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Prevalence of Echinococcosis and Cysticercosis in Sheep in Abeche Slaughterhouse in Chad

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ABSTRACT

Echinococcosis and cysticercosis are severe veterinary and medical issues that are prevalent worldwide, particularly in developing countries where canines interact with domestic ruminants on a more frequent basis. The primary reservoir of both cestodes is sheep, which serve as intermediate hosts. Therefore, it is crucial to evaluate the incidence of hydatid cysts and cysticerci in livestock that have been slaughtered at the abattoir. This is due to the likelihood of cestode larvae infesting offal that is transmitted to definitive hosts, including humans and canines. The research was conducted from August to October 2024 at the Abeche abattoir in Chad. Throughout the duration of the study, all sheep that were slaughtered were examined. A total of 19,047 sheep, consisting of 8,726 males and 10,321 females, were inspected. The presence of hydatid cysts and cysticerci (*Cysticercus ovis* and *Cysticercus tenuicollis*) in the skeletal muscles and/or visceral organs was used to determine the animal's positivity to echinococcosis and cysticercosis. The results indicated that the sheep examined had an overall prevalence of hydatidosis of 3.30%. The prevalence was lower in animals from transhumant breeders (2.86%) than in the urban (3.94%) and periurban (3.40%) areas, and it was higher in females (3.85%) than in males (2.67%). The prevalence of cysticercosis was far lower for *C. ovis* infestations (0.21%) than for *C. tenuicollis* (4.39%). The two sexes did not exhibit a significant difference in the prevalence of *C. ovis* cysticercosis. However, the study reported a significantly higher quantity of *C. tenuicollis* in females *(5.37%)* compared to males *(3.23%)*. This study concludes that the prevalence of these two larval cestodoses in sheep has increased in comparison to previous research conducted in slaughterhouses in Chad. Significant efforts must be made to prevent the transmission of these larvae from slaughterhouses by destroying all infested offal in order to reduce the infestation.

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INTRODUCTION

Hydatid echinococcosis (hydatidosis) and cysticercosis are zoonotic parasitic diseases of environmental origin that are caused by the eggs of cestodes, flatworms, and transmitted by carnivores. These diseases occur in the majority of regions worldwide and result in substantial morbidity and mortality **(Sidhartha and Subhash, 2012; Hashemnia and Frajani, 2016; Mukatakamba *et al*., 2023).** The health risks are the primary concern of public health. These pathologies are the result of the larval form of dog cestodes, *Echinococcus granulosus* (*E. granulosus*), *Taenia ovis* (*T. ovis*), and *Taenia hydatigena* (*T. hydatigena*), developing in the muscle, liver, and lungs of the intermediate host. The larvae are responsible for echinococcosis and cysticercosis, respectively **(Ould Ahmed Salem *et al*., 2010; Khaled *et al*., 2020).** The eggs of *E. granulosus*, *T. ovis*, and *T. hydatigena*, which are released into the environment via the feces of a dog carrying adult worms, are ingested by sheep, which are the intermediate hosts, resulting in the development of hydatidosis and cysticercosis **(Hashemnia and Frajani, 2016).** The larvae (hydatid cyst or cysticerci)

are ingested by the definitive host (carnivores) in the raw or undercooked meat, resulting in the development of taeniasis, the adult parasite in the digestive tract **(Abdel-Baki *et al*., 2018).** Hydatidosis or cysticercosis is acquired by humans through human-to-human contamination, which involves the ingestion of eggs, resulting in their status as intermediate hosts **(Lahmar *et al*., 2004; Schweiger *et al*., 2012).**

Though the larvae of these cestodes are not a herd health issue when the parasite burden is low, they do affect the quality of sustenance. Hydatid cysts or cysticerci, both viable and degenerated, are visible in the meat of infected animals, rendering it unsuitable for human consumption **(Hajipour *et al*., 2020).**

Consequently, the Food and Agriculture Organization of the United Nations (FAO) recommends that a carcass be condemned for cestode larval infection (*hydatid cyst* or *Cysticercus ovis*) if lesions are detected in two of the standard inspection sites, including masseter muscle, tongue, esophagus, heart, diaphragm, or exposed musculature **(Bradley *et al*., 2012).** As a result, farmers may incur substantial financial losses as a result of the presence of animals in regions with a high prevalence **(Khaled *et al.,* 2020; Rong et *al*., 2021).**

Additionally, cysticercosis and hydatidosis are severe medical conditions that are frequently overlooked **(Umhang, 2017; Birk *et al*., 2018).** The World Health Organization (WHO) has designated the disease as a priority neglected disease that has the potential to be eradicated due to its epidemiological cycle and significant impact on human health **(Fromsa and Jobre, 2011; N'Dri *et al*., 2024).**

The prevalence of pathologies induced by the development of cestode larvae in small ruminants, particularly sheep, has been the subject of very few studies in Chad. The few studies that have been conducted are outdated **(Graber and Thome, 1964; Graber and Chailloux, 1970; Assana *et al*., 2001).** Nevertheless, sheep are the primary source of small ruminant meat ingested by the population and are a significant contributor to the agricultural economy of Chad **(Djalal, 2011).**

In addition, echinococcosis and cysticercosis are significant zoonoses; therefore, it is imperative to evaluate the prevalence and identify the risk factors to facilitate control and treatment. The purpose of this investigation was to evaluate the prevalence of cestode infestation in sheep that were slaughtered at the Abeche abattoir in Chad, specifically with larvae of *Echinococcus granulosus* (*hydatid cyst*), *Taenia ovis* (*Cysticercus ovis*), and *Taenia hydatigena* (*Cysticercus tenuicollis*).

MATERIALS AND METHODS

Study period and location

The study was carried out between August 1 and October 30, 2024, for a total of three (3) months. This was done in the Abeche slaughterhouse in Chad. Abeche is the capital of the province of Ouaddaï and is situated in the country's east. It spans from latitude 13° 48'584" North to longitude 20° 50'139" East **(MEERH, 2009).** With a three-month rainy season (July to September) and a nine-month dry season (October to June), Abeche experiences 300 mm of rainfall annually and an average temperature of 28°C (with variations in the cold season of 16 to 35°C and 25 to 45°C in the hot period). Abeche is influenced by the intertropical climate.

Study animals' population

From August to October, all sheep that were slaughtered were inspected and sampled. Our sample size consisted of the animals that were examined. A systematic search for hydatid lesions and cysticerci was conducted on a total of 19,047 sheep, which included 8,726 males and 10,321 females, during the post-mortem inspection. The age of the sheep slaughtered was one to four years. The periurban area of the city of Abeche is the primary source of the slaughtered animals, accounting for 59.93% **(Table 1).**

Table 1: sheep's effective and origin

Variable		Animals number	Percentage (%)
Sheep	Males	8,726	45.81
	Females	10,321	54.18
Origin	Urban	2,182	11.45
	Periurban	11,416	59.93
	Transhumant	5,449	28.60

Postmortem examination

By visual inspection and palpation, the carcasses and visceral organs of all slaughtered sheep were examined for the presence of hydatid cysts and cysticerci in accordance with the procedure previously described **(Wilson, 2005).** The presence of hydatid cyst, *Cysticercus ovis* (*C. ovis*), and *Cysticercus tenuicollis* (*C. tenuicollis*) in the muscles and/or all visceral organs, including the diaphragm, triceps, thigh muscles, masseter muscle, cardiac muscle, intercostal muscles, lungs, liver, tongue, kidneys, intestinal mucosa, and spleen, respectively, was used to determine the animal's positivity to echinococcosis or cysticercosis (**Fig. 1**).

Carcasses that exhibited two or more lesions at the standard inspection locations were deemed to be severely infected and were subsequently condemned **(Food and Agriculture Organization of the United Nations, 2000).** Hydatid cysts and cysticerci are categorized and enumerated based on their location on the animals at the conclusion of the inspection.

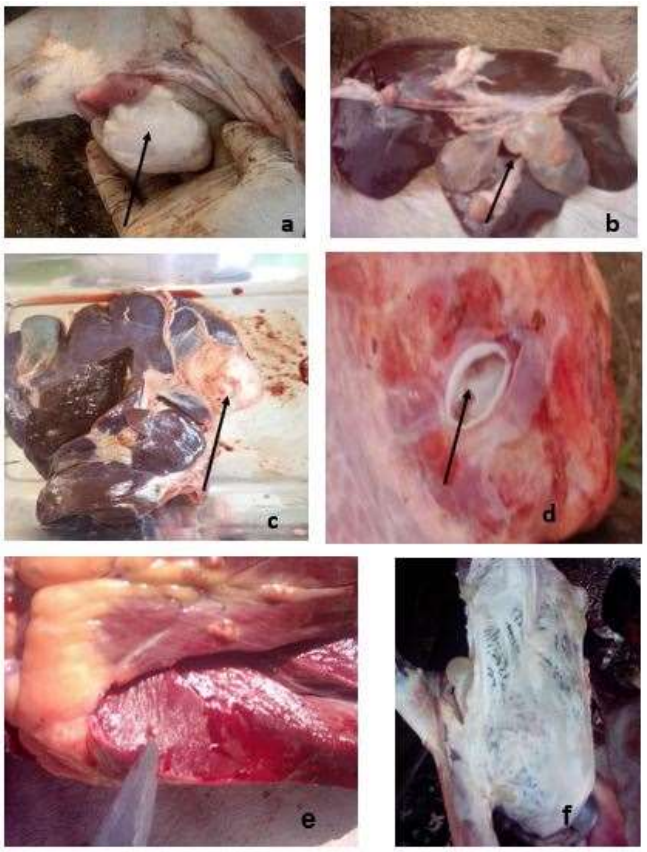

Fig. 1: Photos of the few hydatid cysts and cysticerci found during examinations of carcasses and visceral organs **(a**. Hydatid cyst at thigh level, **b.** *Cysticercus tenuicollis* (water balls) on liver, **c.** Hydatid cyst on liver, **d.** Hydatid cyst in lung, **e.** *Cysticercus ovis in* heart, **f.** *Cysticercus tenuicollis* on thorax).

Data analysis

The collected data were entered in Microsoft Office Excel and the XL-STAT software (versions 6.1.9 and 2009 Copyright© 2002, and 2008, Addinsoft) was used to perform descriptive statistics (means and incidence), and analysis of variances (ANOVA) with the Newman-Keuls multiple comparison test, with $p<0.05$ indicating statistical significance.

RESULTS

Prevalence of echinococcosis due to *Echinococcus granulosus*

A total of 19,047 sheep were slaughtered and inspected during the study period from August to October 2024. Six hundred and thirty (630) sheep, which constitutes 3.30% of the total number of sheep, were identified as having at least one *E. granulosus* cyst in the muscles or visceral organs. In comparison to females, males were substantially more infested **(Table 2).** Infestation rates were higher among animals from the urban area of Abeche (3.94%) than those from the periurban area of Abeche (3.40%) and transhumant livestock (2.86%) **(Table 3).**

Table 2: Prevalence of hydatid cysts by sex of sheep.

Sex	Number of inspected sheep	Number of infested	Prevalence (%)
Males	8,726	233	2.67[a]
Females	10,321	397	3.85[b]

For the same column, values carrying different superscript letter are significantly different ($p<0.05$).

Table 3: Prevalence hydatid cysts by origin of sheep.

Origin of sheep	Number of inspected sheep	Number of infested	Prevalence (%)
Urban	2,182	86	3.94[a]
Periurban	11,416	388	3.40[a]
Transhumant	5,449	156	2.86[b]

For the same column, values carrying different superscript letter are significantly different ($p<0.05$).

In the liver, 572 sheep (an overall prevalence of 3%) were found to have hydatid cysts, 28 sheep (0.14%) in the lungs, and 23 sheep (0.12%) in muscle tissue **(Table 4).**

Table 4: Distribution of hydatid cysts by infested organ of sheep.

Organ	Number of infested	Prevalence (%)
Muscle	23	0.120
Liver	572	3.000
Lung	28	0.147
Spleen	3	0.015

Prevalence of cysticercosis due to *Cysticercus ovis* et *Cysticercus tenuicollis*

Within the 19,047 animals that were slaughtered and inspected during the study period, 40 (corresponding to a prevalence of 0.21%) were found to harbor *Cysticercus ovis* (*C. ovis*) cyst, while 836 (corresponding to a prevalence of 4.39%) harbored *Cysticercus tenuicollis* (*C. tenuicollis*) cyst. The two sexes did not exhibit any significant difference in the prevalence of *C. ovis* cysticercosis. While, the prevalence of C. *tenuicollis* was considerably higher in females (5.37%) than in males (3.23%) **(Table 5).**

Table 5: Distribution of *Cysticercus ovis* and *Cysticercus tenuicollis* by sheep' sex.

Sex	Number of inspected sheep	*Cysticercus ovis*		*Cysticercus tenuicollis*	
		Number of infested	Prevalence (%)	Number of infested	Prevalence (%)
Males	8,726	25	0.29[a]	282	3.23[a]
Females	10,321	15	0.15[b]	554	5.37[b]

For the same column, values carrying different superscript letter are significantly different ($p<0.05$).

The prevalence of *C. ovis* infestation was considerably higher in animals from the urban area than in those from the periurban area and transhumant livestock, as indicated by the analysis based on the animals' provenance **(Table 6).** The liver exhibited a significantly higher distribution of parasitic larvae on the organs (0.20% and 2.13% for *C. ovis* and *C. tenuicollis*, respectively) than other organs **(Table 7).**

Table 6: Distribution of *Cysticercus ovis* and *Cysticercus tenuicollis* by sheep' origin.

Origin of sheep	Number of inspected sheep	*Cysticercus ovis*		*Cysticercus tenuicollis*	
		Number of infested	Prevalence (%)	Number of infested	Prevalence (%)
Urban	2,182	7	0.321[a]	58	2.66[a]
Periurban	11,416	24	0.210[b]	464	4.06[b]
Transhumant	5,449	8	0.147[b]	304	5.58[b]

For the same column, values carrying different superscript letter are significantly different ($p<0.05$).

Table 7: Distribution of *Cysticercus ovis* and *Cysticercus tenuicollis* in different organs.

Organs	*Cysticercus ovis*		*Cysticercus tenuicollis*	
	Number of nfested	Prevalence (%)	Number of infested	Prevalence (%)
Liver	39	0.204	406	2.131
Heart	1	0.005	19	0.100
Lung	0	0.000	7	0.036
Intestine	0	0.000	404	2.121
Peritoneum	0	0.000	1	0.005
Thorax	0	0.000	1	0.005

DISCUSSION

Carcass inspection is a reference technique for the detection of larval cestodoses in animals, including hydatidosis and cysticercosis **(Wilson, 2005).** Consequently, the study concentrated on data collected during the examination of sheep carcasses in the Abeche abattoir. All sheep that were slaughtered at the abattoir during the study period were sampled and inspected.

This study indicates that the Abeche abattoir had an overall mean prevalence of ovine hydatidosis of 3.30% during the study period. No recent study has been conducted in this study area to compare the results of our study with the prevalence of ovine hydatid echinococcosis that has been previously published. Nevertheless, a study conducted in the geographic Ouaddaï on sheep, which is quite outdated, indicates a prevalence of 0.44% **(Graber *et al.,* 1969).** The low infestation observed by **Graber *et al*., (1969)** may be attributed to the low demography of the Ouaddaï region at the time, as well as the sampling method of selecting animals. **Doutoum *et al*., (2020)** also observed a low frequency (0.26%) in cattle slaughtered at the Abattoirs Frigorifiques de Farcha (AFF) in Ndjamena (Chad) in 2016 (July and October 2016). The higher incidence observed in this study may be attributed to the expanding city of Abeche and its population, as well as the origin of the animals transported to the slaughterhouse.

The study reveals that the urban and periurban areas of the city are the source of the majority of the animals that are slaughtered. In these regions, the animals are in close proximity to the population and the carnivores (dogs), which are the reservoirs of parasitosis by nature **(Hashemnia and Frajani, 2016).** This observation showed that the population's hygienic conditions, which were characterized by the absence of latrines as well as the unregulated wandering of carnivores (dogs) and sheep, were impoverished, leading to an increase in infestations. This observation was documented also by **Assana *et al*., (2001)** in a study on the prevalence of porcine cysticercosis in Mayo-Danay, Cameroon, and Mayo-Kebbi, Chad.

The prevalence of ovine hydatidosis in this study was low in comparison to that observed in other countries. In Africa, a prevalence of 5.1% was reported in cattle in abattoirs in northern Nigeria **(Luka *et al*., 2023),** 5.6% in sheep in Mauritania **(Ould Ahmed Salem *et al*., 2010),** 9.8% in sheep in abattoirs in Cairo and Giza in Egypt **(Abo-Aziza *et al*., 2019)**, 16.6% in sheep in Tanzania **(Miran *et al*., 2017)**, and 8.7% in small ruminants in Ethiopia at Modjo Modern Export Abattoir **(Abiyot *et al*., 2011).** In other countries, sheep have been reported to have a prevalence of 11.5% and 31.3% in Pakistan **(Mehmood *et al.*, 2020)** and northern Greece **(Founta *et al.*, 2016),** respectively. On the other hand, the prevalence rate of the present studies was higher than that of a study conducted on sheep in the city of Riyadh, Saudi Arabia, where the prevalence was 1.06% **(Almalki *et al*., 2017).** Males were also observed to be the main carriers of the infection in comparison to females by **(Almalki *et al*., 2017).** Additionally, the liver (3%) was found to be more infested than other organs, including the lungs (0.14%) and musculature (0.12%), in the current study. **Almalki *et al*., (2017)** and **Haffaf *et al*., (2020)** also reported this in their respective studies.

The study's findings regarding cysticerci infestation indicated that the rate of *C. ovis* infestation was significantly lower (0.21%) than that of *C. tenuicollis* (4.39%). This prevalence was significantly lower than that reported by **Daiba (2006)** at the Farcha Refrigerated Slaughterhouses (AFF) in Ndjamena (Chad), where he observed a prevalence of 9.59% for *C. tenuicollis* infestations in both goats and sheep. In contrast, he had reported the absence of *C. ovis* cysticercosis. The prevalence of *C. ovis* in this study was significantly lower than that reported in Iran (2.9%) in sheep **(Hajipour *et al*., 2020).**

On the other hand, *C. ovis* infestations are infrequent in Europe, with only a handful of cases documented in France and Great Britain (0.2% of sheep) **(Euzeby, 1998). Bouhalit and Zerdoudi (2020)** also reported the absence of *C. ovis* in Algeria during their study. However, they observed a higher rate of infestation with *C. tenuicollis* (12.92% in sheep). **Miran *et al.,* (2017)** also reported a significant rate of livestock mortality in Tanzania (42.2%). On the other hand, the prevalence of infestation in Tunisia was low with *C. tenuicollis* (2.8%) **(Khaled *et al*., 2020).**

In this study, the high prevalence of *C. tenuicollis* cysticercosis observed in females compared to males has also been reported by other authors. In Algeria, **Bouhalit and Zerdoudi (2020)** reported that 61.65% and 39% of females and males, respectively, were affected. In Tunisia, **Khaled *et al*., (2020)**, for their part, reported in their studies 3.4% in females and 2.3% in males. In Tanzania, 46.7% and 40% of females and males, respectively, were reported **(Miran *et al*., 2017).** The present study's findings indicated that the liver and intestinal mesentery were the sites of the majority of *C. tenuicollis* cysts. Several studies have reported hepato-intestinal cysticercosis caused by *C. tenuicollis*, which is cosmopolitan. The prevalence in Tunisia and Turkey ranged from 11.82% **(Khaled *et al*., 2020)** to 56.7% **(Murat, 2005),** respectively.

CONCLUSION

According to the investigation, hydatid, *Cysticercus ovis*, and *Cysticercus tenuicollis* cysts, respectively, contaminated 3.3%, 0.21%, and 4.39% of sheep slaughtered at the Abeche abattoir. This study indicates that the incidence of cysticercosis and hydatidosis in Chad has increased. It is imperative to enhance the measures that are intended to regulate the transmission of larvae from slaughterhouses by eradicating all contaminated offal in order to prevent their consumption by canines, the ultimate final host, given that larval cestodosis is a global veterinary and human health issue.

Conflict of interest

The authors declare that they have no competing interests.

Author contributions

The research idea was conceptualized by ARD, IYA, MHA, AA, and JMG. Planning the study design was the responsibility of ARD and IYA. The sample collection at the abattoir was conducted by ARD and AA. The manuscript was drafted by ARD and MHA. The manuscript was edited by IYA, MHA, and JMG. The final manuscript was examined and endorsed by all participating authors.

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