Mashhad University of Medical Sciences (MUMS)

Reviews in Clinical Medicine

Clinical Research Development Center Ghaem Hospital

Human Cystic Echinococcosis in Mashhad, Northeast Iran: A 24-Year Population Study on 2000 Patients

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ARTICLE INFO

Article type
Original article

Article history
Received: 05 March 2025
Accepted: 16 Nov 2025

Keywords
Cystic echinococcosis
Hydatidosis
Hospital record
Epidemiology

ABSTRACT

Introduction: Hydatidosis is a parasitic disease that remains a significant public health concern worldwide. Iran is considered an endemic area for this infection. The present study aimed to analyze the demographic and epidemiological characteristics of confirmed cases over 24 years in Mashhad, Northeastern Iran.

Methods: Pathology reports and hospital records of all patients diagnosed with hydatid cysts between 2000 and 2024 were reviewed. Demographic and clinical data, including age, sex, place of residence, cyst location and number, as well as relapse status, were extracted and analyzed using SPSS software (version 29.0).

Results: The results revealed that 51.2% of the patients were female and 48.79% were male. The frequency of hydatid cysts was nearly equal between rural (50.1%) and urban (49.9%) areas. Approximately 31.95% of the patients were housewives. Lung involvement was the most common localization, observed in 52.6% of cases, followed by the liver (40.33%). The highest incidence occurred in the 21–40-year age group. Most patients (92.8%) had involvement of a single organ, while 6.25% showed concurrent infection in two organs, primarily involving the hepatopulmonary system. In addition, 80% of patients had only one cyst, and relapse was reported in 4.5% of cases.

Conclusion: Given the substantial costs associated with the diagnosis and treatment of hydatidosis, it is crucial to collect comprehensive data on disease prevalence, transmission patterns, and high-risk populations to inform effective control and prevention efforts.

Please cite this paper as:
Amoueian S, Mohammadian Roshan N, Akbari Z, Toghtamesh M , Hassanzadeh Y. Human Cystic Echinococcosis in Mashhad, Northeast Iran: A 24-Year Population Study on 2000 Patients. *Reviews in Clinical Medicine*. 2025;12(4): 136-144.

Introduction

Hydatidosis is a well-known parasitic disease with a global distribution. The causative agent is *Echinococcus*, a small tapeworm belonging to the family *Taeniidae* (1). Several species of *Echinococcus* have been identified, of which *Echinococcus granulosus* (the agent of cystic echinococcosis) and *Echinococcus multilocularis* (the agent of alveolar echinococcosis) are the most clinically significant (2).

In the lifecycle of Echinococcus granulosus, cattle serve as intermediate hosts, whereas dogs act as definitive hosts. Human infection occurs through the ingestion of parasite eggs excreted in dog feces; therefore, humans serve as accidental intermediate hosts (3). Human hydatidosis has a significant impact on public health, leading not

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only to high rates of morbidity and mortality but also to considerable economic losses in endemic countries (4). Cystic echinococcosis (CE) has a global distribution, with endemic regions including Australia, South America, Mediterranean countries, and the Middle East (2). This disease represents a significant public health concern in Iran, which is recognized as an endemic area within the Middle East. CE has been reported in approximately 1% of surgical patients, and it is particularly prevalent in Mashhad, a city in northeastern Iran (5–7). Evidence suggests that CE is spreading rapidly throughout Iran, as reflected by increasing reports of new cases and the growing number of infected children each year (8).

The primary objective of this study is to investigate the epidemiological patterns of hydatidosis. Notably, there has been a lack of large-scale, comprehensive epidemiological studies conducted in this region over the past decade. Such research can provide updated information on hydatid cyst infection, support the development of more effective preventive measures, aid in identifying and controlling risk factors, and ultimately contribute to improving public health.

Method and Materials

The present study was a retrospective descriptive study conducted at three university hospitals affiliated with Mashhad University of Medical Sciences (Emam Reza, Qaem, and Omid hospitals) from 2000 to 2024. Patients were identified by reviewing all pathology reports with a confirmed diagnosis of hydatid cyst. The diagnosis of cystic echinococcosis (CE) was confirmed through microscopic examination of surgical specimens submitted to the pathology department following surgery. The diagnosis was based on the presence of characteristic microscopic features such as the laminated membrane and/or protoscolices. All patients with a confirmed pathological diagnosis of hydatid cyst during the 24-year study period were included. However, cases with missing or incomplete data in their medical records (including key variables such as age, sex, cyst location, and cyst number) were excluded from the final analysis. Data were extracted and categorized into the following three main groups:

1. Demographic characteristics: age, sex, occupation, and place of residence (urban or rural).
2. Clinical features: the anatomic location of the cyst(s), the number of involved organs, and the number of cysts per organ.
3. Outcome data: relapse (which was defined as the histopathological confirmation of a new hydatid cyst at the original or a different site, occurring at least six months after the initial surgical treatment).

We developed a standardized data extraction checklist based on relevant literature to ensure consistent data collection, thereby controlling for variability in data quality and collection procedures that may have occurred during the 24-year study period. This tool was used to systematically extract all necessary variables from medical records. Its use provided uniform criteria for variable definitions and classifications, thereby minimizing interpretation bias. Furthermore, to enhance reliability, data extraction was independently verified by two members of the research team against the source documents, and any discrepancies were resolved by consensus or adjudicated by a senior investigator.

After data preparation, statistical analyses were performed using SPSS software (version 29.0; IBM Corp., Armonk, NY, USA). Descriptive statistics, including means and standard deviations, were calculated, and inferential analyses were conducted using t-tests and chi-square tests where appropriate. Ethical principles were adhered to by coding and storing all data in a manner that did not include any personally identifiable information.

Results

Over the 24-year study period (2000–2024), a total of 2,233 cases of hydatid cyst were identified from pathology reports across three university hospitals affiliated with Mashhad University of Medical Sciences (MUMS). Due to missing or incomplete data, 232 cases were excluded, and the final analysis was conducted on 2,000 patients. The demographic characteristics of the infected patients, including gender, age, place of residence, and occupation, are summarized in Table 1 and discussed below (Table 1).

Table 1. Demographic features of patients with hydatid cyst by sex in 2000-2024.

Variable	Male (N=976, 48.8%)	Female (N= 1024, 51.2%)	*p*-value
Location			
Urban	494 (50.61%)	504 (49.22%)	0.53
Rural	482 (49.39%)	520 (50.78%)	
Age			
0-20	85 (8.71%)	78 (7.62%)	
21-40	472 (48.36%)	415 (40.53%)	
41-60	276 (28.28%)	355 (34.67%)	0.001
> 61	143 (14.65%)	176 (17.19%)	
Mean	41.1±17.1	43.5±16.8	
Job			
Employed	58 (5.94%)	31 (3.03%)	
Student	68 (6.97%)	44 (4.30%)	
Housekeeper	N/A	639 (62.40%)	
Farmer	116 (11.89%)	10 (0.98%)	≈ 0
Rancher	24 (2.46%)	6 (0.59%)	
Self employed	369 (37.81%)	19 (1.86%)	
Non-specified	341 (34.94%)	275 (26.86%)	

As shown in Table 1, among the 2,000 patients, 1,024 (51.2%) were female and 976 (48.8%) were male, resulting in a male-to-female ratio of 0.96. The mean age of women was higher than that of men (43.5 ± 16.8 vs. 41.1 ± 17.1 years). The majority of patients (n= 887, 44%) were in the 21–40-year age group, showing a significant age-related variation (p< 0.001). The oldest patient was a 95-year-old woman, while the youngest were two 5-year-old children (one boy and one girl). A total of 998 (49.9%) patients resided in urban areas and 1,002 (50.1%) in rural areas, with no statistically significant difference between the two groups (p= 0.53). Regarding occupation, 639 (31.95%) were housewives and 388 (19.4%) were self-employed, showing a statistically significant difference (p< 0.001).

Of the 2,000 patients, 1,857 (92.8%) had involvement of a single organ. In total, 34 different organs were affected. These cases were categorized into ten groups based on the organ system involved. Details of organ system involvement are described below, and the distribution of each group is presented in (Table2).

Table 2. Location of Hydatid cyst with single organ involvement by sex, age, and place of residence

Systems	S.1	S.2	S.3	S.4	S.5	S.6	S.7	S.8	S.9	S.10	p-value
Sex											**≈0**
Male (n=914)	564 (57.1%)	298 (39.7%)	11 (35.4%)	9 (40.9%)	11 (52.3%)	7 (41.1%)	8 (57.1%)	4 (50%)	2 (28.5%)	0 (0%)	
Female (n=943)	423 (42.8%)	451 (60.2%)	20 (64.5%)	13 (59%)	10 (47.6%)	10 (58.8%)	6 (42.8%)	4 (50%)	5 (71.4%)	1 (100%)	
Location											0.12
Urban (n=936)	505 (51.1%)	358 (47.7%)	20 (64.5%)	13 (59%)	9 (42.8%)	13 (76.4%)	8 (57.1%)	6 (75%)	4 (57.1%)	0 (0%)	

Systems	S.1	S.2	S.3	S.4	S.5	S.6	S.7	S.8	S.9	S.10	p-value
Rural (n=921)	482 (48.8%)	391 (52.2%)	11 (35.4%)	9 (40.9%)	12 (57.1%)	4 (23.5%)	6 (42.8%)	2 (25%)	3 (42.8%)	1 (100%)	
Age											≈0
0-20 (n=155)	89 (9%)	53 (7%)	7 (22.5%)	1 (4.5%)	0 (0%)	0 (0%)	1 (7.1%)	3 (37.5%)	0 (0%)	100 (100%)	
21-40 (n=825)	479 (48.5%)	309 (41.2%)	5 (16.1%)	7 (31.8%)	13 (61.9%)	6 (32.2%)	2 (14.2%)	2 (25%)	2 (28.5%)	0 (0%)	
41-60 (n=585)	295 (29.8%)	248 (33.1%)	11 (35.4%)	10 (45.4%)	7 (33.3%)	3 (17.6%)	4 (28.5%)	2 (25%)	5 (71.4%)	0 (0%)	
>=61 (n=292)	124 (12.5%)	248 (33.1%)	11 (35.4%)	10 (45.4%)	7 (33.3%)	3 (17.6%)	4 (28.5%)	2 (25%)	5 (71.4%)	0 (0%)	

S.1: Respiratory, S.2: Gastrointestinal, S.3: Nervous, S.4: Genitourinary, S.5: Lymphatic, S.6: Pertoneum, S.7: Musculoskeletal, S.8: Cardiovascular, S.9: Endocrine, S.10: Eye

1. Respiratory system: lung (n: 978), chest wall (n: 6), maxillary sinus (n: 1), true vocal cord (n: 1), supranasal (n: 1)
2. Gastro-intestinal system: Liver (n: 749)
3. Central and Peripheral Nervous System: Brain (n: 18), Para-spinal (n: 5), Extra-Dural (n: 3), Epidural (n: 3), Spine (n: 1)
4. Genitourinary system: kidney (n: 19), Bladder (n: 1), uterus (n: 1), Fallopian tube (n: 1)
5. Lymphatic system: Spleen (n: 21)
6. Peritoneum and Retro-peritoneum: Pelvis (n: 9), Abdominal wall (n: 4), Abdomen (n: 3), Retroperitoneum (n: 1)
7. Musculoskeletal system: Iliac bone (n: 2), Femur bone (n: 1), Rectus muscle (n: 1), Lumbosacral (n: 3), Inguinal canal (n: 2), Scapula bone (n: 1), Thigh soft tissue (n: 1), Neck (n: 1), Shoulder (n: 1), Axillary space (n: 1)
8. Cardiovascular system: Heart (n: 6), Pericardium (n: 2)
9. Endocrine system: Adrenal (n: 2), Pancreas (n: 5)
10. Eye: Upper eyelid (n: 1)

The most commonly involved organs were the lung (978 cases, 52.7%) and the liver (749 cases, 40.0%). Lung involvement was more frequent in males (558 males vs. 420 females) and was slightly more common among urban residents (n= 505, 51.1%). In contrast, liver involvement occurred more often in females (451 females vs. 298 males) and was more prevalent in rural areas (52.2%). A statistically significant association was found between gender and the affected organ (p< 0.001), whereas no significant association was observed between place of residence and the involved organ (p= 0.12). The highest rates of lung and liver hydatid infection were observed in the 21–40-year age group, showing a significant age-related difference (p< 0.001).

As shown in Table 2, involvement of organs other than the liver and lung was more prevalent among females, except in the musculoskeletal and lymphatic systems. It was also more common among urban residents, except for ocular and lymphatic involvement. The highest rates of infection in other organs were observed in the 21–40-year age group, except for the musculoskeletal, nervous, and peritoneal systems, which were most frequently affected in patients over 60 years of age—a total of 1,856 (92.85%) cases involved only a single organ.

According to Table 3, 125 (6.25%) patients had simultaneous involvement of two organs, with 76 of them showing co-infection of the lung and liver. This condition was more prevalent in females (n= 48, 63.15%). Additionally, 37 patients had simultaneous infection of the liver and other organs,[1] while six people presented with co-infection of the lung and other organs.[2] Six patients had simultaneous involvement of two organs, including the pancreas and spleen, the lumbosacral region and retroperitoneum, the pelvis and abdominal wall, the diaphragm and inferior vena cava, and the pelvis and abdomen. Twelve patients presented with concurrent involvement of three organs, such as the pelvis–kidney–omentum, pelvis–kidney–liver, pelvis–liver–omentum, lung–liver–spleen, liver–kidney–omentum, pelvis–ovary–liver, lung–liver–diaphragm, sacrum–pelvis–paravertebral muscle, and pelvis–spleen–liver. In addition, twelve patients showed simultaneous involvement of four organs, including the pelvis–omentum–spleen–mesentery, pelvis–omentum–liver–peritoneum, pelvis–omentum–liver–

[1] Spleen, pelvis, omentum, diaphragm muscle, abdomen, kidney, ovary, retroperitoneum, bladder, pancreas and abdominal wall

[2] Spleen, kidney, heart, and the posterior wall of the stomach.

spleen, liver–omentum–colon–duodenum, omentum–bladder–peritoneum–presacral space, and spleen–pancreas–omentum–liver. Multi-organ involvement was more common among females and rural residents, except for cases involving four organs, which were slightly more common among males. Unlike other groups, where the highest frequency was observed in the 21–40-year age group, patients with three-organ involvement were more prevalent among those over 60 years of age. No statistically significant associations were observed between multi-organ involvement and sex, age, or place of residence (p> 0.05).

Table 3. Location of a Hydatid cyst with multi-organ involvement.

	Male (n=62)	Female (n=81)	Total (n=143)
2 Organs	**55**	**70**	**125**
Liver + Lung	28	48	76
Liver+ Pelvis	6	1	7
Liver+Spleen	4	3	7
Liver+Omentum	3	3	6
Others	14	15	29
3 Organs	**3**	**9**	**12**
Liver+ Pelvis+ Omentum	1	3	4
Others	2	6	8
4 Organs	**4**	**2**	**6**

As shown in Table 4, of the 2,000 patients, 1,610 (80.5%) had a single cyst, while 390 (19.5%) had multiple cysts ranging from two to ten. Among these, 374 (18.7%) had two to four cysts, ten patients had five cysts, three had six cysts, two had seven cysts, and one patient had ten cysts. Multi-cystic infection was more prevalent among females, showing a statistically significant difference (p= 0.01). It was also slightly more frequent in rural areas, although the difference was not statistically significant (p= 0.30). The majority of multi-cystic cases occurred in the 21–40-year age group, showing a significant association with age (p= 0.007). Overall, 91 patients (4.5%) experienced disease recurrence. The recurrence rate was slightly higher in females (n= 48, 52.7%) than in males (n= 43, 47.3%), but the difference was not statistically significant (p> 0.76). The rates were also comparable between rural (n= 45, 50.5%) and urban (n= 46, 49.5%) residents, with no significant difference (p> 0.89).

Table 4. Number of cysts.

# of cysts	1 (n=1610)	2-4 (n=374)	>=5 (n=16)	*p*-value
Sex				0.01
Male	811 (50.4%)	160 (42.8%)	5 (31.3%)	
Female	799 (49.6%)	214 (57.2%)	11 (68.7%)	
Location				0.3
Urban	817 (50.7%)	174 (46.5%)	7 (43.8%)	
Rural	793 (49.3%)	200 (53.5%)	9 (56.2%)	
Age				0.007
0-20	145 (9%)	15 (4%)	3 (18.8%)	
21-40	718 (44.6%)	161 (43%)	8 (50%)	
41-60	488 (30.3%)	139 (37.2%)	4 (25%)	
>=61	259 (16.1%)	59 (15.8%)	1 (6.2%)	

Discussion

Hydatid disease (HD) is a prevalent parasitic infection that has shown a resurgence in several regions, indicating its expanding geographical distribution (2). HD is associated with considerable morbidity, mortality, and substantial economic burden on both patients and the healthcare system. The cost of diagnostic procedures such as imaging, laboratory tests, surgery, medications, and hospital accommodation is considered a direct expense. In contrast, indirect costs include productivity loss due to absence from work (9). Currently, the annual economic burden of hydatidosis is estimated at approximately $200 million in Spain (10), $89 million in Turkey (11), $14.7 million in Tunisia (12), $9 million in Uruguay (13), $6.3 million in Peru (14), and $232.5 million in Iran (9). The average duration of hospital stay ranges from 7.5 to 11.4 days across different studies (7–9). Middle Eastern countries are recognized as endemic regions for this infection (7), and previous studies have indicated that Iran is hyperendemic for cystic echinococcosis, with a high prevalence reported in nearly all provinces (15,16).

Northeastern Iran is an endemic region for hydatidosis, with a particularly high prevalence reported in the city of Mashhad (5). In the present study, we evaluated 2,000 patients with cystic echinococcosis (CE) who underwent surgery over 24 years, and all diagnoses were confirmed through microscopic examination. The actual number of infected individuals may be higher than reported, as alternative treatments, such as systemic chemotherapy and percutaneous drainage, can reduce the need for surgical intervention (7). In our study, CE was more prevalent among females (51.2%), consistent with findings from previous studies reporting rates of 53% in Mazandaran (17), 53.2% in Qom (18), 56% in Tehran (19), and 53.3% in West Azerbaijan (8). Housewives had the highest rate of infection, which is in agreement with the reports by Aliabadi et al (5), Fallah et al (20), and Farazi et al (21). The higher infection rate in females may be attributed to routine domestic activities such as cooking, washing vegetables and fruits, and cleaning, which may increase exposure to contaminated materials. Additionally, some women may experience geophagia (eating clay) during pregnancy, which could further elevate the risk of infection. The age of patients in our study ranged from 5 to 95 years, with the highest prevalence observed in the 21–40-year age group. This pattern aligns with the observations of Moradi et al (22), Kohansal et al (23), and Khazaei et al (24).

However, other studies have reported peak incidences in different age ranges, including 20–30 years (5), 20–50 years (20), over 50 years (7), and 40–60 years (25). The mean age of female patients was 43.5 ± 16.8 years, while that of males was 41.1 ± 17.1 years. This finding is consistent with those reported by Fallah et al (20) and Pakroohi et al (17). The 20–40-year age group represents the most active segment of the population and may be more exposed to hydatid disease risk factors due to increased outdoor and occupational activities. It is worth noting that cystic echinococcosis (CE) typically grows slowly, increasing in size by approximately 1–5 cm per year. However, in some cases, cyst growth remains static for extended periods, meaning the infection may be acquired in childhood but remain asymptomatic until adulthood. Host immune response and the histological characteristics of the affected tissue can also influence the timing of symptom manifestation (26–28). In our study, the number of rural patients was only slightly higher than that of urban patients. Similar findings were reported in other studies (8, 21, 23, 25), although some investigations have yielded contrasting results (5, 9, 17, 24). Hydatid disease may no longer be confined to rural areas, as unhealthy lifestyle practices and environmental factors could contribute to the high frequency of HD in both rural and urban populations. This infection can affect almost all organs of the human body, except the skin, hair, and nails (29).

Infections were detected in various body organs, with the lungs being the most frequently affected, followed by the liver. Other organs were involved in approximately 10% of cases, including the brain, spleen, and kidneys. This finding is consistent with our previous study (6) and with reports by Ould Ahmed Salem et al (30) and Farazi et al (21). Studies conducted among children have similarly shown that the lungs are the most commonly affected organ (31–33). In contrast, several investigations have identified the liver as the primary site of infection (9, 17, 18, 28, 34,). The predominance of hepatic and pulmonary involvement can be explained by the role of these organs as physiological filters, where most parasite larvae are trapped, with only a small proportion reaching other tissues. Because these organs possess a dense capillary network, the likelihood of infection is higher (35, 36). Furthermore, since the city of Mashhad serves as the primary referral center for thoracic surgery in northeastern Iran, the higher prevalence of pulmonary hydatid cysts observed in the present

study is not unexpected (6). Most patients had cysts confined to a single organ, while 7.15% showed multi-organ involvement in various combinations, with hepatopulmonary infection being the most common (3.8%). The majority of these patients were rural females aged 20–40 years. Previous studies have reported that the rate of concurrent organ involvement ranges from 1.1% to 34% (8, 9, 17, 18, 31, 37).

Clinicians should carefully evaluate patients for concurrent hydatid infections, as the frequency of such cases has reportedly increased in recent years (38). Surgical management of these cases often requires a different approach to save time and costs, as well as to minimize postoperative complications (37). In the present study, the number of cysts per patient ranged from one to ten. Most individuals (80.5%) had a single cyst, consistent with previously published reports (38–42). Approximately 14% of patients had two cysts, in agreement with the findings of Hajipirloo et al (8), while about 5% had more than two cysts. Multi-cystic disease was more prevalent in the liver, particularly among rural females aged 20–40 years (28). also reported that the majority of multi-cystic infections occur in patients under 50 years of age. Multi-cystic involvement is often associated with earlier symptom onset and an increased risk of relapse (43). Such cases can be managed with a combination therapy of albendazole and praziquantel, which may reduce the need for surgical intervention (44). In the present study, 4.55% of patients experienced disease recurrence. Reported recurrence rates vary widely across studies, ranging from 23.8% (Cappello et al., 29) to 13% (7), 9.2% (45), and 12% (46). Hydatid disease may recur within 3 months to 20 years after initial treatment; therefore, long-term follow-up of at least three years is recommended (47). Although recurrence can occur following any treatment modality, several studies have suggested that perioperative therapy with anthelmintic agents (albendazole or mebendazole) before and after surgery can significantly reduce the risk of relapse (28, 44).

Although hospital records represent valuable sources of information on hydatid disease, advances in healthcare services and medical facilities across Iran have resulted in many surgeries being performed in local medical centers. As a result, patient referrals to university hospitals have decreased, and not all patients undergo surgical intervention. Consequently, data collection limited to a few hospitals and archived medical records may underestimate the true prevalence of the disease, even in large tertiary or referral centers. Furthermore, comprehensive analyses may be challenging due to the potential for incomplete or inaccurate hospital documentation.

Conclusion

Hydatid disease remains a prevalent and significant public health concern. To reduce the diagnostic and treatment burden on the healthcare system and to address disease recurrence, effective prevention and regular follow-up are essential. Establishing an integrated national registry system for recording patient information could provide a reliable and comprehensive database for identifying risk factors, tracking disease progression and incidence, and informing prevention, control, and eradication strategies nationwide.

Ethics approval and consent to participate

This study was approved by the Ethical Committee of Mashhad University of Medical Sciences, Mashhad, Iran (IR.MUMS.MEDICAL.REC.1403.113).

The committee waived the requirement for informed consent due to the retrospective nature of the study, which involved only the analysis of existing hospital records without any direct patient contact

Consent for publication

The article is a Descriptive cross sectional.

Availability of data and materials

All data and materials are available in the article.

Competing interests

The author(s) declare that they have no competing interests.

Funding

The Mashhad University of Medical Sciences funded this project.

Authors' contributions

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Acknowledgements

We would like to express our sincere gratitude to all hospital staff who assisted us in conducting this study. We also wish to extend our gratitude to Dr. Mahdi Ahmadi for his insightful guidance throughout the data analysis process, which significantly enriched the quality of our findings.

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