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Original article

Prevalence of Hydatidosis in Sheep, Goats, Cattle, and Camels Slaughtered in Selected Abattoirs in Sabratha City, Libya

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Abstract
Cystic echinococcosis (CE) is a widespread zoonotic parasitic disease that negatively affects both human health and livestock productivity. It represents a major medical and economic concern in many developing countries, including Libya. Nevertheless, the economic impact of CE in most endemic regions remains poorly characterized. The present study was conducted to assess the prevalence of hydatid cyst infection in key livestock species slaughtered in Sabratha, Libya. A total of 8,907 animals, including sheep, goats, cattle, and camels, were examined through post-mortem inspection of visceral organs. Overall prevalence varied significantly among species ($p < 0.05$), with cattle showing the highest infection rate (5.806%), followed by goats (4.942%), camels (4.292%), and sheep (3.447%). Seasonal analysis revealed higher prevalence during winter and spring, suggesting environmental influences on parasite transmission. Age-related patterns indicated consistently higher infection rates in older animals, supporting the role of cumulative exposure. Organ distribution analysis showed the liver and lungs as the most frequently affected organs across species. Females exhibited higher prevalence than males, likely reflecting management practices and longevity within herds. No significant difference was detected between local and imported animals, indicating widespread environmental contamination. These findings confirm the endemic nature of cystic echinococcosis in the study area and highlight the importance of integrated control measures, including improved slaughterhouse hygiene, proper offal disposal, and regular deworming of dogs. The study provides essential baseline epidemiological data to support surveillance programs and targeted control strategies in western Libya.
Keywords. Cystic Echinococcosis, Livestock, Prevalence, Libya, Zoonotic Disease.

Introduction

Cystic echinococcosis (CE), commonly referred to as hydatidosis, is a zoonotic parasitic disease caused by the metacestode (larval) stage of the Echinococcus granulosus complex, a threat to both human and animal populations [1,2]. Owing to its zoonotic nature, CE remains a significant global concern and a major socio-economic burden in many parts of the world [3]. The life cycle of the parasite involves dogs as the primary definitive hosts, while livestock serve as intermediate hosts, and humans become accidental hosts when exposed to infective eggs. Following ingestion, hydatid cysts develop predominantly in the liver and lungs, with occasional formation in other organs [4].

Disease manifestations arise mainly from the space-occupying nature of cysts, which exert pressure on surrounding tissues. In severe cases, cyst rupture can lead to anaphylactic reactions or secondary echinococcosis [5]. Completion of the parasite's life cycle occurs when viable cysts ingested by the definitive host develop into adult tapeworms within the intestines [6]. Human infection typically results from ingesting Echinococcus eggs present in contaminated food and water or through direct contact with infected dogs.

Globally, CE is widely distributed, being reported across the Mediterranean basin, Asia, Australia, South America, and parts of Africa [4]. In North Africa—and especially in Libya—numerous studies conducted over the past four decades have documented persistently high prevalence rates of EC among livestock [7]. In livestock, cystic echinococcosis imposes substantial losses by decreasing the quality and quantity of meat, milk, and wool, thereby compromising overall animal productivity [7-8]. The disease is particularly prevalent in regions where sheep, goats, and cattle production systems are common. Domestic animals such as sheep, goats, camels, and cattle play a central role in transmission, especially when kept near dogs [9].

Poor slaughterhouse hygiene, inadequate veterinary inspection, and the widespread practice of backyard slaughtering in many developing countries further facilitate the persistence of CE. Infected viscera are often discarded improperly, allowing stray or domestic dogs to consume them and perpetuate the parasite's life cycle. Ruminants become infected primarily through grazing on pastures contaminated with dog feces containing Echinococcus eggs [10]. In regions such as Libya, the absence of effective meat inspection systems, uncontrolled home slaughter practices, and the widespread presence of free-roaming dogs are considered key factors contributing to the high prevalence of CE [11].

Given the persistent endemicity of cystic echinococcosis in Libya—particularly in regions where livestock production closely interacts with free-roaming dog populations—there is a critical need for updated epidemiological data to guide effective control strategies. Despite the significant public health and economic impact of the disease, comprehensive assessments of its prevalence in major livestock species, especially in

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abattoirs of the western region, remain scarce. To address this gap, the present study was undertaken to determine the prevalence of hydatidosis in sheep, goats, cattle, and camels slaughtered at selected abattoirs in Sabratha City, Libya, providing essential baseline data to inform targeted monitoring, prevention, and control interventions.

Methods

Study Area

The study was conducted from January 2019 to the end of December 2019 at Sabratha municipal abattoir, Western Region, Libya. Sabratha is located 80 km northwest of Tripoli, the capital city of Libya. It lies at approximately 32° 48' N latitude and 12° 29' E longitude with an elevation of 5–20 m a.s.l. The annual ambient temperature ranges from 24.7 °C to 34.5 °C with an annual rainfall of around 150 – 250 mm. Mean relative humidity stands at 50–65% all-over the year.

Study Animals

This cross-sectional study was conducted on a diverse population of livestock, including both locally raised and imported animals, totaling 8907 animals, of which 6904 sheep, 607 goats, 930 cattle, and 466 camels, were slaughtered at Sabratha Municipal Abattoir from January 2019 to December 2019, to examine the presence of cystic echinococcosis.

Sample collection and examination

During the study, the slaughterhouse was visited regularly for one-year, visceral organs—liver, lungs, and mesentery were systematically examined using visual inspection, palpation, and incisions for the presence of hydatid cysts. Cysts were identified based on veterinary descriptions and morphological characteristics and were assessed for degeneration and calcification. Suspected cysts were collected in 10% formalin and transported to the parasitology Laboratory at the Faculty of Veterinary Medicine and Agricultural Sciences, University of Zawia, for further analysis.

Statistical analysis

The prevalence estimates presented in this study are not yet considered fully weighted and thus called "unweighted". Prevalence was calculated as the proportion of infected samples among examined animals stratified by species and origin. For each estimate, a 95% confidence interval (CI) was computed using the Wilson score method [12], which provides more accurate coverage than the normal approximation, particularly for small sample sizes or proportions near 0 or 1. Comparison of prevalence values among species and origin and between seasons was done by performing a Chi-Square test. The significance level was set at $p < 0.05$. All computations were performed in R version 4.1 [13], using the appropriate functions for binomial confidence intervals.

Results

The results are presented by summarizing infection prevalence across livestock species (Table 1) and examining how monthly prevalence varies across four livestock species (Figure 1). Table 2 reports prevalence by origin category, and Table 3 presents prevalence across livestock species and seasons. Comparisons between imported and local animals across seasons (Table 4), supported by statistical testing (Table 5), assess whether origin influences infection risk across seasons. Age-stratified analyses further illustrate variation between young and older animals (Table 6). Assessment of organ-specific infection prevalence across the four livestock species demonstrated clear differences both between species and among organs (Table 7), with statistical analysis confirming significant variation in infection prevalence within each species (Table 8). Moreover, infection prevalence differed by sex across the four species examined (Table 9), and risk ratio analysis supported the observed species-level differences (Table 10). Together, these findings provide a comprehensive overview of the distribution of hydatid cyst infection across species, organs, sex, age groups, and animal origin in the study population.

Across all sampled species (Table 1), notable variation was observed in the overall prevalence of infection. Cattle showed the highest prevalence, with 5.806% of examined animals testing positive (95% CI: 4.477–7.499%). Goats and camels showed comparable levels of infection, with prevalence estimates of 4.942% (95% CI: 3.484 – 6.968%) and 4.292% (95% CI: 2.795 – 6.536%), respectively. Although these species demonstrated moderate infection levels, their wider confidence intervals reflect smaller sample sizes and, therefore, some uncertainty around the estimates. Sheep, which represented the largest proportion of the total sample, had the lowest prevalence at 3.447% (95% CI: 3.042 –3.904%). The narrow confidence interval for sheep indicates a high degree of precision in the estimate, driven by the substantial number of animals examined. A chi-square test for equality of proportions revealed a statistically significant difference in infection prevalence among the four livestock species (χ^2= 14.88, df = 3, p = 0.0019). This A significant result that indicates that infection rates (prevalence) were not uniform across species, suggesting that species identity is associated with differing levels of infection risk.

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Table 1. Overall Prevalence of Hydatid Cyst by Species

Species	Infected	Examined	Prevalence (%)	95% CI (Lower) (%)	95% CI (Upper) (%)
Camel	20	466	4.292	2.795	6.536
Cattle	54	930	5.806	4.477	7.499
Goat	30	607	4.942	3.484	6.968
Sheep	238	6,904	3.447	3.042	3.904

Notes: Prevalence = Infected / Examined. 95% CI computed using the Wilson score method

Monthly prevalence (Figure 1) of infection was assessed across four livestock species: camel, cattle, goat, and sheep. Monthly prevalence remained below 10% but showed some seasonal variations. Cattle consistently showed the highest prevalence, with peaks in February and March (approximately 9%), followed by sustained moderate levels throughout the year. Sheep, despite their large sample sizes, showed relatively low but stable prevalence ranging from about 1.8% to 6.4%, with modest increases in March, May, and December. Goats demonstrated greater fluctuation, including months with no detected infections (March and April) and intermittent peaks in February, July, and September (6–8%). Camel prevalence remained generally low and sporadic, with occasional increases in February, March, and December (6–9%). Overall, prevalence tended to rise during late winter and mid-summer across species, suggesting potential seasonal influences on infection dynamics.

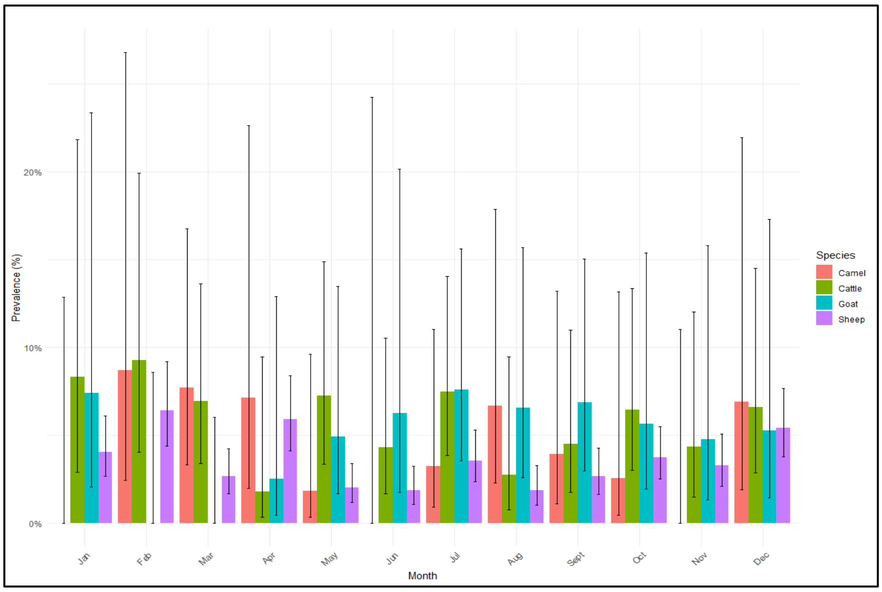

Figure 1. Showed the monthly prevalence associated with a confidence interval of Hydatid Cyst across species.

Of the 8,907 animals examined, 336 were infected (Table 2), including 83 imported animals and 253 local animals. The imported-origin animals showed a prevalence of 3.7% (95% CI: 3.0–4.6%), while the local animals showed a prevalence of 3.8% (95% CI: 3.4 – 4.3%). These similar estimates, along with the overlapping confidence intervals, indicate no meaningful difference in infection burden between the two groups. This conclusion is further supported by a Pearson's test with Yates' continuity correction, which showed no evidence of a difference in infection prevalence between the imported and local animals (χ^2= 0.0017, df = 1, p = 0.967). Overall, the analysis demonstrates that infection rates did not differ significantly between imported and locally sourced livestock.

Table 2. Prevalence of Infection by Origin Category

Origin	Infected	Examined	Prevalence	95% CI Lower	95% CI Upper
Imported	83	2,222	3.7	3.0	4.6
Local	253	6,685	3.8	3.4	4.3
Total	336	8,907			

Notes: Prevalence = Infected / Examined. 95% CI computed using the Wilson method.

Across all seasons and livestock species (Table 3), notable variation in infection prevalence was observed. During winter, cattle showed the highest prevalence (7.83%), followed by camels (5.13%), while goats and sheep showed comparatively lower levels (3.77% and 4.57%, respectively). In spring, cattle again showed the highest infection rate (5.83%), and goats maintained the lowest (2.48%). Sheep demonstrated a moderate

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prevalence of 3.30%, consistent with their winter levels. In the summer season, goats showed a marked increase in infection prevalence (6.28%), representing the highest seasonal value for this species, whereas sheep recorded their lowest prevalence across all seasons (1.89%). Camels and cattle showed moderate summer prevalence values (3.36% and 5.13%, respectively). By autumn, goats continued to show relatively elevated prevalence (5.95%), while cattle and camels maintained moderate levels (5.18% and 3.31%). Sheep again showed a low prevalence (3.24%), like their spring values. Overall, cattle consistently demonstrated the highest prevalence across seasons, while sheep maintained the lowest infection levels, particularly in summer. Goats showed the greatest seasonal fluctuation, with a clear peak in the summer and autumn seasons. Confidence of intervals across species and seasons remained relatively narrow in high-sample groups (e.g., sheep), indicating stable estimates, while wider intervals in camels and goats reflected smaller sample sizes and greater uncertainty.

Table 3. Prevalence of Infection in Livestock by Species and Season

Season	Species	Examined	Infected	Prevalence %	95% CI Lower (%)	95% CI Upper (%)
Winter	Camel	78	4	5.128	2.012	12.457
Winter	Cattle	166	13	7.831	4.634	12.937
Winter	Goat	106	4	3.774	1.477	9.303
Winter	Sheep	1,444	66	4.571	3.609	5.774
Spring	Camel	148	8	5.405	2.764	10.303
Spring	Cattle	240	14	5.833	3.506	9.552
Spring	Goat	161	4	2.484	0.970	6.213
Spring	Sheep	1,760	58	3.295	2.558	4.236
Summer	Camel	119	4	3.361	1.315	8.325
Summer	Cattle	273	14	5.128	3.079	8.423
Summer	Goat	191	12	6.283	3.630	10.659
Summer	Sheep	1,857	35	1.885	1.358	2.610
Autumn	Camel	121	4	3.306	1.293	8.192
Autumn	Cattle	251	13	5.179	3.051	8.658
Autumn	Goat	168	10	5.952	3.265	10.609
Autumn	Sheep	1,824	59	3.235	2.516	4.150

Notes: Prevalence = Infected / Examined. Confidence intervals computed using the Wilson method.

Analysis of seasonal and origin-specific prevalence estimates (Table 4) showed clear temporal fluctuations in infection rates. During winter, prevalence was highest for both imported (5.05%, 95% CI: 3.29 – 7.67) and local cases (4.79%, 95% CI: 3.79 – 6.04). Infection levels declined markedly in spring, particularly among imported animals (2.86%, 95% CI: 1.86 – 4.38), while local animals showed a moderate reduction (3.98%, 95% CI: 3.13 – 5.04). The lowest prevalence values were observed in summer, with imported and local animals showing similarly reduced rates (2.42% and 2.73%, respectively). A slight increase re-emerged in autumn, where prevalence rose to 3.01% (95% CI: 1.93 – 4.65) in imported animals and 3.87% (95% CI: 3.06 – 4.88) in local animals. Across all seasons, local animals consistently showed slightly lower or comparable prevalence relative to imported animals, though the differences were modest. Overall, this indicates a pronounced seasonal variation, with peak infection levels in winter, a progressive decline through spring and summer, and a mild resurgence in autumn.

Table 4. Seasonal Variation in Infection Prevalence among Imported and Local Animals

Season	Origin	Examined	Infected	Prevalence %	95% CI Lower (%)	95% CI Upper (%)
Winter	Imported	396	20	5.051	3.293	7.672
Winter	Local	1,398	67	4.793	3.791	6.041
Spring	Imported	699	20	2.861	1.860	4.378
Spring	Local	1,610	64	3.975	3.125	5.044
summer	Imported	495	12	2.424	1.392	4.189
summer	Local	1,945	53	2.725	2.089	3.547
autumn	Imported	632	19	3.006	1.933	4.648
autumn	Local	1,732	67	3.868	3.058	4.883

Notes: Prevalence = Infected / Examined. Confidence intervals computed using the Wilson method.

Analysis of combined infection prevalence in imported and local animals across seasons (Table 5) showed no evidence of a significant association in any season. Chi-square tests produced non-significant results for winter (p=0.841), spring (p=0.204), summer (p=0.718), and autumn (p=0.338), indicating that the distribution of infection status did not differ meaningfully by origin in any season. Fisher's exact test results

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were consistent with these findings, with all p-values well above the conventional significance threshold of 0.05. Effect size estimates further supported the absence of a strong seasonal association. Odds ratios for imported versus local animals were close to 1 across all seasons: winter (OR = 1.05), spring (OR = 0.72), summer (OR = 0.89), and autumn (OR = 0.78), and all corresponding 95% confidence intervals included 1. These wide, overlapping intervals (e.g., 0.60–1.78 in winter; 0.41–1.22 in spring) indicate substantial uncertainty and no detectable difference in infection odds between origins. Overall, the results demonstrate that infection prevalence did not differ significantly between imported and local animals in any season, and no seasonal pattern of association was observed.

Table 5. Seasonal Comparison of Infection Prevalence between Imported and Local animals

Season	Chi-square Statistic	Degrees of Freedom	Chi-square p-value	Fisher's Exact p-value	Fisher Odds Ratio	Fisher 95% CI Lower	Fisher 95% CI Upper
Winter	0.040	1	0.841	0.793	1.054	0.598	1.784
Spring	1.611	1	0.204	0.227	0.720	0.409	1.216
summer	0.131	1	0.718	0.876	0.890	0.429	1.702
Autumn	0.916	1	0.338	0.385	0.777	0.437	1.322

Notes: Prevalence = Infected / Examined. Confidence intervals computed using the Wilson method.

All livestock—camels, cattle, goats, and sheep—were examined to assess infection prevalence by species, origin, and age group (Table 6). Across all species, older animals consistently showed higher prevalence than young animals, regardless of origin. Imported camels, cattle, and goats showed higher infection levels in older age animals (4.21%, 5.66%, and 3.67%, respectively) compared with young animals (<1%). Local animals showed the same pattern, with prevalence rising from near zero in young animals to 2.73% in older camels, 5.15% in older cattle, and 4.66% in older goats. Sheep demonstrated the same age-related pattern but with overall lower prevalence (2.58% in imported old and 3.01% in local old). Confidence intervals were narrowest in sheep due to large sample sizes and widest in camels due to smaller sample sizes. Overall, age was the strongest predictor of infection, while differences between imported and local animals were modest.

Table 6. Prevalence of infection in livestock species by origin and age group.

Species	Origin	Age	Infected	Examined	Prevalence %	95% CI Lower (%)	95% CI Upper (%)
Camel	Imported	Young	2	356	0.562	0.154	2.025
Camel	Imported	Old	15	356	4.213	2.570	6.835
Camel	Local	Young	0	110	0.000	0.000	3.374
Camel	Local	Old	3	110	2.727	0.932	7.713
Cattle	Imported	Young	2	212	0.943	0.259	3.374
Cattle	Imported	Old	12	212	5.660	3.267	9.632
Cattle	Local	Young	3	718	0.418	0.142	1.221
Cattle	Local	Old	37	718	5.153	3.762	7.022
Goat	Imported	Young	1	218	0.459	0.081	2.552
Goat	Imported	Old	8	218	3.670	1.871	7.073
Goat	Local	Young	2	408	0.490	0.135	1.769
Goat	Local	Old	19	408	4.657	3.001	7.158
Sheep	Imported	Young	6	1,436	0.418	0.192	0.909
Sheep	Imported	Old	37	1,436	2.577	1.875	3.531
Sheep	Local	Young	23	5,449	0.422	0.281	0.633
Sheep	Local	Old	164	5,449	3.010	2.588	3.498

Notes: Prevalence = Infected / Examined. Confidence intervals computed using the Wilson method.

All four livestock species were examined to determine organ-specific infection prevalence, demonstrating differences between organs across species (Table 7). Liver infections were most common in sheep, which showed the highest prevalence (37.7%; 95% CI: 32.5–43.3), followed by goats (30.6%; 19.5–44.5) and cattle (29.0%; 19.6–40.6), while camels showed the lowest liver infection (20.5%; 10.8–35.5). In contrast, lung infections were most frequently detected in cattle (36.2%; 25.9–48.0) and sheep (35.7%; 30.6–41.3). Goats showed the lowest lung prevalence (18.4%; 10.0–31.4), whereas camels showed a moderate level of lung infection (28.2%; 16.5–43.8). The multi-organ differed from a single organ. Concurrent infection of both liver and lungs was highest in camels (48.7%; 33.9–63.8) and goats (38.8%; 26.4–52.8), while sheep (22.0%; 17.7–26.9) and cattle (21.7%; 13.6–32.8) showed substantially lower dual organ infection. Mesenteric infection was generally uncommon across all species, with cattle (13.0%; 7.0–23.0) and goats (12.2%; 5.7–24.2) showing the highest prevalence, and sheep (4.6%; 2.8–7.6) and camels (2.6%; 0.5–13.2) demonstrating notably low levels. Overall, infection varied by organs across species: sheep and cattle showed the highest

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single organ prevalence in the liver and lungs, respectively, whereas camels and goats demonstrated greater multi organ infection.

Table 7. Prevalence by Species and Organs

Species	Organs	Prevalence %	95% CI Lower	95% CI Upper
Cattle	Liver	0.290	0.196	0.406
Sheep	Liver	0.377	0.325	0.433
Goat	Liver	0.306	0.195	0.445
Camel	Liver	0.205	0.108	0.355
Cattle	Lung	0.362	0.259	0.480
Sheep	Lung	0.357	0.306	0.413
Goat	Lung	0.184	0.100	0.314
Camel	Lung	0.282	0.165	0.438
Cattle	Both	0.217	0.136	0.328
Sheep	Both	0.220	0.177	0.269
Goat	Both	0.388	0.264	0.528
Camel	Both	0.487	0.339	0.638
Cattle	Mesentery	0.130	0.070	0.230
Sheep	Mesentery	0.046	0.028	0.076
Goat	Mesentery	0.122	0.057	0.242
Camel	Mesentery	0.026	0.005	0.132

Notes: Prevalence = Infected / Examined. Confidence intervals computed using the Wilson method.

Statistical analysis confirmed significant variation in infection prevalence among organs within each species (Table 8). Overall chi-square tests indicated significant differences across organ categories in cattle (χ^2= 8.159, df = 3, P = 0.043), sheep (χ^2= 85.702, df = 3, P < 0.001), goats (χ^2= 8.388, df = 3, P = 0.039), and camels (χ^2 = 17.103, df = 3, P = 0.001). Pairwise comparisons showed species-specific patterns. In cattle, only the contrast between lung and mesentery remained significant after Bonferroni correction (P = 0.019), indicating higher lung infection relative to mesenteric infection. In sheep, all pairwise comparisons except liver vs. lung were statistically significant (P ≤ 0.002), with the strongest contrasts involving the mesentery. Among goats, only the comparison between dual organ infection and mesenteric infection remained significant (P = 0.034), reflecting elevated prevalence in animals with concurrent liver-lung infection. In camels, significant differences were observed between lung and mesentery (P = 0.022) and between dual organ infection and mesentery (P < 0.001), again showing notably low mesenteric involvement. All other pairwise contrasts in goats and camels were non-significant. These findings demonstrate that infection prevalence differs significantly among organs within each species, with sheep showing the most pronounced variation. Across all species, mesenteric infection consistently contributed to the strongest contrasts.

Table 8. Pairwise comparison between organs within species

Species	Test	Organ 1	Organ 2	Chi square	df	P value	Effect size	P Bonferroni
Cattle	Overall			8.159	3	0.043	-	0.300
Sheep	Overall			85.702	3	0.000	-	0.000
Goat	Overall			8.388	3	0.039	-	0.270
Camel	Overall			17.103	3	0.001	-	0.005
Cattle	Pairwise	Liver	Lung			0.468	-0.077	1.000
Cattle	Pairwise	Liver	Both			0.434	0.083	1.000
Cattle	Pairwise	Liver	Mesentery			0.035	0.196	0.248
Cattle	Pairwise	Lung	Both			0.091	0.160	0.634
Cattle	Pairwise	Lung	Mesentery			0.003	0.269	0.019
Cattle	Pairwise	Both	Mesentery			0.261	0.115	1.000
Sheep	Pairwise	Liver	Lung			0.675	0.020	1.000
Sheep	Pairwise	Liver	Both			0.000	0.172	0.000
Sheep	Pairwise	Liver	Mesentery			0.000	0.405	0.000
Sheep	Pairwise	Lung	Both			0.000	0.152	0.002
Sheep	Pairwise	Lung	Mesentery			0.000	0.388	0.000
Sheep	Pairwise	Both	Mesentery			0.000	0.256	0.000
Goat	Pairwise	Liver	Lung			0.240	0.142	1.000
Goat	Pairwise	Liver	Both			0.525	-0.086	1.000
Goat	Pairwise	Liver	Mesentery			0.047	0.224	0.331
Goat	Pairwise	Lung	Both			0.043	-0.226	0.302
Goat	Pairwise	Lung	Mesentery			0.576	0.085	1.000

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Species	Test	Organ 1	Organ 2	Chi square	df	P value	Effect size	P Bonferroni
Goat	Pairwise	Both	Mesentery			0.005	0.304	0.034
Camel	Pairwise	Liver	Lung			0.599	-0.090	1.000
Camel	Pairwise	Liver	Both			0.017	-0.296	0.116
Camel	Pairwise	Liver	Mesentery			0.029	0.281	0.200
Camel	Pairwise	Lung	Both			0.103	-0.211	0.718
Camel	Pairwise	Lung	Mesentery			0.003	0.355	0.022
Camel	Pairwise	Both	Mesentery			0.000	0.528	0.000

Across the four livestock species examined, infection prevalence varied substantially by species and sex (Table 9). Cattle showed an overall prevalence of 5.81% (95% CI: 4.48–7.50), with females showing a noticeably higher prevalence (11.16%) than males (4.11%). Camels had a lower overall prevalence of 4.29% (95% CI: 2.80–6.54), again with higher infection in females (6.48%) compared to males (3.36%). Goats showed a similar pattern, with an overall prevalence of 4.94% (95% CI: 3.48–6.97) and a large sex difference: 12.64% in females versus 3.65% in males. Sheep had the lowest overall prevalence at 3.45% (95% CI: 3.04–3.90), though female sheep still showed a higher prevalence (4.52%) than males (1.00%).

Table 9. Prevalence of species by sex

Species	Sex	Examined	Infected	Prevalence %	95% CI
Cattle	Male	706	29	4.108	2.875 – 5.837
Cattle	Female	224	25	11.161	7.675 – 15.956
Cattle	Total	930	54	5.806	4.477 – 7.499
Camel	Male	327	11	3.364	1.889 – 5.922
Camel	Female	139	9	6.475	3.444 – 11.847
Camel	Total	466	20	4.292	2.795 – 6.536
Goat	Male	520	19	3.654	2.351 – 5.636
Goat	Female	87	11	12.644	7.209 – 21.238
Goat	Total	607	30	4.942	3.484 – 6.968
Sheep	Male	2,098	21	1.001	0.656 – 1.525
Sheep	Female	4,806	217	4.515	3.964 – 5.139
Sheep	Total	6,904	238	3.447	3.42 – 3.904

Notes: Prevalence = Infected / Examined. Confidence intervals computed using the Wilson method.

Risk ratio analysis supported these species-level differences (Table 11). Cattle (RR = 0.926; 95% CI: 0.882–0.973; P < 0.001), goats (RR = 0.907; 95% CI: 0.836–0.984; P < 0.001), and sheep (RR = 0.965; 95% CI: 0.957–0.972; P < 0.001) all showed statistically significant reductions in risk between comparison groups. In contrast, camels did not show a significant difference (RR = 0.968; 95% CI: 0.922–1.016; P = 0.139), indicating comparable risk across groups for this species. These findings highlight consistent sex associated differences in prevalence across species- and species-specific variation in relative risk.

Table 10. Risk Ratio (RR) for Male vs. Female within species

Species	Risk ratio (RR)	95% CI for RR	P value
Cattle	0.926	0.882 – 0.973	<0.001
Camel	0.968	0.922 – 1.016	0.1390
Goat	0.907	0.836 – 0.984	<0.001
Sheep	0.965	0.957 – 0.972	<0.001

Notes: Prevalence = Infected / Examined. Confidence intervals computed using the Wilson method.

Discussion

Hydatidiosis is an important disease in animals and humans with economic significance and increasing prevalence in various geographical locations around the world [14, 4, 2]. The overall prevalence of hydatid cysts in slaughtered animals showed a notable variation among examined species. The highest prevalence of infection was found in cattle 5.806% followed by a comparable level in goats and camels, with estimates of 4.942% and 4.292%, respectively. Sheep had the lowest prevalence of infection 3.447% although it represents the largest population of the total sample. The infection prevalence among the four livestock species was statistically significant in P=0.00019. The higher prevalence rate of hydatidiosis in cattle than in other animal species was consistent with similar studies conducted in Libya (1) and Sudan (2), which reported a higher prevalence rate in examined cattle [15, 16]. In the present study, infection occurrence was similar in both local and imported animals, suggesting widespread environmental exposure.

The seasonal prevalence of Echinococcus infection exhibits a remarkable variation across all examined species. Cattle showed the highest prevalence in spring and winter 5.83% and 7.83% respectively, whereas

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goats showed the lowest rate of infection in both seasons. The observed seasonal fluctuations in prevalence across months and seasons suggest that environmental and ecological factors play an important role in transmission dynamics. The higher prevalence recorded during winter and late winter months may be associated with increased survival of Echinococcus eggs in cooler and more humid conditions. Conversely, the lower prevalence observed during summer may be explained by high temperatures and desiccation. Similar seasonal patterns have been reported in endemic regions where climatic conditions influence parasite transmission cycles [1]. The absence of a significant difference between imported and local animals suggests that infection risk is widespread and relatively uniform across animal sources. This indicates that exposure to infective eggs likely occurs both before and after animal movement, reflecting the endemic nature of the parasite in the broader region [4].

In the present study, older animals exhibit a consistently higher prevalence than young animals. Similarly, imported animals, including cattle, camels, sheep, and goat showed higher infection levels in the older age group compared with young animals. These finding correlates with recently published data in which older animals showed a higher infection rate of hydatidosis. Age-related differences represented the most consistent epidemiological pattern observed in the present study. The higher prevalence in older animals can be explained by cumulative exposure over time [17, 18]. The outcome of this current study indicates that the liver was the most infected organ in sheep, followed by goat and cattle, whereas camel showed the lowest rate of liver infection. In contrast, lung infections were most frequently detected in cattle and sheep. These findings were consistent with a previously published Libyan study [15]. On the other hand, in another study published in Algeria, the lung was more affected than the liver in sheep and goats [19]. The higher prevalence of echinococcus infection of the lung and liver is attributed to the fact that lungs and livers are the first major capillary sites encountered by the migration of the Echinococcus oncosphere. Organ distribution findings also provide insight into parasite biology and host–parasite interactions. The predominance of hepatic and pulmonary localization reflects physiological filtration mechanisms [14]. Our study highlighted a consistent sex associated differences in hydatid cyst prevalence across species. The female rate of infection was higher than male. These findings are in agreement with another study [20]. This could be due to the management system and exposure of both sexes to different risk factors [3]. In addition, males are slaughtered at a young age compared to females, who live longer and are exposed to environmental infection over time [1].

Despite the strengths of the present investigation, including large sample size, multi-species coverage, and year-round sampling, several limitations should be considered when interpreting the findings. First, prevalence estimates were based on abattoir data. Second, cyst fertility and viability were not assessed. Third, molecular characterization of cyst strains was not performed. The epidemiological implications of these findings are substantial. The detection of infection across all examined livestock species confirms that the parasite is well established in the study area. This underscores the need for integrated control strategies focusing on regular deworming of dogs, proper disposal of infected offal, strengthening slaughterhouse inspection, and public health education [1].

Conclusion

The present investigation confirms that cystic echinococcosis remains endemic among livestock species slaughtered in Sabratha, Libya, with statistically significant variation in prevalence among host species, seasons, age groups, and sexes. Cattle showed the highest infection rates, while sheep exhibited the lowest, indicating species-related susceptibility and exposure differences. Seasonal fluctuations suggest that environmental conditions play a key role in transmission dynamics, whereas the higher prevalence observed in older animals reflects cumulative exposure risk. The predominance of hepatic and pulmonary cyst localization is consistent with known parasite migration pathways and host physiological filtration mechanisms. The absence of differences between local and imported animals further demonstrates that infection pressure is widespread within the region.

Overall, these findings emphasize that hydatidosis represents a persistent veterinary, economic, and public health challenge. Effective control will require coordinated intervention strategies combining veterinary surveillance, strict slaughterhouse inspection, safe disposal of infected organs, and community-level education aimed at interrupting the dog–livestock transmission cycle. The data generated by this study provide a valuable epidemiological foundation for future monitoring programs and evidence-based policy planning to reduce disease burden in both animal and human populations.

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Conflict of interest

The authors declare no conflicts of interest.

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