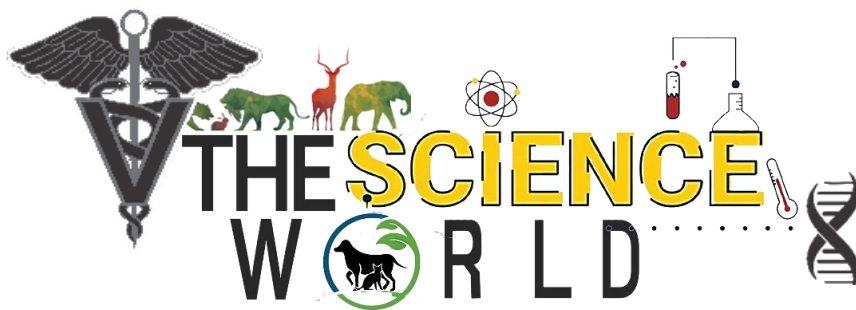




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Global Spatiotemporal Trend in the Reported Incidence of Acute Visceral Cysticercosis in Small Ruminants

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Abstract

Cysticercosis is a parasitic infection caused by *Cysticercus*, the metacestode (larval stage) of *Taenia* spp. In small ruminants, cysticercosis is mainly associated with *Cysticercus tenuicollis*, the metacestode of *Taenia hydatigena*. Most infections are chronic and asymptomatic, and are not usually identified until slaughter. In this short review, 17 outbreak reports of acute visceral cysticercosis in small ruminants are analysed with respect to the geographical distributions and temporal trends across the years, with limited aspects of sex and age predilection discussed.

1. Introduction

Cysticercosis associated with *C. tenuicollis* is more frequently seen in small ruminants than cattle, pigs, and other farm animals. The infection, though important, is usually asymptomatic and goes unnoticed, causing economic losses due to offal or meat condemnation. Cysticercosis caused by the larval stage of the tapeworm *T. hydatigena* can occur in either an acute or chronic form (Scala et al., 2014). The larval migration, in cases of heavy infections, could cause extensive damage to the hepatic parenchyma, accompanied by marked eosinophilic infiltration, which can be lethal. This acute form of hepatic cysticercosis is rare and typically occurs as outbreaks in lambs and kids, resulting in sudden death (Scala et al., 2014).

Over the past decades, there has been a gradual increase in reports of acute visceral cysticercosis in small ruminants. Reports of acute visceral cysticercosis in goats are relatively rare and mostly recorded in kids (Manfredi et al., 2006; Shivasharanappa et al., 2011; Perl et



al., 2015; Kumar et al., 2025). In contrast, reports of outbreaks of acute visceral cysticercosis are relatively more common in sheep (Livesey et al., 1981; Yildirim et al., 2006; Nourani et al., 2010; Koutsoumpas et al., 2013; Scala et al., 2014; Perl et al., 2015; Bozkurt et al., 2015; Kelly and Staples, 2016; Loukopoulos et al., 2018; Corda et al., 2020; Abdollahi et al., 2023).

2. Method

The compiled metadata spanning from 1981 to 2024 (44 years), with clusters around 2013–2018, provides a geographical overview (Table 1 and Fig. 1) of sporadic yet globally distributed occurrence of acute visceral cysticercosis in sheep and goats, emphasizing its relevance as an emerging and under-recognised parasitic condition in small ruminant production systems. This dataset compiles 17 reports of acute visceral cysticercosis (*Cysticercus tenuicollis*) cases in sheep and goats across multiple countries, totalling over 129 individual cases.

Table. 1: Global sporadic outbreak reports of acute visceral cysticercosis in small ruminants

SL No.	Country	Year	Species	Sex	Adult/Young	Age (months)	No. of affected animals	Reference
1	UK	1981	Sheep	Male	Lamb	~2m	5	Livesey et al., 1981
2	India	1996	Sheep	-	Adult	-	1	Loukopoulos et al., 2019
3	Turkey	2006	Sheep	-	Lamb	1m	1	Yildirim et al., 2006
4	Italy	2006	Goat	Female	6Adult +3Kid	-	9	Manfredi et al., 2006
5	Iran	2010	Sheep	-	Lamb	4m	1	Nourani et al., 2010
6	India	2011	Goat	-	Adult	-	9	Shivasharanappa et al., 2011
7	Australia	2011	Sheep	-	Adult	-	1	Loukopoulos et al., 2020
8	Greece	2013	Sheep	-	Lamb	2.5m	27	Koutsoumpas et al., 2013
9	Israel	2013	Sheep	-	Lamb	-	36	Perl et al., 2015
10	Italy	2014	Sheep	Female	Lamb	~2m	5	Scala et al., 2014
11	Israel	2015	Sheep +Goat	-	2Lamb +1Kid	-	3	Perl et al., 2015
12	Turkey	2015	Sheep	-	Adult	-	1	Bozkurt et al., 2015
13	Australia	2016	Sheep	-	Lamb	8m	1	Kelly and Staples, 2016
14	Australia	2017	Sheep	-	Adult	-	1	Loukopoulos et al., 2018
15	Italy	2018	Sheep	-	Lamb	4m	15	Corda et al., 2020
16	Iran	2021	Sheep	-	Lamb	~1.5m	12	Abdollahi et al., 2023
17	India	2024	Goat	Female	Adult	18m	1	Kumar et al., 2025



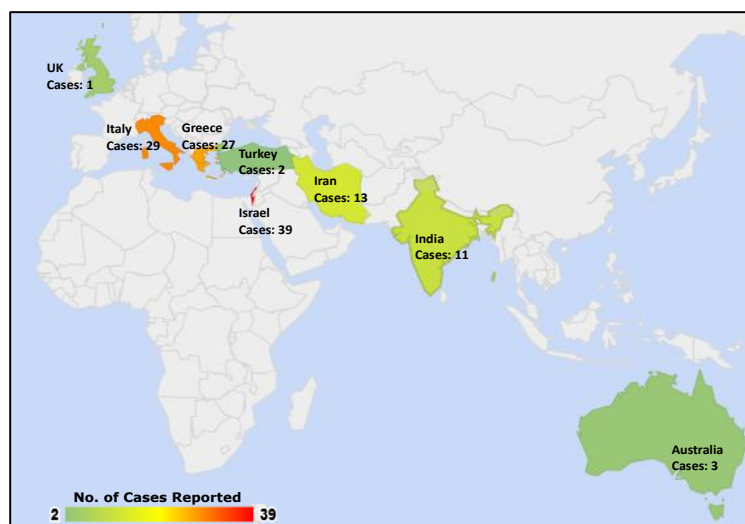


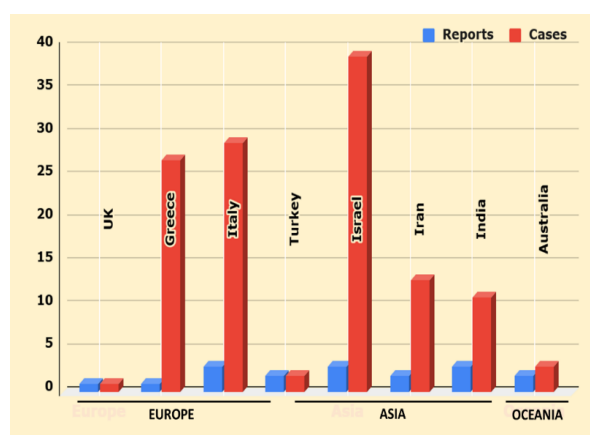
Fig. 1: Choropleth map representing the country-wise distribution of reported cases of acute visceral cysticercosis in small ruminants.

2.1. Geographic Patterns and Temporal Trends

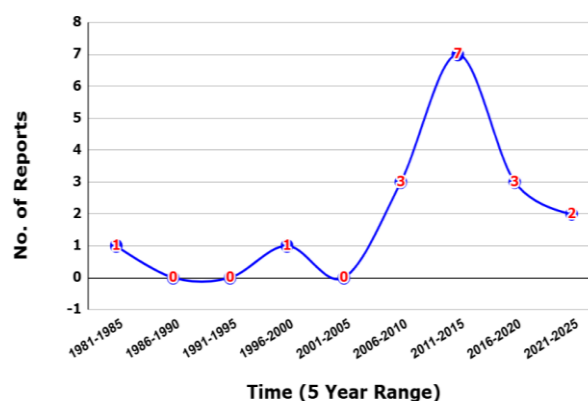
The reported cases originate from Europe (UK, Italy, Greece), Asia (India, Iran, Turkey, Israel), and Australia (Fig. 2) indicating a wide latitudinal range (approximately -36° to $+53^{\circ}$) and demonstrating that AVC is more restricted to subtropical to temperate climatic zones in both north and south hemispheres. Reports cluster in and around the Mediterranean regions of Italy, Israel, Greece, Turkey and Iran (10/17 reports), with outliers in India, Australia, and UK. Northern Hemisphere dominance (14/17 reports) may reflect better reporting in developed veterinary systems or temperate climates favouring *Taenia hydatigena* transmission through canines. This broad distribution suggests that management practices, exposure to definitive hosts (dogs and wild canines), and grazing systems may play a more critical role than climate alone in disease occurrence.

Temporally, reports are intermittent rather than continuous, with long gaps between early reports (1981–1996) and a marked increase in reporting during 2011–2015 followed by a subsequent decline (Fig. 3). The earliest documented report dates back to 1981 (UK), with a gradual increase in published reports after 2000, particularly from Italy, Israel, Australia, Turkey, Iran, Greece, and India. This apparent rise may reflect improved diagnostic awareness and reporting, rather than a true increase in incidence and also increased attention to acute and per-acute mortality events associated with cysticercosis, which were previously underrecognized. Notably, recent reports (2021–2024) from Iran and India suggest that AVC continues to occur and remains epidemiologically relevant.





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Fig. 2: Clustered bar chart showing number of reports and number of cases across countries, grouped by continents. **Fig. 3:** Temporal distribution of published reports on acute visceral cysticercosis in small ruminants over successive 5-year intervals from 1981 to 2025.

2.3. Host species, sex and age predilection

Sheep represent the majority of reported cases, consistent with their grazing behaviour and greater exposure risk to *Taenia hydatigena* eggs. Goats are less frequently affected, though confirmed cases in both adult goats and kids have been reported from Italy, Israel, and India, indicating that goats are not inherently resistant. In sheep, 14 outbreak reports show 84.5% (109/129) and in goats, 4 reports show 15.5% (20/129), of the total acute visceral cysticercosis cases reported.

Analysis of sex predilection was limited due to inconsistently reported data from the studies and we conclude a poor to no sex bias, as only 3 out of 17 reports show the occurrence in females and others report no data. A clear age predilection toward the young (109/129 cases) than adults (20/129 cases) is evident, which corresponds with acute disease severity in immunologically naive juveniles. Most high-incidence outbreaks (Greece 2013, Israel 2013, Italy 2018 and Iran 2021) involved lambs and kids aged approximately 1–4 months, suggesting increased susceptibility due to immature immunity and high exposure during early grazing or contaminated housing environments. Adult animals were less frequently affected and typically involved single or low-number cases, implying partial immunity or reduced exposure over time.

4. Conclusion

4.1. Incidence patterns

Incidence varied widely, from single sporadic cases to outbreaks involving more than 15-30 animals, particularly in lamb populations. Large outbreaks reported from Israel (2013) and Greece (2013) underscore the potential for flock-level morbidity and mortality when



environmental contamination with infective eggs is substantial. The clustering of cases within specific farms or regions supports the role of definitive host density, poor biosecurity and carcass disposal practices and finally the environmental persistence of *Taenia* eggs.

4.2. Reporting gaps

Sex and exact age data were reported inconsistently, limiting analysis, especially of any sex predisposition. Lambs and kids under 4–8 months predominate, as larvae migrate post-ingestion rapidly, causing fatal peritonitis before encapsulation, unlike chronic visceral cysts in adults detected at abattoirs. This highlights a systematic reporting gap in earlier and some contemporary studies and emphasises the need for standardised case reporting in future investigations.

Overall, the metadata indicate that acute visceral cysticercosis is an underreported but globally occurring disease condition, with predominant involvement of lambs and kids with severe outbreaks of significant mortality and sporadic cases in adult sheep and goats. Gaps include underreporting in tropical and endemic areas and the need to integrate molecular epidemiology to refine control through deworming of definitive hosts. Recent cases in India (2024) suggest emergence amid intensive small ruminant farming. The continued emergence of reports over four decades highlights the importance of integrated parasite control strategies, including canine deworming, controlled access of dogs to carcasses, and heightened diagnostic suspicion in cases of acute hepatitis, pneumonitis, and sudden death in young small ruminants.

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