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STRAY DOGS AS A PUBLIC HEALTH THREAT: A COMPREHENSIVE REVIEW OF HYDATID CYST (CYSTIC ECHINOCOCCOSIS) TRANSMISSION AND CONTROL

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Abstract

Hydatid cyst disease, or cystic echinococcosis, is a significant zoonotic parasitic infection caused by the larval stage of *Echinococcus granulosus*. Dogs act as definitive hosts and play a central role in maintaining the transmission cycle, particularly in areas with large stray dog populations. Stray dogs contribute substantially to environmental contamination through the shedding of parasite eggs, increasing the risk of human infection. Humans become accidental intermediate hosts through ingestion of contaminated food, water, or direct contact with infected dogs. The disease is widely distributed in developing countries and imposes considerable health and economic burdens, especially in regions with poor slaughterhouse hygiene and limited veterinary control. This review summarizes current knowledge on the epidemiology, life cycle, transmission pathways, and risk factors of hydatid cyst infection associated with stray dogs. It also highlights clinical manifestations, diagnostic methods, and prevention strategies. Effective control requires integrated measures, including dog population management, regular deworming, improved veterinary surveillance, and public health education. The implementation of a One Health approach is essential for reducing transmission and minimizing the impact of hydatid disease on public health.

1. Introduction

Hydatid cyst disease, also known as cystic echinococcosis (CE), is a globally distributed zoonotic parasitic infection caused primarily by the larval stage of the tapeworm *Echinococcus granulosus* (Staudacher et al., 2026). The disease remains a significant public health problem in many regions of the world, particularly in developing countries where close interactions between humans, livestock, and dogs are common (Pal et al., 2022). The parasite has a complex life cycle involving carnivores, mainly domestic dogs, as definitive hosts and herbivorous animals such as sheep, goats, and cattle as intermediate host (Pal & Tolawak, 2023).

Dogs become infected by consuming organs of infected livestock that contain hydatid cysts (Getnet et al., 2025). Adult tapeworms then develop in the small intestine of the dog and release eggs that are shed in the feces (Weinstock & Leung, 2022). These eggs can survive for long periods in the environment and contaminate soil, water, vegetables, and other food sources (Barosi & Umhang, 2024). Humans become accidental intermediate hosts when they ingest these eggs through contaminated food, water, or direct contact with infected dogs (Yahia et al., 2023).

Stray dogs play a particularly important role in the epidemiology of hydatid disease (Khan et al., 2025). Unlike owned dogs, stray dog populations often lack veterinary care, including routine deworming, and frequently have access to infected animal carcasses or slaughterhouse waste (Langlois et al., 2025). As a result, they act as reservoirs that maintain the parasite transmission cycle and facilitate environmental contamination (Hopkins et al., 2022).

The burden of cystic echinococcosis is considerable, affecting both human health and livestock production (Yang et al., 2024). The World Health Organization estimates that more than one million people are affected by echinococcosis globally at any given time, with substantial economic losses associated with livestock infection and medical treatment costs (WHO, 2023). Hydatid cysts most commonly develop in the liver and lungs of infected individuals, but they can also occur in other organs such as the brain, spleen, and kidneys, leading to severe complications if left untreated (Bhalla et al., 2023).

Several risk factors contribute to the transmission of hydatid cyst infection in endemic regions (Hassan & ThKadhim, 2024). These include close contact with infected dogs, poor hygiene practices, uncontrolled slaughtering of livestock, feeding raw offal to dogs, and inadequate veterinary control measures. In rural communities where livestock farming is common, the interaction between humans, animals, and contaminated environments increases the risk of parasite transmission (Tian et al., 2024).

Table 1. Major characteristics of hydatid cyst infection (cystic echinococcosis)

Feature	Description
Causative agent	<i>Echinococcus granulosus</i>
Definitive host	Dogs and other canids
Intermediate hosts	Sheep, goats, cattle, camels
Accidental host	Humans
Main transmission route	Ingestion of parasite eggs from contaminated food, water, or contact with dogs
Common affected organs	Liver (70%), lungs (20%), other organs (10%)
Geographic distribution	Worldwide, especially in developing countries

1.1 Epidemiology of Hydatid Disease

Cystic echinococcosis (CE), also known as hydatid disease, is a cross-boundary infection that has a high impact on the population and economy in the whole world (Khan et al., 2020). The disease is widespread in most areas as it mostly occurs in places where livestock farming is closely related to domestic and stray dogs (Gebremicael, 2025). They are the Middle East, North Africa, Central Asia, South America, and some sub-Saharan Africa (WHO, 2023). The true burden of hydatid disease in the world is underestimated because countries with endemic diseases have poor surveillance and underreporting (Nocerino et al., 2024). The World Health Organization reports that an average of over one million individuals are affected by echinococcosis on average with an incidence valuing between 1 and 200 individuals per 100,000 populations per year depending on the region (WHO, 2023). Besides affecting the human health, cystic echinococcosis leads to high economic losses in livestock production through organ condemnation and decreased productivity (Omadang et al., 2025). Environmental, cultural and Socioeconomic factors are very dominant on the epidemiology of the hydatid disease. Close interaction between animals, humans, and dogs contributes to a higher rate of rural population infection (Domatskiy & Sivkova, 2025). Most of the traditional farming methods such as home slaughtering and feeding the dogs on raw offal are major contributors to the life cycle of the parasites (Aftab et al., 2025). Stray dogs are an essential epidemiological issue in the maintenance and propagation of hydatid disease (Kakamad et al., 2024). Compared to household dogs, stray dogs are never given proper veterinary care such as deworming (Nametov et al., 2025). These animals can often have free access to infected carcasses and slaughter waste, and they are reinfected constantly and the *Echinococcus* eggs spread into the environment (Serra et al., 2022). Therefore, regions that have high numbers of stray dogs have higher transmission and a higher chance of being infected by humans (Omadang et al., 2025), see Table 2.

Table 2. Global distribution and epidemiological characteristics of hydatid disease

Region	Endemicity level	Key risk factors	Dog infection role
Middle East	High	Livestock farming, stray dogs	Major reservoir
North Africa	High	Poor sanitation, home slaughter	High transmission
Central Asia	Very high	Nomadic farming	Critical role
South America	Moderate-High	Rural livestock systems	Sustained cycle
Europe	Low-Moderate	Controlled systems	Limited

In the Middle East, including Iraq, hydatid disease remains a persistent public health issue due to the combination of traditional livestock practices, increasing stray dog populations, and insufficient control measures. (Mahjoub, 2025).

1.2 Hydatid Disease in Iraq

Cystic echinococcosis (CE) is a zoonotic disease that is endemic in Iraq and is a cause of major public health and economic challenges especially in rural and livestock keeping settings (Issa et al., 2022). Traditional animal husbandry, a growing stray dog population, and insufficient veterinary control represent the major drivers of epidemiology of the disease (Jasim et al., 2024). Research in the north of Iraq has verified the presence of various types of *Echinococcus granulosus*, specifically the most common G1 genotype, that are highly zoonotic and most commonly cause infection in humans and animals (Al-Shehari et al., 2025). The prevalence of the infection in livestock stays high with the reported prevalence rates of about 5.93% in Duhok, and as much as 8 percent in Sulaimani, which shows the continued transmission between animals and dogs (Rashid & Mohammed, 2025). Human infection is also well reported and liver involvement being the most frequent clinical presentation. In southern Iraq, hydatid disease has been estimated at about 4.5 per 100,000 people per annum (Issa et al., 2022). Farmers and people who are in close contact with livestock and dogs are believed to be the most vulnerable groups and are rural people (Aggar, 2025). The dogs are the key elements in the chain of infection, and the infection rate is more than 20 percent in certain areas, and up to 49.5 percent in northern Iraq, which demonstrates the selection of them as the source of environmental pollution and the infection carrier (Jasim et al., 2024).

Table3 . Epidemiological data of hydatid disease in Iraq

Study area	Host	Prevalence
Duhok	Livestock	5.93%
Sulaimani	Livestock	8%
Basrah	Humans	4.5/100,000
Northern Iraq	Dogs	up to 49.5%

2. Life Cycle of *Echinococcus granulosus*

The life cycle of *Echinococcus granulosus* sensu lato, the causative agent of cystic echinococcosis, involves a two-host system consisting of definitive hosts (primarily dogs and other canids) and intermediate hosts such as sheep, goats, cattle, and occasionally humans (Santa, 2022). Worms become adults 2-7mm long and inhabit the small intestine of the definitive host (Al-Shuraify et al., 2022). Gravid proglottids ovulate and this ovulation is excreted by the feces and is directly infectious on release into the environment (Parija & Pramodhini, 2022). These are very tough eggs that can survive in different conditions of the environment leading to massive pollution. After being ingested by a suitable intermediate host, eggs hatch in the small intestine releasing six-hooked oncospheres (Jeon & Eom, 2024). These enter the intestinal wall and into the bloodstream, and travel mostly to body parts (liver and lungs) (Ohiolei et al., 2022). In such organs the larvae grow up into hydatid cysts, distinguished by a thick laminated wall, and an inner germinal layer (ElShewy, 2024). The cyst slowly continues to grow and generates many protoscolices and daughter cysts inside (Govindasamy et al., 2023). Life cycle cycle is complete when definitive host feeds on infected organs with cysts of Hydatid amoebae with viable cysts (Ahmed et al., 2024). After ingestion, protoscolices evaginate, adhere to the intestinal mucosa, and grow into adult worms in a period of about 4-7 weeks (Pal et al., 2022). Human beings are the accidental intermediate hosts and contract the parasites by ingesting the eggs of the parasites through contaminated food, water or by personal contacts with infected dogs. Like in animal hosts, the oncospheres permeate into the intestinal wall and proceed to internal organs where hydatid cysts grow (Santos et al., 2022). Protoscolices can spread and cause secondary cysts in case of the rupture of cysts, which is called secondary echinococcosis (Yakubu et al., 2022).

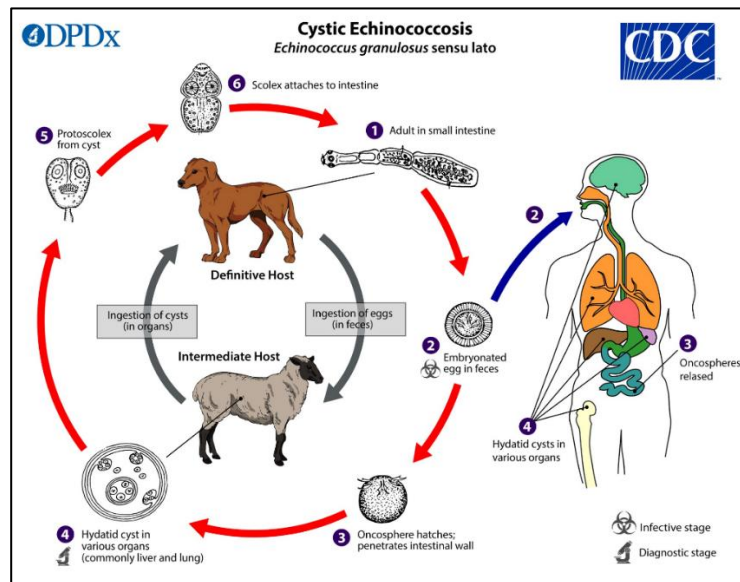


Figure 1. Life cycle of *Echinococcus granulosus* showing dog–livestock–human transmission. (“CDC - DPDx - Echinococcosis,2023).

Table 4. Global prevalence of hydatid cyst infection in humans and dogs WHO, 2023

Region	Human prevalence (%)	Dog infection (%)
Middle East	1–7%	10–35%
North Africa	2–10%	15–40%
Central Asia	5–10%	20–50%
South America	2–8%	10–30%

3. Role of Stray Dogs in Hydatid Transmission

Stray dogs are very important in the transmission and persistence of cystic echinococcosis as they are the most important definitive hosts that help to sustain life cycle of *Echinococcus granulosus* (Gharbi & Giraudoux, 2024). In contrast to owned dogs, the population of stray dogs is usually not controlled and has no access to regular veterinary services, including anthelmintic treatment, which substantially contributes to the rates of their infection and epidemiological role (Tamarozzi et al., 2021). The feeding habit of stray dogs is one of the major factors that cause transmission (Anuk & Çantay, 2022). These animals often eat infected animal feces especially those in poorly regulated slaughterhouses (Mares et al., 2022). This enables the parasite to enter its life cycle since the dogs are infected after ingesting viable protoscolices that exist in hydatid cysts (Mukhopadhyay, 2023). After infection, adult worms grow in the intestine of the dogs and lay out enormous amounts of eggs into the environment as feces (Aziz et al., 2022). They are very resistant eggs that can contaminate soil, water, and vegetation and cause the high risk of infection of livestock and people (WHO, 2023). Epidemiological researches have shown that the rates of infection of stray dogs are high in the endemic areas. Infection rates in stray dogs have been reported to be over 20 in Iraq and other Middle Eastern nations, some studies have shown it to be even higher, making them a significant source of environmental contamination and the main point of infection reservation (Tian et al., 2024). Besides the environmental pollution, there is close contact between people and stray dogs exposing people to even greater risks of contracting the disease. Rural dwellers, especially farmers and children, have higher chances of coming in contact with eggs of parasites or dealing with contaminated foodstuffs (Tamarozzi et al., 2021).

4. Risk Factors of Hydatid Infection

The Hydatid cyst infection is predisposed by an environment, behavioral and socio-economic factors which support the interactions between the definitive and intermediate hosts of the *Echinococcus granulosus* and accidental infection of humans (Baumann et al., 2019). Being in close contact with dogs, especially the stray dogs is rated as one of the greatest risk factors to human infection (Yin et al., 2025). People that come into contact with dogs or live in the high-density areas are at increased risk of getting exposed to the eggs of the parasites due to direct contact or contaminated surfaces (Tamarozzi et al., 2021). Children are particularly sensitive since they have a frequent contact with animals and poor hygiene habits. Transmission is also significantly caused by consumption of contaminated water and food (Rodriguez-Morales et al., 2025). The eggs may also be

infective and contained in vegetables and fruits produced in contaminated soil or irrigated with hazardous water and cause the infection when eaten without the appropriate washing (WHO, 2023). The traditional livestock activities such as home slaughtering and feeding the dogs with raw offal also play a significant role in the perpetuation of the parasite life cycle (Khan et al., 2025). Infected organs in most of the endemic areas are not handled in a proper way, and dogs have easy access to them, leading to reinfection (Mukhopadhyay, 2023). Another factor is occupational exposure. Farmers, shepherds, butchers, and employees at an abattoir are more vulnerable because they constantly have direct contact with livestock and infected materials (Getnet et al., 2025). Poor sanitation, absence of clean water and poor waste management as part of the environmental conditions also contribute to transmission. Areas with a lack of veterinary and public health companies have a higher infection rate in rural areas than in urban areas (Tamarozzi et al., 2021).

Table 5. Major risk factors associated with hydatid cyst infection

Risk factor	Description	Impact on transmission
Contact with dogs	Direct interaction with infected or stray dogs	High
Contaminated food/water	Ingestion of eggs from soil, vegetables, or water	High
Home slaughtering	Uncontrolled slaughter and offal disposal	Very high
Feeding raw offal to dogs	Dogs ingest infected organs	Critical
Occupational exposure	Farmers, butchers, shepherds	High
Poor sanitation	Lack of hygiene and waste management	High
Low awareness	Limited knowledge about disease transmission	Moderate–High

5. Clinical Manifestations of Hydatid Disease

Cystic echinococcosis is a chronic and parasitic condition which is marked by gradual formation of hydatid cysts within the different organs (Badwaik et al., 2024). Clinical manifestations are based primarily on the size of the cysts, their location, and number and the presence of additional complications such as rupture or secondary infection (Tamarozzi et al., 2021). The liver is the most frequently involved organ about of all chronic hepatitis cases, 60 to 70 percent (Bhutani & Kajal, 2018). The hepatic hydatid cysts are usually asymptomatic over a long period but can be followed by the development of right upper quadrant pains, hepatomegaly, jaundice, or biliary obstruction as the cyst grows bigger (WHO, 2023). The second most common site is the lungs; this has a figure of approximately 20-30 percent. Pulmonary cysts can be characterized by cough, chest pain, dyspnea and in certain cases by hemoptysis. Expectoration of cystic fluid and membranes may be caused by rupture of pulmonary cysts (Goussard et al., 2021). Hydatid cysts can also occur in other body organs like the brain, the spleen, kidney, bones, and heart although very rarely (Yesilyurt & Esdur, 2023). Such unusual locations are connected with more severe and even life-threatening complications (Kiliccalan & Cingoz, 2023). To illustrate, brain-based hydatid cysts can lead to convulsions and brain build-up, whereas the presence of bone can create pathological fractures (Mukhopadhyay, 2023). Hydatid disease complications include cyst rupture that could bring anaphylactic events or secondary pathogen dissemination (secondary echinococcosis) (Hanalioglu et al., 2022). The secondary infection of the cyst by bacteria can also occur and lead to the development of abscess (WHO, 2023).

6. Diagnosis of Hydatid Disease

Cystic echinococcosis (CE) diagnosis is based on a complex of clinical examination, radiographic tests, serology, and the epidemiological history (Hogea et al., 2024). The process of diagnostics is often incidental because hydatid cysts grow slowly and have no or minimal symptoms (Meng et al., 2023). Imaging is the key of diagnosis, especially in cases of hepatic and pulmonary involvement (WHO, 2023). The first diagnostic instrument of liver cysts is the ultrasonography (US) because it is accessible, cost-effective, and it allows classifying the cyst stages with the help of the WHO standardized classification system (Aziz et al., 2025). CT and magnetic resonance imaging (MRI) give anatomical details and are particularly effective in identifying cysts in complicated or untypical locations like the brain, the bones, and the lungs (Hajjafari et al., 2024). Serology is a popular auxiliary diagnostic method (Can et al., 2025). The most widely used technique in the determination of antibodies against Echinococcus antigens is enzyme-linked immunosorbent assay (ELISA), Such other methods as Western blot and indirect hemagglutination assay (IHA) can enhance diagnostic specificity (Erganis et al., 2024). Nonetheless, serological tests can show negative outcomes, especially in early infections or dormant cysts (Mukhopadhyay, 2023). The methods of molecular diagnostics, such as polymerase chain reaction (PCR), are becoming more and more

significant over the last several years. The methods that are based on PCR can be used to identify species as well as genotype *Echinococcus granulosus*, which is especially helpful when it comes to epidemiological research and control programs (Kadir et al., 2024).

Table 6. Diagnostic methods for hydatid disease

Diagnostic method	Application	Advantages	Limitations
Ultrasound (US)	Liver cysts	Non-invasive, cost-effective, WHO classification	Operator-dependent
CT scan	Complex/extrahepatic cases	High resolution, detailed imaging	Radiation exposure
MRI	Brain, soft tissues	Excellent soft tissue contrast	Expensive
ELISA	Antibody detection	High sensitivity	False negatives possible
Western blot	Confirmatory test	High specificity	Limited availability
PCR	Molecular identification	High accuracy, genotyping	Costly, requires lab facilities

7. Control and Prevention of Hydatid Disease

The One health approach that involves the combination of control and prevention of cystic echinococcosis (CE) is based on intervention to the life cycle of the parasites, the relationship between dogs, livestock, and humans (Tamarozzi et al., 2021).

The major control and prevention measures are:

- Frequent worming of dogs: The frequency of administration of anthelmintics, including praziquantel, decreases the number of adult *Echinococcus granulosus* in dogs and minimizes the impact of eggs of the parasite on the environment (WHO, 2023).
- Stray dog population control: Humane programs, vaccination, and proper registration of free-roaming dogs will help in controlling the size of the reservoir of infection and transmission (Widdicombe, 2025).
- Better slaughterhouse measures: Introducing correct meat inspection and control of the slaughtering process will keep the dogs out of the infected offal, and the life cycle of the parasite is disrupted (Mukhopadhyay, 2023).
- Formal disposal of infected body parts: Good handling and disposal of infected body parts like burial or incineration should be adopted to ensure dogs are not reinfected or soil contaminated (Lopes et al., 2022).
- Education in the field of public health: spreading awareness of hygiene, such as handwashing, proper washing of vegetables, and contact with stray dogs decreases the risk of human infection, particularly in rural populations (WHO, 2023).
- Vaccination of intermediate hosts: The use of vaccines such as EG95 in livestock, particularly sheep, has shown effectiveness in reducing cyst development and breaking the transmission cycle (Tamarozzi et al., 2021).

8. One Health Approach in Hydatid Disease Control

Management of cystic echinococcosis needs a One Health approach to acknowledge the interrelationship between human, animal, and environmental health (Alho et al., 2023). *Echinococcus granulosus* occurs between dogs, livestock, and humans, so in most cases, isolated control measures alone cannot break the transmission (Tamarozzi et al., 2021). The One Health strategy requires a collaboration among veterinary services, the government through the health sector, environmental agencies and local communities in order to be effectively implemented (Sadr & Borji, 2026). The combination of the use of regular deworming of dogs, livestock vaccination programs, and the enhancement of slaughterhouse control with the help of educating the population and sanitizing environment should be used to achieve a sustainable level of control (WHO, 2023). In this strategy, surveillance systems are important in the observation of the infection rate among human beings, livestock, and dog populations (Christofi, 2022).

9. Conclusion

Cystic echinococcosis is a significant disease of the zoonosis, especially in the developing areas where humans, livestock and dogs are closely in contact with each other, promoting the growth of the disease. Stray dogs are major sources of contamination of the environment and long-term dissemination of diseases because they serve as reservoirs. Controlling measures must be combined, such as deworming of dogs, management of stray dogs, safe disposal of contaminated offals and educating the people about the disease. Reduction of transmission and sustainable disease control can only be done through the adoption of a One Health approach.

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