 (36.27%) and 1,233 (36.28%) cases, respectively. In males, reproductive and cutaneous systems accounted for 181 (12.95%) and 173 (12.38%) cases, respectively, while respiratory-gastrointestinal involvement accounted for 166 (11.87%) cases. In females, reproductive and cutaneous systems accounted for 440 (12.94%)

and 422 (12.41%) cases, respectively, while respiratory-gastrointestinal involvement accounted for 400 (11.77%) cases. Other body systems accounted for smaller proportions in both sexes. There was no statistically significant association between sex and body system affected in caprine ($\chi^2 = 6.276$, $df = 11$, $p = 0.854$).

Across breeds, the gastrointestinal system was the most frequently affected body system in all caprine breeds, accounting for 1,311 (36.30%) cases in Red Sokoto, 120 (36.36%) in Sahel, 131 (36.29%) in West African Dwarf and 178 (36.03%) in cross-breeds. Cutaneous, reproductive and musculoskeletal systems were also commonly affected across all breeds, while respiratory-gastrointestinal involvement accounted for moderate proportions. Other systems, including mammary, nervous, urinary, ocular, unspecific and thermoregulatory systems, accounted for smaller proportions across all breeds. There was no statistically significant association between breed and body system affected in caprine ($\chi^2 = 2.257$, $df = 33$, $p = 0.999$) (Table 3c).

Discussion

The high prevalence of helminthic infection in bovines in peracute, acute and subacute disease conditions could be due to rapid larval migration and massive worm burden, which overwhelm the immune system of the host, and is most commonly seen in wet and contaminated environments, which are predominant in most grazing systems in Nigeria (Obi *et al.*, 2020). This

Table 3b: Cross-tabulation for the influence of demographic factors on systems affected by infectious and non-infectious diseases for ovine

Ovine	GIT	MSK	CUT	RES	REP	UNS	NER	URI	MAM	OCU	RES-GIT	TRR	CIR	AUD	X ²	df	p value
Young	648 (41.20)	248 (15.77)	217 (13.80)	155 (9.85)	78 (4.96)	77 (4.90)	44 (2.80)	18 (1.14)	14 (0.89)	9 (0.57)	49 (3.11)	7 (0.44)	2 (0.13)	1 (0.06)	66.27	13	< 0.001*
Adult	2297 (41.23)	880 (15.80)	766 (13.75)	549 (9.85)	503 (9.03)	268 (4.81)	167 (3.00)	66 (1.18)	51 (0.92)	50 (0.90)	76 (1.36)	3 (0.05)	1 (0.02)	1 (0.02)			
Male	1391 (40.97)	536 (15.79)	457 (13.46)	335 (9.87)	298 (8.78)	164 (4.83)	105 (3.09)	41 (1.21)	28 (0.82)	30 (0.88)	63 (1.86)	4 (0.12)	2 (0.06)	1 (0.03)	6.102	13	0.942
Female	1554 (41.44)	592 (15.79)	526 (14.03)	369 (9.84)	283 (7.55)	181 (4.83)	106 (2.83)	43 (1.15)	37 (0.99)	29 (0.77)	77 (2.05)	6 (0.16)	1 (0.03)	1 (0.03)			
Ouda	1805 (41.24)	691 (15.79)	602 (13.75)	431 (9.84)	356 (8.13)	211 (4.82)	129 (2.95)	51 (1.17)	40 (0.91)	36 (0.82)	58 (1.33)	6 (0.14)	1 (0.02)	1 (0.02)	8.706	52	0.999
Yankasa	395 (41.28)	151 (15.78)	132 (13.79)	94 (9.82)	78 (8.15)	46 (4.81)	28 (2.93)	11 (1.15)	9 (0.94)	8 (0.84)	13 (1.36)	1 (0.10)	0 (0.00)	0 (0.00)			
Balami	259 (41.24)	99 (15.76)	86 (13.69)	62 (9.87)	51 (8.12)	30 (4.78)	19 (3.03)	7 (1.11)	6 (0.96)	5 (0.80)	4 (0.64)	0 (0.00)	0 (0.00)	0 (0.00)			
Sudanese	26 (41.94)	10 (16.13)	8 (12.90)	6 (9.68)	5 (8.06)	3 (4.84)	2 (3.23)	1 (1.61)	0 (0.00)	0 (0.00)	1 (1.61)	0 (0.00)	0 (0.00)	0 (0.00)			
Cross	460 (41.03)	177 (15.79)	155 (13.83)	111 (9.90)	91 (8.12)	55 (4.91)	33 (2.94)	13 (1.16)	10 (0.89)	10 (0.89)	15 (1.34)	1 (0.09)	1 (0.09)	1 (0.09)			

Key: AUD: Auditory, CIR: Circulatory, CUT: Cutaneous, GIT: Gastrointestinal, MAM: Mammary, MSK: Musculoskeletal, NER: Nervous, OCU: Ocular, REP: Reproductive, RES: Respiratory, RES-GIT: Respiratory-Gastrointestinal, TRR: Thermoregulatory, UNS: Unspecific, URO: Urogenital, X²: Chi-square, DF: Degree of freedom, p-value: Probability value, Spp.: Species, *Significantly different at $p < 0.05$.

demonstrates the economic significance of helminthic infections in cattle, with herd-level prevalence exceeding 70% in abattoir and field studies (Ola-Fadunsin *et al.*, 2020). A high prevalence of helminthic infections observed across various clinical courses could be due to some factors reported by Charlier *et al.* (2016), which include the animal's nutritional status, the infective stage of the parasite, the parasite species and the presence or absence of concurrent infections. Thus, helminthic diseases such as Haemochus infection have been reported to manifest as a rapidly progressive peracute disease condition with hypovolemic shock presentation (Flay *et al.*, 2022), and acute gastroenteritis has been reported to manifest as subclinical weight loss and ill-thrift (Babiuk, 1990). CBPP is the leading cause of chronic conditions in cattle, according to findings from this study, which agree with an epidemiologic study by Di Teodoro *et al.* (2020)

on *Mycoplasma mycoides* subsp. *Mycoides*, which manifests a protracted clinical course lasting up to 2 years, with major constraints on livestock production, including chronic weight loss and intermittent respiratory signs. In ovine, helminthosis was the most prevalent disease condition across all clinical severity categories, which may be attributed to the high susceptibility of sheep to gastrointestinal nematode infections acquired during grazing, where animals are continually exposed to infective larvae and eggs on contaminated pasture. The persistence and accumulation of infective stages in grazing environments can result in repeated infections and increasing parasite burdens, which may progress from subclinical disease to acute and severe clinical manifestations when the host's immune response is unable to adequately control the infection. This finding is consistent with Tramboog *et al.* (2015), who identified nematode parasites,

Table 3c: Cross tabulation for the influence of demographic factors on systems affected by infectious and non-infectious diseases for caprine

Caprine	GIT	MSK	CUT	RES	REP	UNS	NER	URI	MAM	OCU	RES-GIT	TRR	X ²	df	p value
Young	414 (36.22)	115 (10.06)	142 (12.42)	58 (5.07)	148 (12.95)	36 (3.15)	22 (1.92)	16 (1.40)	41 (3.59)	15 (1.31)	134 (11.72)	2 (0.17)	0.793	11	0.999
Adult	1326 (36.29)	365 (9.99)	453 (12.40)	187 (5.12)	473 (12.95)	113 (3.09)	67 (1.83)	50 (1.37)	130 (3.56)	47 (1.29)	432 (11.82)	3 (0.08)			
Male	507 (36.27)	140 (10.01)	173 (12.38)	71 (5.08)	181 (12.95)	43 (3.08)	26 (1.86)	19 (1.36)	50 (3.58)	18 (1.29)	166 (11.87)	4 (0.29)	6.276	11	0.859
Female	1233 (36.28)	340 (10.00)	422 (12.41)	174 (5.12)	440 (12.94)	106 (3.12)	63 (1.85)	47 (1.38)	121 (3.56)	44 (1.29)	400 (11.77)	1 (0.03)			
Red	1311 (36.30)	361 (9.99)	448 (12.40)	185 (5.12)	468 (12.96)	112 (3.10)	67 (1.85)	50 (1.38)	129 (3.57)	47 (1.30)	428 (11.85)	6 (0.17)	2.257	33	0.999
Sokoto	120 (36.36)	33 (10.00)	41 (12.42)	17 (5.15)	43 (13.03)	10 (3.03)	6 (1.82)	5 (1.52)	12 (3.64)	4 (1.21)	38 (11.52)	1 (0.30)			
Sahel	131 (36.29)	36 (9.97)	45 (12.47)	18 (4.99)	47 (13.02)	11 (3.05)	7 (1.94)	5 (1.39)	13 (3.60)	5 (1.39)	43 (11.91)	0 (0.00)			
West African Dwarf	178 (36.03)	50 (10.12)	61 (12.35)	25 (5.06)	63 (12.75)	16 (3.24)	9 (1.82)	6 (1.21)	17 (3.44)	6 (1.21)	57 (11.54)	0 (0.00)			
Cross															

Key: AUD: Auditory, CIR: Circulatory, CUT: Cutaneous, CUT-MSK: Cutaneous-Musculoskeletal, GIT: Gastrointestinal, MAM: Mammary, MSK: Musculoskeletal, NER: Nervous, OCU: Ocular, REP: Reproductive, RES: Respiratory, RES-GIT: Respiratory-Gastrointestinal, TRR: Thermoregulatory, UNS: Unspecific, URO: Urogenital, X²: Chi-square, df: Degree of freedom, p-value: Probability value, Spp.: Species, *Significantly different at $p < 0.05$.

particularly Strongyles and Haemonchus, as major causes of parasitic infection in sheep worldwide. A study by Biffa *et al.* (2006) attributed the high prevalence of helminthosis in subacute and chronic clinical severity to suboptimal deworming practices and gradual worm burden in immunologically mature hosts, which favour subclinical manifestation over sudden outbreak. Additionally, Alkadir & Ayana (2024) highlighted the role of environmental larval survival and poor body condition score in prolonging the course of helminthic infection rather than causing a sudden death. The high prevalence of helminthosis in goats across all clinical durations aligns with findings from Bihaqi *et al.* (2017), which reported high infection rates often exceeding 75% in Kashmir goats with nematode infection at 70% and a higher prevalence rate in adults. This pattern can be attributed to

persistent exposure, which may explain the higher occurrence of helminthosis in adult goats, as repeated exposure over time can result in the accumulation of substantial parasite burdens, particularly where effective parasite control practices are limited. Similarly, Aliyu *et al.* (2020) reported over 80% helminth prevalence in goats, with strongyle infection dominating and attributing chronic occurrence to prolonged grazing in a moisture-laden environment and limited use of anthelmintic agents. Lower per-acute and acute clinical courses compared to chronic reflect field-based biased reporting of chronic cases over acute reports from abattoir slaughter (Dolori *et al.*, 2025).

Findings from this study revealed the gastrointestinal (GI) system as the most affected body system in cattle, followed by the musculoskeletal and

cutaneous systems. The high prevalence of GI disorders may be attributed to the susceptibility of cattle to enteric parasites such as *Ostertagia ostertagi* and *Cooperia* spp., which can establish and proliferate in the gastrointestinal tract under favourable environmental and management conditions. In addition, non-infectious disorders such as bloat and acidosis may occur when intensive farming practices and improperly balanced feeds disrupt normal ruminal fermentation and gastrointestinal function, thereby increasing the risk of digestive disturbances (Khan *et al.*, 2023). Similarly, Tiele *et al.* (2023) attributed the high prevalence of GI parasites to the extensive grazing system and inadequate deworming, which is a common feature of ruminant husbandry in Nigeria. However, most studies focus extensively on parasitic infection, neglecting other broader GI syndromes such as *Clostridium perfringens* and other viral enteritis (Moustafa *et al.*, 2022). The lower occurrence of musculoskeletal and cutaneous disorders compared with gastrointestinal disorders may reflect the more localized nature of trauma and ectoparasite infestations, which primarily affect the skin, muscles and associated structures rather than the broader range of systemic and enteric conditions that commonly affect the gastrointestinal system (Cramer, 2024).

In sheep, a high prevalence of GI disorders is consistent with existing epidemiologic studies and may be attributed to their grazing behaviour, which increases exposure to parasite contaminated pasture and feed, as well as to dietary changes that can disrupt normal ruminal function. These factors favour parasitic infections such as *Moniezia* spp. and coccidia and may also predispose sheep to conditions such as ruminal acidosis and bacterial overgrowth (Desalegn & Berhanu, 2023; Kumar *et al.*, 2015; Monteiro & Faciola, 2020). The GI tract has a vast mucosal surface that is usually exposed to environmental pathogens through contaminated soil, feed and water, making it susceptible to various etiological agents such as bacteria, viruses and parasites and non-infectious agents from conditions like nutritional imbalances, ruminal acidosis and toxicosis (Alby & Nachamkin, 2016; Navarre *et al.*, 2012). The high prevalence of musculoskeletal disorders as the second most prevalent disease in sheep aligns with an existing radiographic analysis in Nigeria, which reports fracture and osteoarthritis as predominant cases of musculoskeletal system and caused by trauma or genetic predisposition (Binhambali *et al.*, 2025). The prevalence of cutaneous diseases was lower than that

reported in some global studies, which documented higher rates of mange and bacterial skin conditions (Teshome, 2016; Woga & Alemu, 2019). This difference may be attributable to variations in husbandry and management practices, such as animal housing and access to veterinary care, which can influence exposure to ectoparasites and bacterial pathogens and consequently affect the occurrence of skin diseases. The inconsistencies may be due to regional management practices and breed differences (Ahmed & Hassanein, 2012). The lower prevalence of cutaneous disease conditions, especially in temperate regions, could be due to improved biosecurity and climatic conditions, contrasting with other regions (tropics) where there is a high prevalence, which is often due to poor housing and vector abundance (Makepeace *et al.*, 2022).

In goats, the GI system is the most affected body system, similar to the findings in cattle and sheep, which also aligns with existing studies that have identified GI parasites such as *Haemonchus* spp. and *Trichostrongylus* spp. as the most prevalent infection in goats, often exceeding 70% in endemic regions due to favorable environmental conditions and inadequate deworming practices (Kaur *et al.*, 2025). The high prevalence of cutaneous and reproductive disorders could be due to secondary stressors such as ectoparasites and brucellosis-induced abortion, which ranked lower compared to GI disorders, potentially reflecting emphasis on mange and venereal infections in an environment of poor biosecurity (Ganesan *et al.*, 2024; Teshome, 2016; Elzein *et al.*, 2016). The prevalence of respiratory-gastrointestinal comorbidities could be due to contagious caprine pleuropneumonia frequently occurring with GI nematodes as a result of immune suppression and overcrowding, as evidenced in the pastoral system, where respiratory signs compound parasitic burdens (Maritim *et al.*, 2018; Yatoo *et al.*, 2019).

Regarding the influence of demographic factors in cattle, findings from this study revealed that age significantly influenced the disease distribution across various body systems. The age-related findings align with a study on bovine tuberculosis, where infection rates increase with age up to 24-36 months and peak in young adults due to cumulative exposure, immune maturation and frequent contacts with older animals (Brooks-Pollock *et al.*, 2013). These findings were demonstrated in a UK study analysis of data from herd testing from 2004 to 2009 (Brooks-Pollock

et al., 2013). Also, haemprotozoan infection in cattle also demonstrates age-related significance, with younger animals showing high susceptibility due to an immature immune system, whereas adults may show resistance due to the development of partial immunity post recovery, though the prevalence may still vary based on pathogen and geographical location (Maharana *et al.*, 2016).

In sheep, there was a significant association between demographic factors and body systems, which aligns with existing studies, such as peer-reviewed research on progressive pneumonia, where infection prevalence increases with age due to a prolonged incubation period that allows the accumulation of antibodies, making age a key factor in disease prevalence (Snowder *et al.*, 1990). Similarly, sex and breed effects show significant association, such as their emergence as risk factors for ovine theileriosis, often linked to behavioral differences as well as hormonal influence on the immunity (Niaz *et al.*, 2021).

In goats, age, sex and breed all showed a statistical association based on the findings from this study. These findings align with Ashagrie *et al.* (2024), where older goats show high seroprevalence for pathogens such as contagious caprine pleuropneumonia, which is caused by prolonged exposure and reduced maternal immunity. The breed alignment is also in agreement with the findings from Fakri *et al.* (2017) and Baazizi *et al.* (2017), where 67% of Moroccan goats showed susceptibility to Peste des Petits Ruminants virus, which is attributed to genetic variation in the immune system and viral excretion. The strong significance of sex highlighted in this study contrasts with some findings that shows a non-significant relationship, which can be attributed to factors such as management bias (Ashagrie *et al.*, 2024; Aftabuzzaman *et al.*, 2023).

This study provides a summary of disease patterns in cattle, sheep and goats presented to the Veterinary Clinic Sokoto, along Aliyu Jodi Road, between 2021 and 2023, highlighting the significant role of helminthic infections across species, illness durations and body systems. Helminthosis emerged as the most prevalent disease in peracute, acute, subacute and chronic cases, stressing its possible effects on ruminant health and productivity in semi-arid pastoral systems. The gastrointestinal system was consistently the most affected across all species, reflecting the vulnerability of ruminants to enteric pathogens, nutritional imbalances and parasitic challenges.

Demographic factors played an important role in disease distribution, particularly age, which significantly influenced the systems affected in all species. While sex and breed showed limited influence in cattle, their significant associations in sheep and goats suggest species-specific interactions between physiology, management practices and genetic susceptibility. The significance of chronic conditions such as contagious bovine pleuropneumonia in cattle further emphasizes the long-term economic and welfare consequences of inadequately controlled infectious diseases.

Overall, these findings highlight the need for integrated disease control strategies that prioritize regular parasite control, age-targeted interventions and improved husbandry. Such approaches are essential to reducing morbidity, improving productivity and sustaining the socio-economic benefits of ruminant production in north-western Nigeria and similar settings.

Funding

No funding was received.

Conflict of Interest

The authors declare that there is no conflict of interest.

References

- Aftabuzzaman M, Pioquinto JM, Espiritu H, Valet E, Kim S-H, Jin S-J, Jung M, Lee S-S and Cho Y-I (2023). Pilot study on the distribution of caseous lymphadenitis in Korean native goats and the relationship between sex and age in disease occurrence. *Frontiers in Veterinary Science*, doi. 10.3389/fvets.2023.1274359.
- Ahmed AF & Hassanein KMA (2012). Ovine and caprine cutaneous and ocular neoplasms. *Small Ruminant Research*, **106**(2–3): 189–200.
- Alby K & Nachamkin I (2016). Gastrointestinal infections. *Microbiology Spectrum*, doi.10.1128/microbiolspec.DMIH2-0005-2015.
- Aliyu AA, Maikenti JI, Aimankhu OP, Ayuba SO, Ahmed HO, Haruna A & Idris AM (2020). Helminth parasites of goats and sheep at slaughter house in Lafia, Nasarawa State, Nigeria. *FUDMA Journal of Sciences*, **4**(2): 34–40.
- Alkadir G & Ayana D (2024). Helminth control practices in sheep and cattle in urban and

- peri-urban areas of Adea District, Central Ethiopia. *Veterinary Medicine: Research and Reports*, doi.10.2147/VMRR.S450106.
- Armson B, Ekiri AB, Alafiatayo R, Cook AJ (2020). Small Ruminant Production in Tanzania, Uganda, and Ethiopia: A Systematic Review of Constraints and Potential Solutions. *Veterinary Sciences*, doi.10.3390/vetsci8010005.
- Ashagrie M, Tadesse B, Abebe E & Yasmine A (2024). Seroprevalence and associated risk factors of contagious caprine pleuropneumonia in selected districts of South Wollo Zone, Northeast Ethiopia. *BMC Veterinary Research*, doi.10.1186/s12917-024-04181-x.
- Baazizi R, Mahapatra M, Clarke BD, Ait-Oudhia K, Khelef D & Parida S (2017). *Peste des petits ruminants* (PPR): A neglected tropical disease in Maghreb region of North Africa and its threat to Europe. *PLoS One*, doi.10.1371/journal.pone.0175461.
- Babiuk LA (1990). Viral gastroenteritis in ruminants. In: *Virus Infections of Ruminants*. Elsevier. doi.10.1016/B978-0-444-87312-5.50076-X.
- Bayne JE & Edmondson MA (2021). Diseases of the gastrointestinal system. In: *Sheep, Goat, and Cervid Medicine*. Elsevier. doi.10.1016/B978-0-323-62463-3.00014-1.
- Biffa D, Jobre Y & Chakka H (2006). Ovine helminthosis, a major health constraint to productivity of sheep in Ethiopia. *Animal Health Research Reviews*, 7(1–2): 107–118.
- Bihaqi SJ, Allaie IM, Banday MAA, Wani ZA & Shahardar RA (2017). Prevalence of caprine gastrointestinal helminths in temperate areas of Jammu and Kashmir. *Journal of Parasitic Diseases*, 41(3): 843–849.
- Binhambali A, Lawal M, Salawu NA, Abodunrin A, Bappah MN, Gaba EE, Mohammed A & Mustapha RA (2025). Radiographic evaluation of pelvic limb musculoskeletal lesions in animals presented for clinical diagnosis. *SVU-International Journal of Veterinary Sciences*, 8(3): 84–105.
- Bolajoko MB, Van Gool F, Peters AR, Suarez Martinez J, Vance CJ & Dungu B (2020). Field survey of major infectious and reproductive diseases responsible for mortality and productivity losses of ruminants amongst Nigerian Fulani pastoralists. *Gates Open Research*, doi.10.12688/gatesopenres.13164.1.
- Brooks-Pollock E, Conlan AJK, Mitchell AP, Blackwell R, McKinley TJ & Wood JLN (2013). Age-dependent patterns of bovine tuberculosis in cattle. *Veterinary Research*, doi.10.1186/1297-9716-44-97.
- Charlier J, De Waele V, Ducheyne E, van der Voort M, Vande Velde F & Claerebout E (2016). Decision making on helminths in cattle: Diagnostics, economics and human behaviour. *Irish Veterinary Journal*, doi.10.1186/s13620-016-0073-6.
- Christodouloupoulos G (2025). Subacute ruminal acidosis in cattle: A critical review of clinical management. *Veterinary Research Communications*, doi.10.1007/s11259-025-10842-5.
- Colditz IG, Harrison RG & Sypherd P (1996). Relationships between age, immune responsiveness and disease resistance in sheep. *Veterinary Immunology and Immunopathology*, 54(1–2): 171–181.
- Coleman DA, Thayne WV & Dailey RA (1985). Factors affecting reproductive performance of dairy cows. *Journal of Dairy Science*, 68(7), 1793–1803.
- Cramer G (2024). Epidemiology of lameness in cattle. In *MSD Veterinary Manual*. Merck & Co., Inc. <https://www.msdvetmanual.com>, retrieved 13-11-2025.
- Crane AR (2024). Corriedale. In: *Encyclopedia of Meat Sciences*, third edition. Elsevier. <https://www.sciencedirect.com>, retrieved 17-12-2025.
- Desalegn C & Berhanu G (2023). Assessment of the epidemiology of gastrointestinal tract nematode parasites in sheep in Toke Kutaye, West Shoa Zone, Ethiopia. *Veterinary Medicine: Research and Reports*, doi.10.2147/VMRR.S427828.
- Di Teodoro G, Marruchella G, Di Provvido A, D'Angelo AR, Orsini G, Di Giuseppe P, Scacchia M & Colitti B (2020). Contagious bovine pleuropneumonia: A comprehensive overview. *Veterinary Pathology*, 57(4): 476–489.
- Doloriert HC, Chocce MEP, Vargas-Calla A, Robles Noriega K, Godoy Padilla D, Coronel Berrospi S, Ayala Roldan R & Acosta Granados I (2025). Cross-sectional study of gastrointestinal helminthosis in goats from three ecosystems in Peru: Prevalence and associated factors. *Parasitology Research*, doi.10.1007/s00436-025-08573-2.
- Elzein E, Osman I & Mohammed SYM (2016). Assessment of reproductive problems in

- caprine, ovine, bovine and equine species in Nyala City, South Darfur State, Sudan. *International Journal of Current Research*, **8**(11), 42324–42327.
- Fakoya EO & Oloruntoba A (2009). Socio-economic determinants of small ruminant production among farmers in Osun State, Nigeria. *ASSET: An International Journal (Series C)*, **4**(1):90-100.
- Fakri FZ, Elhajjam A, Bamouh Z, Jazouli M, Boumart Z, Tadlaoui K, Fassi-Fihri O & Elharrak M (2017). Susceptibility of Moroccan sheep and goat breeds to *Peste des petits ruminants* virus. *Acta Veterinaria Scandinavica*, doi.10.1186/s13028-017-0323-y.
- Flay KJ, Hill FI & Muguiro DH (2022). Haemonchus contortus infection in pasture-based sheep systems. *Animals*, doi.10.3390/ani12101238.
- Ganesan P, Singh V & Bhalla V (2024). Prevalence of fungal and dermatophyte infections in caprine and associated risk factors. *International Journal of Veterinary Sciences and Animal Husbandry*, **9**(4): 645–649.
- Hussain R, Zhang G, Abbas RZ, Siddique AB, Mohiuddin M, Khan I, Rehman TU & Khan A (2022). *Clostridium perfringens* types A and D involved in peracute deaths in goats kept in Cholistan ecosystem during winter season. *Frontiers in Veterinary Science*, doi.10.3389/fvets.2022.849856.
- Ibrahim M, Schelling E, Zinsstag J, Hattendorf J, Andargie E & Tschopp R (2021). Sero-prevalence of brucellosis, Q-fever and Rift Valley fever in humans and livestock in Somali Region, Ethiopia. *PLoS Neglected Tropical Diseases*, doi.10.1371/journal.pntd.0008100.
- Kamel MS, Davidson JL & Verma MS (2024). Strategies for bovine respiratory disease diagnosis and prognosis. *Animals*, doi.10.3390/ani14040627.
- Kaur A, Kaur N, Chauhan K, Jyoti & Singh H & Singh NK (2025). Epidemiology of caprine gastrointestinal nematodes and associated efficacy of anthelmintic drugs in Punjab districts, India. *Scientific Reports*, doi.10.1038/s41598-025-89784-6.
- Kebede IA, Dahesa GD & Gebremedhin EZ (2025). Prevalence of zoonotic helminths in ruminants. *One Health*, **20**, 101094. doi.10.1016/j.onehlt.2025.101094.
- Khan A, Tasleem S, Saddozai S, Ullah A, Rahat A, Aziz T, Azeem T, Ur Rehman H & Saeed K (2023). Prevalence of gastrointestinal tract parasites in dairy cattle in Tehsil Gagra District Buner Khyber Pakhtunkhwa, Pakistan. *Journal of Health and Rehabilitation Research*, **3**(2): 982–987.
- Kumar S, Jakhar KK, Singh S, Potliya S, Kumar K & Pal M (2015). Clinicopathological studies of gastrointestinal tract disorders in sheep with parasitic infection. *Veterinary World*, **8**(1):29-32.
- Maharana BR, Tewari AK, Saravanan BC & Sudhakar NR (2016). Important hemoprotozoan diseases of livestock: Challenges in current diagnostics and therapeutics—An update. *Veterinary World*, **9**(5): 487–495.
- MAHF (Ministry of Animal Health and Fisheries). (2012). Ministry of Animal Health and Fisheries, Sokoto State, Nigeria. Government Printer. Pp 3.
- Makepeace C, Nixon EJ, Burgess STG, Stubbings L & Wall R (2022). Sheep scab: Comparison of spatial and temporal patterns determined by clinical diagnosis or ELISA. *Parasites & Vectors*, **15**(1): 419.
- Maritim N, Ngeiywa M, Siamba D, Mining S & Wesonga H (2018). Influence of worm infection on immunopathological effect of *Mycoplasma capricolum* subsp. capripneumoniae pathogen in goats. *Advances in Animal and Veterinary Sciences*, **6**(6): 234–241.
- Monteiro HF & Faciola AP (2020). Ruminal acidosis, bacterial changes, and lipopolysaccharides. *Journal of Animal Science*, doi.10.1093/jas/skaa248.
- Moustafa S, Zakaria I, Moustafa A, AboSakaya R & Selim A (2022). Bacteriological and serological investigation of *Clostridium perfringens* in lambs. *Scientific Reports*, doi.10.1038/s41598-022-21918-6.
- Mustapha SB, Shehu H, Nwosu CN & Malabe KM (2024). Small ruminant production and their uses among farmers in Nigeria: A review. *International Journal of Agriculture and Earth Science*, **10**(4): 1–9.
- NBS (National Bureau of Statistics). (2020). Demographic statistics bulletin. National Bureau of Statistics. Pb 10.
- Navarre CB, Baird AN & Pugh DG (2012). Diseases of the Gastrointestinal System. In: *Sheep and*

- Goat Medicine* (DG Pugh & AN Baird, editors) Pp 71–105.
- Niaz S, Ur Rahman Z, Ali I, Cossío-Bayúgar R, Amaro-Estrada I, Alanazi AD, Khattak I, Zeb J, Nasreen N & Khan A (2021). Molecular prevalence, characterization and associated risk factors of *Anaplasma* spp. and *Theileria* spp. in small ruminants in Northern Pakistan. *Parasite*, doi.10.1051/parasite/2020075.
- Nuvey FS, Mensah GI, Zinsstag J, Hattendorf J, Fink G, Bonfoh B & Addo KK (2023). Management of diseases in a ruminant livestock production system: A participatory appraisal of the performance of veterinary services delivery, and utilization in Ghana. *BMC Veterinary Research*, doi.10.1186/s12917-023-03793-z.
- Obi CF, Akata MC & Ezubelu OJ (2020). Prevalence of gastrointestinal helminth parasites of trade cattle in Aguata and Orumba South Local Government Areas, Southeastern Nigeria. *Journal of Parasitic Diseases*, **44**(3): 546-552.
- Ocheja JO, Yahaya B, Bukola OA, Abel-Achimugu J, Yahaya YA, Sadiq MS, Shettima I & Sechii J (2025). The potentials and prospects of the Nigerian cattle industry. In Proceedings of the 50th Conference of the Nigerian Society for Animal Production, 16–20 March, 2025, Federal University of Lafia, Nigeria. Pp 1330–1332.
- Ola-Fadunsin SD, Ganiyu IA, Rabi M, Hussain K, Sanda IM, Baba AY, Furo NA & Balogun RB (2020). Helminth infections of great concern among cattle in Nigeria: Insight into prevalence, species diversity, infection patterns and risk factors. *Veterinary World*, **13**(2): 338–344.
- Snowder GD, Gates NL, Glimp HA & Gorham JR (1990). Prevalence and effect of subclinical ovine progressive pneumonia virus infection on ewe wool and lamb production. *Journal of the American Veterinary Medical Association*, **197**(4): 475–479.
- Tabor AE (2022). Anaplasmosis in Ruminants. In: *MSD Veterinary Manual*. Merck & Company, Inc. <https://www.msdvetmanual.com>, retrieved 26-11-2025.
- Teshome D (2016). Prevalence of major skin diseases in ruminants and associated risk factors at University of Gondar Veterinary Clinic, Northwest Ethiopia. *Journal of Research and Development*, <https://www.longdom.org/open-access/prevalence-of-major-skin-diseases-in-ruminants-and-its-associated-risk-factors-at-university-of-gondar-veterinary-clinic-13881.html>, retrieved 20-11-2025.
- Tiele D, Sebro E, H/Meskel D & Mathewos M (2023). Epidemiology of gastrointestinal parasites of cattle in and around Hosanna Town, Southern Ethiopia. *Veterinary Medicine: Research and Reports*, doi.10.2147/VMRR.S389787.
- Torsson E, Berg M, Misinzo G, Herbe I, Kgotlele T, Päärne M, Roos N, Blomström AL, Ståhl K & Wensman JJ (2017). Seroprevalence and risk factors for *Peste des petits ruminants* and selected differential diagnoses in sheep and goats in Tanzania. *Infection Ecology and Epidemiology*, doi.10.1080/20008686.2017.1368336.
- Tramboo SR, Shahardar RA, Allaie IM, Wani ZA & Bushra MS (2015). Prevalence of gastrointestinal helminth infections in ovine population of Kashmir Valley. *Veterinary World*, **8**(10): 1199–1204.
- Tsega M, Dereso S & Getu A (2015). A review on ruminant fasciolosis. *Open Access Library Journal*, doi.10.4236/oalib.1101655.
- Tsouloufi TK, MacVicar IS, Donnison LM, Smyth KL & Peters AR (2023). Systematic map of the most recent evidence (2010-2019) on ruminant production-limiting disease prevalence and associated mortality in Ethiopia. *Frontiers in Veterinary Science*, doi.10.3389/fvets.2023.995213.
- Underwood WJ, Blauwiekel R, Delano ML, Gillesby R, Mischler SA & Schoell A (2015). Biology and diseases of ruminants (sheep, goats, and cattle). In: *Laboratory Animal Medicine*. Elsevier. doi.10.1016/B978-0-12-409527-4.00015-8.
- Wang Y, Wang L, Wang Z, Xue B, Peng Q, Hu R & Yan T (2023). Recent advances in research on rumen bloat in ruminant animals fed high-concentrate diets. *Frontiers in Veterinary Science*, doi.10.3389/fvets.2023.1142965.
- Woga Z, Alemu B (2019) Prevalence of Skin Diseases in Small Ruminants and Associated Risk Factors in Gamogofa Zone, South-West Ethiopia. *Journal of Veterinary Medicine and Research*, **6**(1): 1173.
- Yadav S, Stenfeldt C, Branan MA, Moreno-Torres KI, Holmstrom LK, Delgado AH & Arzt J (2019). Parameterization of the durations of phases of foot-and-mouth disease in cattle.

- Frontiers in Veterinary Science*, doi.10.3389/fvets.2019.00263.
- Yatoo MI, Parray OR, Bashir ST, Bhat RA, Gopalakrishnan A, Karthik K, Dhama K & Singh SV (2019). Contagious caprine pleuropneumonia – a comprehensive review. *Veterinary Quarterly*, **39**(1): 1–25.