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Original Article

# Evolving Pattern of Human Cystic Echinococcosis: A Cross-Sectional Study

Ayman M. Mustafa[1], Yousif M. Mahmood[1], Fakher Abdullah[2], Suhaib H. Kakamad[3], Hemn H. Kaka Ali[4], Azad Star Hattam[1], Abdullah K. Ghafour[5], Saywan K. Asaad[6], Deari A. Ismaeil[6], Rawa Bapir[7], Saman S. Fakhralddin[6,7], Bnar Sardar Saida[6,8], Khanda A. Anwar[9,10], Sasan M. Ahmed[1], Berun A. Abdalla[11], Fahmi H. Kakamad[6*]

1. *Scientific Affairs Department, Smart Health Tower, Madam Mitterrand Street, Sulaymaniyah, Iraq*
2. *Kscien Organization for Scientific Research (Europe office), Rotterdam, Netherlands*
3. *Department of Immunology and Hematology, College of Medicine, Kurdistan University of Medical Science, Sanandaj, Iran*
4. *Gastroenterology and Hepatology Teaching Hospital, Sulaymaniyah, Iraq*
5. *Department of Orthopedic, Shahid Peshraw Hospital, Chamchamal, Iraq*
6. *College of Medicine, University of Sulaimani, Madam Mitterrand Street, Sulaymaniyah, Iraq*
7. *Department of Urology, Sulaimani Surgical Teaching Hospital, Sulaymaniyah, Iraq*
8. *Department of Nephrology, Shar Teaching Hospital, Sulaymaniyah, Iraq*
9. *Department of Basic Medical Sciences, College of Medicine, University of Sulaimani, Madam Mitterrand Street, Sulaymaniyah, Iraq*
10. *Anwar Shekha Medical Laboratory, Anwar Sheikha Medical City, Zagros Street, Sulaymaniyah, Iraq*
11. *Department of Biology, College of Education, University of Sulaimani, Madam Mitterrand Street, Sulaymaniyah, Iraq*

* ***Corresponding author***: fahmi.huseein@univsul.edu.iq *(F.H. Kakamad). Doctor City, Building 11, Apartment 50, Zip code: 46001, Sulaymaniyah, Iraq*

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## Abstract

### Introduction

Cystic echinococcosis (CE) poses a considerable public health challenge in many countries. Due to the absence of comprehensive CE surveillance and management guidelines and varying demographic and geographical factors across countries, examining the disease's epidemiology and clinical manifestations within specific regions is essential. The current study aims to investigate CE trends, clinical features, and patient complaints in an endemic area of Iraq.

### Methods

This retrospective cross-sectional study was conducted at Smart Health Tower in Sulaymaniyah, Iraq, from May 2020 to May 2024. It involved patients diagnosed and treated for CE. Data was collected using detailed case forms covering patient demographics, cyst location, presentation, medical and surgical history, and recurrence.

### Results

The study involved 605 CE patients with nearly equal gender distribution and a mean age of 40.1 ± 18.6 years. Most patients, 217(35.9%), were aged 31-50 and lived in urban areas 505(83.5%). The majority, 382(63.1%), were asymptomatic, with liver cysts being the most common 361(59.7%). Single cysts were more prevalent in 513(84.8%) cases, with surgery performed in 222(36.7%) of cases, and recurrence was rare 8(1.3%).

### Conclusion

This study highlights a significant burden of CE in urban areas, where asymptomatic cases often lead to delayed diagnosis. The high prevalence of liver and lung cysts underscores the necessity for targeted public health strategies and enhanced control measures for free-roaming dogs.

## 1. Introduction

Cystic echinococcosis (CE) is a significant parasitic zoonosis caused by the larval stage of the *Echinococcus granulosus* sensu lato complex [1]. This complex includes various species that primarily affect domestic dogs as definitive hosts. At the same time, ungulates such as sheep, cattle, and goats serve as intermediate hosts, where the larval stage develops into fluid-filled cysts within the viscera [2]. As accidental dead-end hosts, humans acquire the infection by ingesting viable parasite eggs present in the environment, often through contaminated food, water, or direct contact with infected dogs. The slow progression of the disease frequently results in asymptomatic cases, with cysts primarily developing in the liver and lungs, although other organs may also be affected [3,4].

The global burden of CE is considerable, with an estimated 2–3 million cases worldwide [5,6]. Historically, CE has been endemic in regions with significant animal husbandry, including North and East Africa, the Middle East, Central and South America, Central Asia, and Australia. Recently, CE has been classified by the World Health Organization (WHO) as one of the 20 neglected tropical diseases of significant public health concern [7,8]. To ensure consistent global disease assessment, the WHO Informal Working Group on Echinococcosis has categorized cysts of cystic echinococcosis (CE) into five distinct types and three main groups. Specifically, CE1 and CE2 are indicative of active infection, CE3 represents an intermediate stage, while CE4 and CE5 denote inactive cysts [8].

In endemic regions, factors such as free-roaming dogs, home slaughtering practices, and inadequate regulation of slaughterhouses contribute to the spread of the disease [9]. Environmental and climatic conditions also play a crucial role, as they affect the survival of parasite eggs and the living conditions of both livestock and stray dogs. For instance, *Echinococcus granulosus* eggs can remain viable in water and damp sand for up to three weeks at 30°C, 4.5 weeks at 10–21°C, and 32 weeks at 6°C. They can persist for several months in green pastures and gardens [10].

Despite its classification by the WHO as a neglected disease, CE remains a significant public health concern due to its status as the second most important foodborne parasitic disease, its zonal endemicity, and its potential for substantial morbidity. The control and prevention of CE are crucial objectives for the WHO, particularly from a Health perspective, as the disease impacts humans, animals, and the food chain. However, many countries' lack of comprehensive CE surveillance, reporting systems, and management guidelines has resulted in relatively scarce recent epidemiological data. Consequently, ongoing research is needed to delineate the specific geographical distribution of CE. To address this gap, the current study aims to investigate the trends, clinical features, and main complaints associated with CE in individuals living in an endemic area in Iraq.

## 2. Methods

### 2.1. Study Design, Setting, and Period

This retrospective cross-sectional study was conducted at Smart Health Tower in Sulaymaniyah, Iraq, from May 2020 to May 2024. Ethical approval for the study was obtained from the Kscien Organization for Ethical Approval (reference number: 24/No. 25). Before initiating data collection, all participants were fully informed about the study's purpose, procedures, and potential risks, and their written informed consent was secured in accordance with international ethical standards

### 2.2. Study Population

The study cohort comprised patients diagnosed and treated for CE during the study period. The population included individuals across various age groups. The most frequently employed surgical techniques included laparotomy, thoracotomy, and craniotomy, tailored to the cysts' anatomical locations and patient-specific factors.

### 2.3. Diagnostic Procedures

The diagnosis of CE was established through a combination of advanced imaging modalities, including ultrasonography, computed tomography, and conventional radiography. These diagnostic tools were crucial in determining hydatid cysts' presence, size, and location. Postoperatively, the excised cysts were subjected to thorough histopathological examination to differentiate between CE and other potential diagnoses, thereby confirming the presence of the disease.

### 2.4. Data Collection

Comprehensive data was collected through detailed case report forms for each CE patient. The information encompassed patient demographics (including age, gender, and place of residence) and clinical data such as the location of the cyst, cyst presentation, family history, medical history, surgical history, recurrence, and the primary presenting complaint. This approach ensured a robust dataset that facilitated in-depth disease pattern analysis.

### 2.5. Statistical Analysis

Descriptive statistical analysis was performed to evaluate the distribution of key variables and identify trends over the study period. Statistical measures were calculated to summarise the data, including mean values, standard deviations, and proportions. The pattern of CE cases was analyzed using linear regression, and all statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) software, version 27.

## 3. Results

During the four-year study period, 605 patients from various provinces were diagnosed and treated for CE (Figure 1). The data showed nearly the same gender distribution, with 307 cases (50.7%) male and 298 cases (49.3%) female. The mean patient age was 40.1 ± 18.6 years. Most patients were aged 31 to 50, with 116 (19.2%) in the 31-40 age group and 101 (16.7%) in the 41-50 age group, followed by 100 patients (16.5%) in the 51-60 age group. The majority, 505 patients (83.5%), resided in urban areas. Notably, 598 patients (98.8%) had no relevant medical history, with only 7 (1.2%) reporting such a history. Similarly, 597 patients (98.7%) had no recorded surgical history, while eight patients (1.3%) had undergone prior surgical interventions for hydatid cysts. A family history of the condition was noted in just one patient (0.2%), with 604 patients (99.8%) reporting no such history.

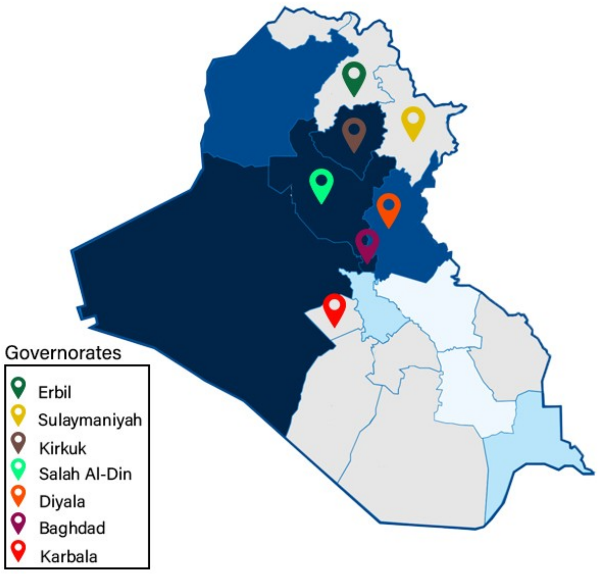


**Figure 1.** Geographical distribution of patients diagnosed with cystic echinococcosis during the study period in Iraq

Clinical presentations varied, with a substantial majority of patients, 382 (63.1%), asymptomatic. Among those with symptoms, abdominal or chest discomfort was the most frequent, reported by 160 patients (26.4%). Most hydatid cysts were located in the liver, affecting 361 patients (59.7%), followed by the lungs in 176 patients (29.1%). A smaller number of patients presented with cysts in both the lung and liver 40(6.6%), while isolated cases were observed in the brain 8(1.3%), spleen 6(1.0%), and kidney 3(0.5%). Regarding cyst presentation, the majority were single 513(84.8%), with multiple cysts reported in 92 patients (15.2%). Management strategies varied, with surgery performed in 222 cases (36.7%) and conservative treatment in 63 cases (10.4%). Recurrence was rare, occurring in only eight patients (1.3%), while 597 patients (98.7%) had no recurrence (Table 1).

In terms of gender distribution, urban areas exhibited an almost equal ratio of males 256(50.7%) to females 249(49.3%), mirroring the pattern seen in rural areas, where 51 males (51.0%) and 49 females (49.0%) were recorded. The age distribution revealed that the 31-40 age group had the highest representation in urban areas, accounting for 107(21.2%) of the urban population. In contrast, rural areas had the largest proportion of patients in the 21-30 age group, representing 36(36.0%) of the rural population (Table 2).

The distribution of cyst locations indicated that liver cysts were more prevalent among females 207(57.3%) and in urban areas

**Table 1.** Demographic and Clinical Characteristics of Study Participants.

| Variables | Frequency / Percentage |
|---|---|
| **Sex** | |
| Male | 307 (50.7%) |
| Female | 298 (49.3%) |
| **Age group** | |
| <10 | 35 (5.8%) |
| 11-20 | 74 (12.2%) |
| 21-30 | 96 (15.9%) |
| 31-40 | 116 (19.2%) |
| 41-50 | 101 (16.7%) |
| 51-60 | 100 (16.5%) |
| >60 | 83 (13.7%) |
| **Residency** | |
| Urban | 505 (83.5%) |
| Rural | 100 (16.5%) |
| **Medical history** | |
| Yes | 7 (1.2%) |
| No | 598 (98.8%) |
| **Surgical history** | |
| Yes | 8 (1.3%) |
| No | 597 (98.7%) |
| **Family history** | |
| Yes | 1 (0.2%) |
| No | 604 (99.8%) |
| **Main chief complains** | |
| Abdominal/chest discomfort | 160 (26.4%) |
| Shortness of breath | 28 (4.6%) |
| Coughing | 19 (3.1%) |
| Nausea/vomiting | 7 (1.2%) |
| Headache | 4 (0.7%) |
| Lump/mass in midsection | 3 (0.5%) |
| Bloody stools | 1 (0.2%) |
| Weight loss | 1 (0.2%) |
| Asymptomatic | 382 (63.1%) |
| **Location of hydatid cyst** | |
| Liver | 361 (59.7%) |
| Lung | 176 (29.1%) |
| Lung and liver | 40 (6.6%) |
| Brain | 8 (1.3%) |
| Spleen | 6 (1.0%) |
| Kidney | 3 (0.5%) |
| Lung and spleen | 2 (0.3%) |
| Liver and spleen | 4 (0.6%) |
| Lung, liver and brain | 1 (0.2%) |
| Lung, liver and kidney | 1 (0.2%) |
| Spine | 1 (0.2%) |
| Intramuscular | 1 (0.2%) |
| Thigh | 1 (0.2%) |
| **Cyst presentation** | |
| Single | 513 (84.8%) |
| Multiple | 92 (15.2%) |
| **Management** | |
| Surgery | 222 (36.7%) |
| Conservative | 63 (10.4%) |
| Follow-up | 190 (31.4%) |
| Not mentioned | 130 (21.5%) |
| **Recurrence** | |
| Yes | 8 (1.3%) |
| No | 597 (98.7%) |

**Table 2.** Distribution of Patients by Gender and Age Group in Urban and Rural Areas.

| Variables | Urban | Rural | Total |
|---|---|---|---|
| **Sex** | | | |
| Male | 256 (50.7%) | 51(51.0%) | 307 (50.7%) |
| Female | 249 (49.3%) | 49 (49.0%) | 298 (49.3%) |
| **Age group** | | | |
| <10 | 28 (5.5%) | 7 (7.0%) | 35 (5.8%) |
| 11-20 | 62 (12.3%) | 12 (12.0%) | 74 (12.2%) |
| 21-30 | 60 (11.9%) | 36 (36.0%) | 96 (15.9%) |
| 31-40 | 107 (21.2%) | 9 (9.0%) | 116 (19.2%) |
| 41-50 | 84 (16.6%) | 17 (17.0%) | 101 (16.7%) |
| 51-60 | 87 (17.2%) | 13 (13.0%) | 100 (16.5%) |
| >60 | 77 (15.2%) | 6 (6.0%) | 83 (13.7%) |

309(85.6%), while lung cysts were more common in males 110(62.5%) and urban residents 143(81.3%). Liver cysts were most frequently observed in the 31-40 age group 74(20.5%) and the 41-50 age group 70(19.4%), whereas lung cysts were predominantly found in the 11-20 age group 32(18.2%) (Table 3).

field studies that employ imaging techniques, such as portable ultrasound [5]. In this study, the diagnosis of CE was confirmed using a combination of advanced imaging techniques, including ultrasonography, computed tomography, and conventional radiography. In a study conducted by Amahmid et al. in Morocco involving 260 patients, the annual mean incidence of CE was recorded at 37.1 cases [14]. In comparison, a study by Viad et al. conducted in Western Romania over seven years reported a higher mean incidence of 64.4 CE cases per year [15]. Furthermore, a study in Uruguay spanning six years documented 318 CE cases, an average of 53 cases annually [16].

Additionally, a nationwide study in Iran, encompassing data from all provinces, revealed mean annual incidence rates of 119 cases in the northwest and 120 cases in the central regions [17]. The current study, which analyzed data over four years, observed an elevated mean incidence of 151.25 CE cases per year, reflecting a higher disease burden than the aforementioned studies. This elevated incidence may be attributed to several factors, including limited access to healthcare facilities, the prevalence of free-roaming dogs, and suboptimal hand hygiene practices among the population [14].

**Table 3.** Distribution of Cyst Locations by Gender, Age Group, and Residency.

| Variables | Cyst location | | | |
|---|---|---|---|---|
| | Liver | Lung | Uncommon | Total |
| **Sex** | | | | |
| Male | 154 (42.7%) | 110 (62.5%) | 43 (63.2%) | 307 (50.7%) |
| Female | 207 (57.3%) | 66 (37.5%) | 25 (36.8%) | 298 (49.3%) |
| **Age group** | | | | |
| <10 | 17 (4.7%) | 10 (5.7%) | 8 (11.8%) | 35 (5.8%) |
| 11-20 | 32 (8.9%) | 32 (18.2%) | 10 (14.7%) | 74 (12.2%) |
| 21-30 | 57 (15.8%) | 25 (14.2%) | 14 (20.6%) | 96 (15.9%) |
| 31-40 | 74 (20.5%) | 27 (15.3%) | 15 (22.1%) | 116 (19.2%) |
| 41-50 | 70 (19.4%) | 21 (11.9%) | 10 (14.7%) | 101 (16.7%) |
| 51-60 | 62 (17.2%) | 31 (17.6%) | 7 (10.3%) | 100 (16.5%) |
| >60 | 49 (13.6%) | 30 (17.0%) | 4 (5.9%) | 83 (13.7%) |
| **Residency** | | | | |
| Urban | 309 (85.6%) | 143 (81.3%) | 53 (77.9%) | 505 (83.5%) |
| Rural | 52 (14.4%) | 33 (18.7%) | 15 (22.1%) | 100 (16.5%) |

## 4. Discussion

Cystic echinococcosis is a zoonotic infection with a broad geographical spread, causing significant economic impacts and posing substantial public health challenges in numerous endemic regions [11]. Despite global initiatives aimed at controlling and managing CE, the disease continues to be endemic and even hyperendemic in various countries worldwide [12]. Given the demographic and geographical variations across countries, it is crucial to investigate the different aspects of cystic echinococcosis within each region, including its epidemiology and clinical manifestations [13].

Various immunodiagnostic assays have been utilized in serological studies to evaluate the prevalence and associated risk factors of CE in human populations globally. However, many of these serological assays have not detected all cases of CE in infected individuals. This limitation is primarily due to the lower sensitivity and specificity of serological methods compared to

A study examining the epidemiology and clinical features of CE in adults from Morocco found that individuals from rural areas were significantly more affected by CE (74.2%) compared to their urban counterparts (25.8%) [14]. Risk factors contributing to this prevalence include lower education levels, poor economic conditions, and inadequate medical services. Previous surveys indicate that approximately 50% of individuals in rural areas are unfamiliar with CE, and 78.7% lack awareness of dogs' role in its transmission. Common practices, such as allowing dogs to roam freely around homes and access kitchens and livestock areas, exacerbate the risk. Limited education and poor understanding of transmission risks lead to risky behaviors, such as improper handling of infected ruminant organs and inadequate hygiene [16,18].

Conversely, a study encompassing data from all provinces of Iran, collected from March 2016 to March 2017, found that most CE patients were from urban areas (59.2%) [17]. Additionally, a study conducted on 38 patients in Serbia reported that 65.8%

of the patients were from urban areas [19]. In the present study, a notable majority of patients, 505(83.5%), were found to reside in urban areas. The higher prevalence of CE in this region can be attributed to patients originating from peri-urban regions or frequently travelling to rural high-risk areas where CE transmission is more likely. Additionally, migration into urban centers often leads to peripheral settlements where rural-like risk factors persist. Free-roaming owned and stray dogs, which can move between peri-urban and urban areas, further exacerbates the risk. These infected dogs may shed *E. granulosus* eggs in urban public spaces, such as gardens and parks, increasing the potential for CE transmission to urban residents [19].

According to the European Centre for Disease Prevention and Control, the incidence of CE shows no significant gender disparity, with a nearly equal male-to-female ratio of 0.98:1 [20]. However, other studies have reported a higher non-significant prevalence of CE among females [14, 17]. In contrast, the present study found a slight predominance of male cases, with 307 (50.7%) compared to 298 female cases (47.2%).

Regarding age as a risk factor, most patients were aged 31 to 50, with 116 (19.2%) in the 31-40 age group and 101 (16.7%) in the 41-50 age group, which is consistent with previous studies, in a survey of 260 patients, it was observed that adults aged 18–43 years were significantly more affected by CE [14]. Additionally, in another study in which 228 patients were involved and the study was conducted in Western Romania, it was observed that a high prevalence of CE was observed in patients aged 50-59 years (21.7%) and 30-39 years (20.7%) [21]. Individuals in these age ranges are typically more engaged in livestock rearing and agricultural activities, heightening their risk of CE exposure. Furthermore, they may be more inclined to seek medical care as symptoms arise [14]. Although a significantly higher number of younger adults under 60 years old sought treatment compared to older age groups, the exact duration of infection and onset of symptoms in symptomatic individuals remains unclear, as CE typically takes years to manifest after the initial infection. The reduced risk of infection in older adults may be attributed to lifestyle changes and decreased activity levels with age. Additionally, the chronic nature of CE explains this pattern, as the infection is often acquired during childhood, progresses very slowly, and remains asymptomatic for years, with symptoms often emerging later in adulthood.

In terms of cyst localization, the majority of hydatid cysts were found in the liver, accounting for 361 cases (59.7%), followed by the lungs with 176 cases (29.1%), resulting in a liver-to-lung ratio of 2.05:1. This finding aligns with a study that reported a liver-to-lung ratio of 2.18:1 [14]. Furthermore, in the current study, the liver-to-lung ratio among children was lower at 1.16:1, compared to 2.32:1 in adults over 20 years old, consistent with a study by Vlad et al., which also observed a lower liver-to-lung ratio in children compared to adults [15].

Among the primary chief complaints in this study, abdominal or chest discomfort was the most common symptom, observed in 26.4% of cases, while a significant majority of patients, 382 (63.1%), were asymptomatic. This aligns with the findings of a study conducted in Serbia, where more than half (50%) of the patients were asymptomatic. Among the symptomatic cases, abdominal pain and nausea were reported in 47.4% of cases [19]. Similarly, a study from Iran identified abdominal pain as the predominant complaint, accounting for approximately 39.0% of cases [17].

Regarding management strategies, it is emphasized that surgical intervention for cysts should be performed for life-threatening cases. A watchful waiting approach is advised in over 60% of CE cases, where immediate treatment is not required [22]. A study involving 533 CE-infected patients reported that surgery was performed in 197 cases (37%) [17]. The current study yielded comparable findings, with surgery being performed in 222 cases (36.7%).

In a retrospective study involving 228 adult patients admitted to six surgical clinics in Timisoara, Romania, multiple cysts were reported in 53 patients (23.2%) [21]. A similar finding was noted in Serbia, where Calovski et al. identified multiple cysts in 8 cases (21%) [19]. Consistent with these studies, current study reported multiple cysts in 92 patients (15.2%).

## 5. Conclusion

This study highlights the burden of CE in an endemic region of Iraq, with a higher incidence in urban areas. The prevalence of asymptomatic cases often leads to delayed diagnosis and treatment, with cysts predominantly found in the liver and lungs. These findings emphasize the need for targeted public health interventions, especially in urban areas, improved diagnostics and stricter control of free-roaming dogs to reduce CE transmission.

## Declarations

**Conflicts of interest:** The author(s) have no conflicts of interest to disclose.

**Ethical approval:** The study's ethical approval was obtained from the scientific committee of the Kscien Organization for Scientific Research.

**Patient consent (participation and publication):** Written informed consent was obtained from patients for publication.

**Source of Funding:** Smart Health Tower.

**Role of Funder:** The funder remained independent, refraining from involvement in data collection, analysis, or result formulation, ensuring unbiased research free from external influence.

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**Authors' contributions:** FHK and BAA were significant contributors to the conception of the study and the literature search for related studies. YMM, FA, SHK and HHKA were involved in the literature review, the study's design, and the critical revision of the manuscript, and they participated in data collection. AMM, RB, and SKA were involved in the literature review, study design, and manuscript writing. ASH, AKG, DAI, SSF, BSS and KAA Literature review, final approval of the manuscript, and processing of the tables. FHK and AMM confirm the authenticity of all the raw data. All authors approved the final version of the manuscript.

**Use of AI:** AI was not used in the drafting of the manuscript, the production of graphical elements, or the collection and analysis of data.

**Data availability statement:** Not applicable.

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