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Prevalence of Lungworms and Liver Fluke Infections in Ruminants Slaughtered at Kirkuk City, Iraq

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ABSTRACT

Parasitic infections represent one of the most prevalent and economically significant diseases affecting livestock worldwide. The present study aimed to investigate risk factors associated with liver fluke and lungworm infections in small ruminants, characterize the diversity of lungworm species, and determine the prevalence of infections in Kirkuk, Iraq. The study was conducted from November 2023 to April 2024 in Northeastern Iraq, examining 30,900 sheep, 797 goats, 9,990 cattle, and 84 buffalo at slaughter. All carcasses underwent thorough gross pathological examination to detect parasitic infections, including lungworms, liver flukes, hydatid cysts, and associated pulmonary lesions. Distinct pathological manifestations were particularly evident in naturally infected local sheep. The present study revealed the following disease prevalence patterns across species. Pneumonia was detected in 0.31% of sheep and 0.35% of cattle, with no cases observed in goats or buffalo. Hepatitis showed an incidence rate of 0.39% in sheep and 0.75% in cattle. Hydatid cyst occurrence in hepatic and pulmonary tissues was documented at 0.38% in sheep and 1.13% in cattle, while remaining undetectable in caprine and bovine specimens. Liver fluke infection rates varied significantly among species, with sheep exhibiting 0.32% prevalence, goats demonstrating the highest rate at 3.76%, cattle showing 0.90% infection, and buffalo populations remaining completely uninfected. The present findings revealed significantly higher disease susceptibility in ruminants during winter months, with progressively lower infection rates observed throughout summer and monsoon seasons. This seasonal pattern may reflect environmental factors influencing parasite life cycles and host immunity.

Keywords: Animal disease, Hydatid cyst, Parasitic infection, Pneumonia, Ruminant

INTRODUCTION

Slaughterhouses serve as critical surveillance points for detecting economically significant and zoonotic diseases, playing a pivotal role in ensuring food safety throughout the production chain (Raji et al., 2010; Mohammed and Abass, 2021). Systematic ante-mortem and post-mortem inspections are essential for identifying meat hygiene issues and potential public health risks associated with carcass consumption (Nevas and Lundén, 2014). Meat inspection records serve as a valuable epidemiological tool for veterinary public health surveillance and disease prevention (Edwards et al., 1997; García-Díez et al., 2023). Microbial pathogens such as *Streptococcus pyogenes*, *Staphylococcus aureus*, *Mycobacterium tuberculosis*, *Klebsiella*, *Proteus*, *Pseudomonas*, and *Entamoeba histolytica* are suspected of causing lung and hepatic abscesses in humans and animals (Webb et al., 2014). *Fusobacterium necrophorum* is a Gram-negative, obligately anaerobic, rod-shaped bacterium that primarily colonizes the bovine rumen, where it adheres to the ruminal epithelium. Rumen concentrations of this pathogen are significantly elevated in grain-fed cattle compared to forage-fed animals (Neves et al., 2025). These bacterial microorganisms enter the portal circulation from the rumen and become trapped in the liver, leading to abscesses caused by bacterial pathogens, which represent a primary etiological factor in hepatic abscess development (Tadepalli et al., 2009).

Pneumonia and bronchitis are signs of lungworm infections, which typically strike young calves on permanent or semi-permanent pastures during the first grazing season (Holzhauer et al., 2011; Forbes, 2018). The majority of significant clinical signs are caused by primary parasite pneumonia and manifest during the prepatent and patent stages (Abass et al., 2020). Chakraborty et al. (2014) identified *Dictyocaulus filaria* (*D. filaria*), *Protostrongylus rufescens*, and

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Muellerius capillaris as the primary etiological agents of ovine lungworm infection, clinically manifested as verminous pneumonia or verminous bronchitis.

The life cycle of hydatid cyst consists of two stages, with a definitive host (Canids) that carry the adult worm in the small intestine, and livestock serving as an intermediate host, in which livestock and humans can accidentally become infected, where the larval stage (Hydatid cyst) develops in liver (Eckert and Deplazes, 2004, Stojković et al., 2018). The infection of hydatid cyst in the intermediate host occurs through the accidental ingestion of *Echinococcus* eggs, which are passed through the feces of a dog and contaminated water or food (Lopes et al., 2017). The economic significance of echinococcosis in livestock production stems primarily from carcass degradation and contamination of consumable visceral organs, including lungs, liver, and heart (Hussein et al., 2022).

Fascioliasis represents one of the most globally prevalent parasitic diseases of livestock, with significant economic impacts on cattle and sheep production systems worldwide (Mehmood et al., 2017). Current estimates indicate infection rates exceeding 250 million sheep and 300 million cattle globally. The two primary species of *Fasciola (F.)* spp., which are *F. gigantica* and *F. hepatica*, can infect humans and are widespread parasites in ruminants, particularly in sheep, goats, cattle, buffalo, and pigs (Periago et al., 2006). These ruminants are typically distinguished by their morphological features, including body length and form (Periago et al., 2008; Mazeri et al., 2017). Liver fluke infection is recognized as an economically significant parasitic disease in livestock production systems, primarily due to its global prevalence and the substantial tissue damage caused by hydatid cyst formation in affected organs, particularly the liver and lungs (Jawad et al., 2018). Furthermore, *fasciola*, which affects over 2.6 million people globally, is becoming a significant human health concern. Hence, *fasciola* has been regarded as a neglected illness that is resurfacing (Jaja et al., 2018). The adult bisexual stage of the *fasciola* settles in the bile ducts of the host and releases thousands of eggs per day during sexual reproduction (Fürst et al., 2012). These eggs pass into the intestines through the bile ducts before being dispersed into the fecal stream (Mohammed and Abass, 2021). The present study aimed to assess the risk factors associated with lungworm infections in small ruminants, characterize the prevalence of different lungworm species, and evaluate the incidence of these parasitic infections in Kirkuk, Iraq.

MATERIALS AND METHODS

Ethical approvals

The animal experimentation was approved by the Ethical Clearance Committee of the College of Veterinary Medicine, Kirkuk University, under registration number Ki. Vet. 5 (2025). The present study was conducted from November 2023 to April 2024 at the Al-Asiriyah slaughterhouse in Kirkuk city, Iraq

Study area

The study was conducted in Kirkuk, a city in the Northeastern part of Iraq, with a population of 1.5 million people (Abass et al., 2020). The majority of people in Kirkuk are farmers, and farming is the primary driver of the city's economy (Abass et al., 2020). The majority of livestock are raised using a semi-extensive system, which involves tethering and seasonal confinement (Abass et al., 2019). The current study was carried out at the University of Kirkuk College of Veterinary Medicine and approved by the scientific committee in Iraq.

Animals

The study was conducted at the Kirkuk Al-Asiriyah slaughterhouse in Iraq, which comprises two primary processing halls; one dedicated to sheep with a capacity of 30,900 heads and another for cattle with a capacity of 9,990 heads. The investigation included multiple livestock species (Cattle, goats, sheep, and buffalo) of local Northern Iraqi breeds. All animals were aged 6 months to 2 years, with the following weight ranges. Cattle (150-350 kg), goats (10-40 kg), sheep (15-35 kg), and buffalo (100-400 kg). Both sexes were represented, and all slaughter procedures followed Islamic (Halal) protocols (Abass et al., 2020).

The study population consisted primarily of locally sourced goats. In contrast, sheep and cattle specimens were predominantly acquired from neighboring cities, including Mosul, Tikrit, Sulaymaniyah, and the Northern Iraqi provinces, via the investigated slaughterhouse's supply chain. Routine meat inspection procedures for all four livestock species were primarily conducted by qualified animal health technicians, with veterinary intervention reserved for complex pathological findings (Kadir et al., 2012). Tissue samples from the livers and lungs of 315 sheep, 30 goats, 238 cattle, and 84 buffalo were collected from November 2023 to April 2024. All carcasses underwent thorough gross pathological examination by certified veterinary inspectors to detect hepatic fascioliasis, hydatidosis, and pulmonary lesions, following established protocols (Abass et al., 2019).

Sample collection

During sample collection, liver and lung tissues from cattle, sheep, goats, and buffalo were systematically examined for signs of infection, with a particular focus on bile duct abnormalities. A thorough macroscopic inspection was conducted to assess organ size, color, texture, shape, and the presence of parasitic lesions or other pathological changes. Following visual examination, organs were sectioned into smaller portions and further dissected into thin slices for detailed analysis (Chauke et al., 2014).

Statistical analysis

The statistical analysis was performed using Sigma Plot, version 11. Differences among groups were determined by one-way analysis of variance (ANOVA) followed by Fisher's LSD test. All results were presented as means, with statistical significance set at ($p < 0.05$).

RESULTS

A total of 30,900 sheep, 797 goats, 9,990 cattle, and 84 buffalo were killed at the Kirkuk Alsiriyah slaughterhouse, Iraq. Goat slaughter numbers differed significantly in April compared to other species ($p < 0.05$), whereas buffalo and sheep slaughter rates indicated a marked seasonal decrease in December and November, respectively ($p < 0.05$; Table 1).

Among the 30,900 sheep examined, 95 cases of pneumonia were detected (0.31%), while 35 cases were identified in 9,990 cattle (0.35%). No pneumonia cases were reported in goats or buffaloes at the Kirkuk slaughterhouse (Table 2).

A total positivity of sheep pneumonitis was significantly higher ($p < 0.05$) in April (0.41%) than in November (0.38%), December (0.28%), February (0.26%), March (0.19%), and January (0.3%). Similarly, in cattle, the positivity rate remained high (5%) in April compared to other months ($p < 0.05$; Table 3). Total positivity of pneumonitis in sheep was non-significantly higher in April (0.41%) than in November (0.38%) and January (0.30%), but it was significantly higher compared to the rest of the months (Table 4).

Table 1. The total number of sheep, goat, cattle, and buffalo from November 2023 to April 2024, in Kirkuk city, Iraq

Month	Sheep	Goat	Cattle	Buffalo
November	3900^{a}	108^{b}	1270^{a}	10^{ab}
December	5200^{b}	134^{c}	1560^{b}	7^{a}
January	5000^{b}	134^{c}	1700^{c}	17^{c}
February	5600^{c}	180^{d}	1700^{c}	15^{bc}
March	5200^{b}	194^{d}	1960^{d}	14^{bc}
April	6000^{d}	47^{a}	1800^{d}	21^{d}
Total	30900	797	9990	84

Different superscript letters in a column indicate significant differences ($p < 0.05$) among months.

Table 2. Incidence of lungworm (*Dictyocaulus filaria*) causing pneumonia in sheep, goat, cattle, and buffalo from November 2023 to April 2024 in Kirkuk city, Iraq

Animal species	Slaughtered animals (Number)	Pneumonia infections (Number)	Positive cases (%)
Sheep	30900	95	0.31
Goat	797	0	0
Cattle	9990	35	0.35
Buffaloes	84	0	0

Table 3. General survey of lungworm (*Dictyocaulus filaria*) pneumonia infections in sheep, goat, cattle, and buffalo from November 2023 to April 2024, in Kirkuk city, Iraq

Month / Infected animals (Number)	November	December	January	February	March	April
Sheep (%)	15^{b}	15^{b}	15^{b}	15^{b}	10^{c}	25^{a}
Goat (%)	0	0	0	0	0	0
Cattle (%)	5^{b}	5^{b}	5^{b}	5^{b}	5^{b}	10^{a}
Buffalo (%)	0	0	0	0	0	0
Total	20	20	20	20	15	35

Different superscript letters in a row indicate significant differences ($p < 0.05$) among months.

Table 4. Prevalence of pneumonia in sheep from November 2023 to April 2024 in Kirkuk city, Iraq

Month	Examined animals (Number)	Positive lungs (Number)	Total positive cases (%)
November	3900	15	0.38[a]
December	5200	15	0.28[b]
January	5000	15	0.30[ab]
February	5600	15	0.26[b]
March	5200	10	0.19[c]
April	6000	25	0.41[a]

Different superscript letters in a column indicate significant differences ($p < 0.05$) among months.

While a total positivity of pneumonitis in cattle was significantly higher ($p < 0.05$) in April (0.50%) than in November (0.39%), December (0.32%), January, and February (0.29%; Table 5), no significant difference were recorded among goats and buffaloes in the Kirkuk slaughterhouse, Iraq ($p > 0.05$). Moreover, the incidence of sheep pneumonitis in November differed significantly from that in other recorded months ($p > 0.05$; Table 5). As shown in Table 6, a total of 120 hydatid cysts were found in 30,900 sheep (0.38%) and 113 hydatid cysts were found in 9,990 cattle (1.13%), whereas there were no hydatid cysts found in goats or buffaloes. A total positivity of Hydatidosis in sheep was significantly higher ($p < 0.05$) in April (0.41%) than in December (0.40%), January (0.38%), November (0.38%), February (0.35%), and March (0.19%), as shown in Table 7. Moreover, a total positivity of hydatidosis in cattle was significantly higher ($p < 0.05$) in December (1.28 %) than in November (1.18 %), February (1.17 %), April (1.11 %), March (1.02 %), and January (0.88 %), as shown in Table 8.

Table 5. Prevalence of pneumonia in cattle from the beginning of November 2023 to the end of April 2024 in Kirkuk city, Iraq

Month	Total number of examined animals	Positive in Lungs (Number)	Total positive cases (%)
November	1270	5	0.39
December	1560	5	0.32
January	1700	5	0.29
February	1700	5	0.29
March	1960	5	0.25
April	1800	10	0.50

Table 6. The hydatid cyst infection rate among sheep, goat, cattle, and buffalo from November 2023 to April 2024 in Kirkuk city, Iraq

Animal species	Slaughtered animals (Number)	Hydatid cyst infections (Number)	Positive cases (%)
Sheep	30900	120	0.38
Goat	797	0	0
Cattle	9990	113	1.13
Buffaloes	84	0	0

Table 7. Distribution of endemic hydatid cysts in sheep from November 2023 to April 2024 in Kirkuk city, Iraq

Month	Examined animals (Number)	Positive in liver and lungs (Number)	Total positive cases (%)
November	3900	15	0.38
December	5200	21	0.40
January	5000	19	0.38
February	5600	20	0.35
March	5200	20	0.19
April	6000	25	0.41

Table 8. Distribution of endemic hydatid disease in cattle from November 2023 to April 2024 in Kirkuk city, Iraq

Months	Examined animals (Number)	Positive in liver and lungs (Number)	Total positive (%)
November	1270	15	1.18
December	1560	23	1.28
January	1700	15	0.88
February	1700	20	1.17
March	1960	20	1.02
April	1800	20	1.11

DISCUSSION

Cystic echinococcosis and liver fluke infections significantly impair livestock productivity by reducing growth rates, increasing mortality and morbidity, and predisposing animals to secondary bacterial infections. Additionally, these conditions lead to organ condemnation and diminished meat and milk production, resulting in substantial economic losses (Najjari et al., 2020). Hydatid disease and *Echinococcus* spp. further compromise production efficiency through visceral damage and carcass wastage (Jahed Khaniki et al., 2013). To mitigate these risks, implementing a reliable meat inspection system is crucial for detecting animal diseases, particularly chronic conditions that may go undetected by farmers or veterinarians. Although fascioliasis, which is caused by *Fasciola* spp., has been extensively documented for its substantial veterinary impacts (Mas-Coma et al., 2009), numerous zoonotic bacterial diseases remain underrecognized despite their significant public health consequences. These findings align with the current results, which demonstrated high detection rates of *Fasciola* spp. and *Dictyocaulus* spp. infections. Additionally, *D. filaria* in sheep and goats, and *D. viviparous* in cattle, can cause lungworm infections (Chakraborty et al., 2014). Hydatidosis is a zoonotic parasitic illness caused by *Echinococcus* (Wen et al., 2019). The current study revealed an elevated prevalence of lungworm infections in slaughtered ruminants, with detection rates of 0.35% in cattle and 0.31% in sheep. In Afghanistan, Nangarhar, 21.8% of sheep examined at a slaughterhouse were found to be infected with lungworms (Samadi et al., 2019), although the type of lungworm was not specified. In the current study, the incidence of lungworm infection in small ruminants in April was higher than in other months, which is consistent with the findings of Alemu et al. (2006), Regassa et al. (2010), and Borji et al. (2012), who reported an increased spread of lungworm in small ruminants during spring. Thus, the incidence of lungworms in sheep and cattle is influenced by seasonal dynamics (Fesseha and Mathewos, 2021).

The occurrence of different infections in a given area is influenced by a multifactorial system comprising parasites, hosts, environmental factors, and physical and physiological stressors that can alter the immune status of animals (Kadir et al., 2012). The current study identified hydatid cyst infections in 1.13% of cattle (113 cases) and 0.38% of sheep (120 cases), representing significantly lower prevalence rates than those reported by Saeed et al. (2000) in Erbil Governorate, Iraq (22.3% in cattle and 27.4% in goats). Moreover, Wadood (2005) reported higher organ-specific prevalence rates of hydatid cysts in Basra, Iraq, with liver involvement in 65.4% of cattle and 52.9% of sheep, and lung infection in 52.72% of cattle and 47.01% of sheep. The present study indicated lower hepatic fascioliasis rates compared to the findings of Wadood (2005). Additionally, Jawad et al. (2018) reported a 1.84% prevalence of hydatidosis in cattle from Karbala, Iraq.

CONCLUSIONS

The present study indicated a reduction in the prevalence of fascioliasis, lungworms, hydatid disease, and associated parasites in sheep, goats, cattle, and buffalo. The present study highlighted the critical role of meat examination records in monitoring disease incidence and identifying potential long-term trends. The current findings identified winter as the highest risk season for parasitic infections in livestock, with elevated prevalence of fascioliasis (Liver fluke), hydatidosis, and pulmonary nematodiasis (Lung worms). Moreover, the present study on liver fluke, hydatid cyst, and lungworm infections provided baseline data for future surveillance of these potentially significant parasitic diseases in Kirkuk, Iraq. It is crucial to undertake additional studies on ruminants to thoroughly investigate the effects of parasites, lungworms, and liver flukes, as well as to clarify their potential impact on health and productivity. Therefore, it is advisable to implement strengthened measures for controlling these infections in Kirkuk of Iraq. To accomplish this, stricter treatment protocols and more rigorous monitoring of ruminants should be established.

DECLARATIONS

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Authors' contributions

Abbas Saleh designed and analyzed the study. Cheia Wahhab and Almas Al-Bayati collected samples, wrote the manuscript, and analyzed the data. Kasim Abass and Al Salihi Karima supported the implementation of the study. All authors have read and approved the data and the final edition of the manuscript.

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Competing interests

The authors of the present study declared no conflict of interest.

Ethical considerations

The present study was originally written by the authors and has not been published elsewhere. The authors checked the text of the article for plagiarism index and confirmed that the text of the article is written based on their original scientific results.

Availability of data and materials

Data availability is available according to the request.

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