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Epidemiological characteristics of human cystic echinococcosis in Khuzestan province (Iran), 2011–2021: a retrospective analytical study

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Abstract

Hydatid cyst (HC) disease is endemic in many Mediterranean countries. The most polluted areas of Iran include the Alborz and Zagros Mountain ranges, where animal husbandry is common. This study investigated the epidemiological dimensions of HC in patients admitted to hospitals in Khuzestan province from 2011 to 2021. Of all 183 patients identified, 113 (61.7%) were female with the mean age of 37.7 ± 17, men with the mean age of 36.7 ± 19. Also, we found that housewives made up 49.2% of our HC patients. 65% of the patients in this study lived in urban areas, and 42% had a history of contact with dogs. The liver was reported to be the most HC-affected organ. The most clinical symptoms were abdominal pain and hepatomegaly. 59% of the patients had only one cyst. This study found that surgery and radiology were the most common treatment and diagnostic methods. There were significant relationships between: gender and occupation ($p < 0.001$); location with dog contact, duration of dog contact ($p < 0.001$); ways of washing raw vegetables ($p < 0.01$), and type of treatment ($p < 0.05$); occupation and dog contact ($p < 0.001$); with the involvement of the liver being greater in patients who used only water to wash vegetables ($p < 0.01$). The key to successful disease management is early diagnosis. How to intervene and treat HC necessitates the identification of the stages of the cyst, which is dependent on imaging techniques. The prevalence of human hydatidosis has been overlooked as the most important disease that health policymakers should consider. Furthermore, training programs are required to better understand the disease's symptoms and identify sources of infection.

Keywords Echinococcosis · Hydatidosis · Hydatid cyst surgery · Epidemiology

Introduction

In hyperendemic regions like Iran, hydatid cyst (HC) illness, also known as hydatidosis, is still a major issue on a global scale (Fahimzad et al. 2015). A common parasitic disease in humans and animals, HC occurs by infection with the larval stage of Echinococcus granulosus cestodes (Tamarozzi et al.

2021). A cyclophyllid cestode with a length of 3–7 mm, Echinococcus granulosus, often known as the dog tapeworm or hydatid worm, lives in the small intestine of canids. Its eggs are dispersed in the environment by dog feces. Dogs serve as the primary host in the parasite's evolutionary cycle, followed by vegetarians and then occasionally humans (Vaisi-Raygani et al. 2021). Human infection is most commonly attributed to the consumption of infected food and drink, as well as direct contact with dogs (Gong et al. 2021). Hydatidosis mainly affects the liver (60 to 70%) and lungs (20%), but other sites such as the heart, brain, muscles, peritoneal cavity, salivary glands, spleen, pancreas, bone, adrenal, ovary, and kidney have been also reportedly affected (Latatu-Córdoba et al. 2019; Thapa et al. 2018). The majorities of patients have no symptoms; mainly diagnosed by ultrasound (US), radiography, computed tomography (CT), magnetic resonance imaging (MRI), and confirmation of serum-specific antibodies. However, only a few patients may develop symptoms after complications such as secondary infections, anaphylaxis, compression of adjacent

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organs, and rupture (Akbulut 2018; Eckert and Deplazes 2004). Cystic echinococcosis (CE) includes five stages (CE1-CE5), where CE1 and CE2 stages are considered active stages of the disease. At CE3 stage, called the transition stage, the laminate membrane on the inner surface of the cyst degenerates and takes the shape of a "lotus" mark (CE3a), or girl vesicles are visible on hypo/hyper echogenic images (CE3b). In stage CE4, the cyst appears as a "wool bullet," with heterogeneous internal structures and no girl vesicle, and in stage CE5, partial or complete cyst wall calcification forms a conical ultrasonic shadow. Stages CE4 and CE5 are referred to as inactive phases (Botezatu et al. 2018; Güreser et al. 2019). Radiography is often employed as a CE screening tool, through which calcification is shown in 20 to 30% of HC, usually emerging as a curve or ring. Dense calcification of all cyst components occurs during the natural healing process, though it does not always confirm parasite death (Pedrosa et al. 2000). Therefore, the use of imaging is particularly essential for assessing the anatomy and condition of HC as well as deciding the best course of action. Although surgery and cyst excision are the best treatments, recurrence is frequently seen. Moreover, mebendazole, albendazole, and praziquantel have also been reported to be effective (Gessese 2020; Kjossev and Losanoff 2005).

Hydatidosis is found on sheep and livestock farms all over the world (Gholami et al. 2018). The World Health Organization (WHO) has identified Echinococcus as one of the 20 most neglected tropical diseases (Gong et al. 2021). This illness poses severe health, social, and economic challenges to communities since it destroys animals and causes complications and mortality in humans (Vaisi-Raygani et al. 2021). In Iran, there are 1–2 hydatidosis surgeries performed annually per 100,000 people, with regional variations in the serum frequency from 3 to 19 percent. Unfortunately, a significant percentage of surgeries nationwide still involve HC (Eftekhari 2005; Sarkari et al. 2010; Shoaee et al. 2016). According to studies, most of HC cases in Iran are reported in Khuzestan province due to its low level of public health, making it the center for the outbreak of this disease (Kamali et al. 2018). Given the high cost of hydatidosis diagnosis and treatment, data collection on the degree of the prevalence and transmission of this disease is vital to control and prevent its outbreak in vulnerable groups. Therefore, we conducted this study to investigate the epidemiological status of HC in patients admitted to hospitals in Khuzestan province from 2011 to 2021.

Method

The present study is a retrospective descriptive-analytical study conducted in Khuzestan province in the southwest of Iran. We examined the data on HC patients hospitalized in Khuzestan Province hospitals from 2011 to 2022. The data includes demographic information (age, sex, location and occupation), records of any contact with dogs, raw vegetable consumption, types of organs involved, number and location of cysts, treatment method, level of recovery, diagnosis method, and clinical symptoms. The prevalence of the disease is based on the division of the cities in Khuzestan province.

Statistical analysis

The obtained data was analyzed using SPSS software version 24. The descriptive statistics method was also used to prepare the required graphs. The significance level was considered $p < 0.05$ and the Chi-Square test was used to compare the ratios.

Results

Demographic characteristics of patients with HC

The analysis of the reports for the patients hospitalized in Khuzestan province revealed there were 183 HC patients in these centers between 2011 and 2021. As Table 1 shows, of all 183 patients studied, 113 (61.7%) and 70 (38.3%), were female and male, respectively. The mean age of female and male HC patients were 37.7 ± 17 and 36.7 ± 19, respectively. Also, we examined the frequency percentages in various age groups (10–50). Most patients, 46 subjects, were over 50 years old (25.1%) whereas 11–20-year age group consisted only 17 people (6.3%). Other age groups ≤ 10, 21–30, 31–40, and 41–50 years old, comprising 19 (10.3%), 29 (15.8%), 36 people (19.6%), and 36 individuals (19.6%), respectively. Regarding occupation, housewives had the highest HC prevalence rate (49.2%), followed by students (12%), herdsman (6.5%), workers (4.9%), farmers (4.4%), children (3.8%), employees (2.2%), and others (16.9%). An investigation of the patients' residence showed urban life (65%), rural (33.9%) and nomadic (1.1%), respectively. Regarding contact with dogs, 77 patients had direct contact (42%). They were at the age groups of 5–10 years (32%), 10–15 (17.9%) years, and 15–20 years (26.9). It should be noted that for 23.1% of cases, the duration of contact with dogs was not mentioned in their file records. As regards the variable raw vegetable consumption, it was found that 55.7%, 30.1%, and 3.8% of patients used only water, detergents, and disinfectants to wash raw vegetables, respectively. Only 10.4% of patients used raw vegetable while considering all three requirements. Statistical analysis revealed no significant relationship between patient gender and variables such as age, contact with dog, duration of dog contact,

Table 1 Demographic characteristics of patients with HC based on gender, age, occupation, location, contact with dogs and how to consume raw vegetables

Variable	Subgroup	Number (percent)	Males (n = 70)	Females (n = 113)	p value
Age (year)	Up to 10	19(10.3)	9	10	0.485
	11–20	17(9.3)	7	10	
	21–30	29(15.8)	9	20	
	31–40	36(19.6)	18	18	
	41–50	36(19.6)	12	24	
	Over 50	46(25.1)	15	31	
Occupation	Housewife	90(49.2)	0	88	0.000
	Herdsman	12(6.5)	8	4	
	Worker	9(4.9)	9	1	
	Employee	4(2.2)	3	1	
	Farmer	8(4.4)	6	2	
	Other	31(16.9)	31	1	
	student	22(12)	9	13	
	Child	7(3.8)	4	3	
Location	Urban	119(65)	44	75	0.628
	Rural	62(33.9)	26	36	
	Nomadic	2(1.1)	0	2	
Contact with dogs	Yes	77(42.1)	32	45	0.433
	No	106 (57.9)	38	68	
Duration of contact with the dog (year)	5–10	25(32)	8	17	0.326
	10–15	14(17.9)	8	6	
	15–20	21(26.9)	10	11	
	Not mentioned	18(23.1)	6	12	
How to wash vegetables	Water	102(55.7)	43	59	0.317
	disinfectants	7(3.8)	2	5	
	detergent	55(30.1)	17	38	
	All three	19(10.4)	8	11	

The statistical relationship between gender and age, occupation, location, contact with dogs, duration of contact with dogs and how to wash vegetables was examined. Statistical analysis was performed using chi-square. Significance level was considered $P < 0.05$. In the study of the relationship between gender and occupation and place of residence, group integration was used to provide test validity

and raw vegetable consumption ($p > 0.05$). However, a significant relationship between was discovered gender and occupation ($p < 0.001$). Housewives were more likely to get HC than those with other occupations. In Cramer's V post-hoc test, the strength of this correlation is equal to 0.818. Gender and location had no statistically significant relationship ($p > 0.05$).

The frequency of organs involved with HC

As shown in Fig. 1, an examination of patients' records revealed that the liver was the most affected organ as reported in 113 cases (61.7%), followed by lungs, abdomen, simultaneous liver-lung involvement, spleen, liver-spleen, liver-kidney, liver-abdomen, liver-brain, kidney, and finally lung-spleen in 23 (12.6%), 16 (8.7%), 15 (8.2%), 3 (1.6%), 3 (1.6%), 3 (1.6%), 2 (1.1%), 2 (1.1%), 2 (1.1%), in only one case (0.5%), respectively.
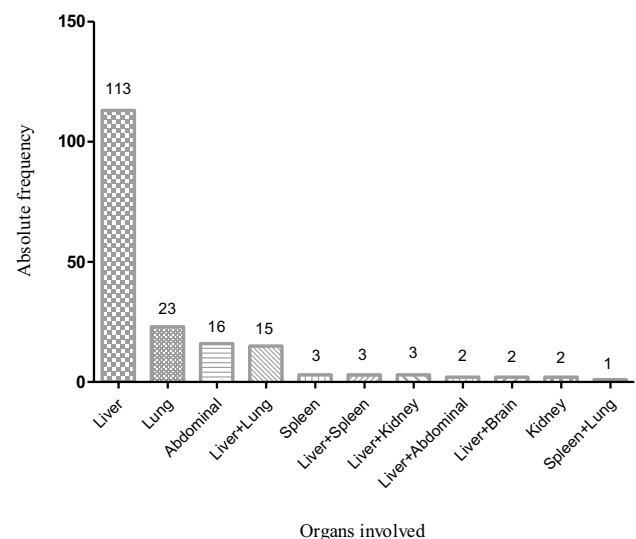

Fig. 1 Type of organ involved in hydatidosis patients admitted to Khuzestan province hospitals between 2011 and 2021

Table 2 The number of cysts, treatment method and the recovery rate in hydatidosis patients

Variable	Subgroup	Number (percent)
Number of cysts	1	108 (59)
	2	37 (20.2)
	3	14 (7.7)
	3 <	14 (7.7)
	Missing	10 (5.5)
Treatment	Surgery	55 (30.1)
	Medicinal	27 (14.8)
	Surgery + medicinal	101 (55.2)
health condition	Recovery	182 (99.5)
	Death	1 (0.5)

The number of cysts, treatment method and the recovery rate in HC patients

Each patient's HC count was calculated, revealing that out of 183 patients, 108 (59%) had only one cyst in the affected organ, 37 (20.2%) had two cysts, and 14 patients had three or more cysts (7.7%). It should be also noted that 10 patients (5.5%) could not be mentioned due to a lack of information in their record files. HC patients were subject to surgical treatment (30.1%), medication (14.8%), and drug treatment (55.2%). The treatment resulted in an improvement in 182 (99.5%) of the cases (Table 2).

Statistical relationship in patients' age, gender, occupation, residence location, contact with dog, duration of contact with dogs, raw vegetable consumption, organs involved, number of cysts, and treatment

In this study, statistical analysis showed that there was no statistically significant relationship between the variables of patients' age, residence location, organ involved, number of cysts, and type of treatment ($p > 0.05$). There was also no significant relationship between patients' gender, residence
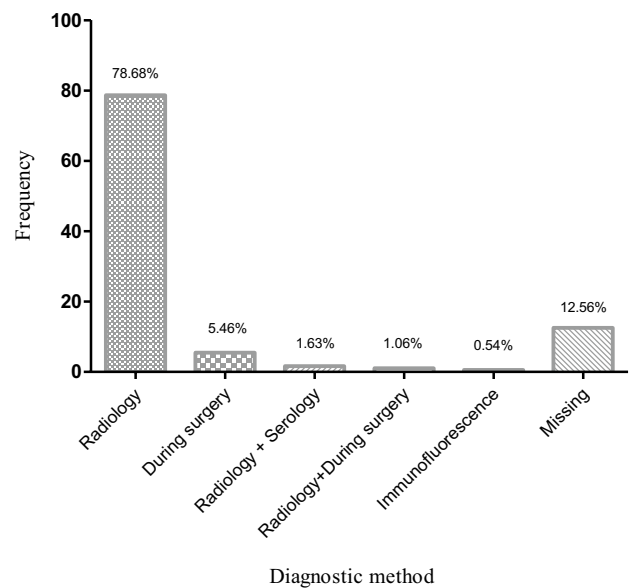

Fig. 2 The frequency of diagnostic methods used in the treatment of HC in patients admitted to Khuzestan province hospitals from 2011 to 2021

location, organ involved, number of cysts, and type of treatment ($p > 0.05$). Herders and farmers were found to be more likely to develop HC in rural areas than in urban areas ($p < 0.001$), but there was no significant relationship between patients' occupation and treatment type ($p > 0.05$). The statistical relationship between residence location, the involved organ, and number of cysts were examined ($p > 0.05$), revealing that patients in urban areas were significantly more likely to be treated with medication and surgery than those in rural areas ($p < 0.05$). Also, Cramer's V post-hoc test indicated that the strength of the correlation between location and type of treatment was 0.193. Moreover, there was a strong relationship between patients' location and dog contact ($p < 0.001$), meaning those residing in rural areas had greater contact

Table 3 Statistical relationship between age, sex, occupation, location, contact and duration of contact with dogs, how to wash vegetables, organs involved, number of cysts, and treatment in hydatidosis patients

	p value			
	Location	Organ involved	Number of cysts	Treatment
Age	0.639	0.437	0.834	0.071
Gender	0.49	0.07	0.8	0.67
Occupation	0.00	–	–	0.334
Location	–	0.837	0.19	0.033
Contact with dogs	0.00	0.131	0.213	0.534
Duration of contact with the dog (year)	0.00	-	–	–
How to wash vegetables	0.003	0.005	0.258	0.204

Statistical analysis was performed using chi-square. The significance level is $p < 0.05$. To examine the relationship between ages, occupation, organs involved and the number of cysts, group integration was used to provide test validity. In some cases, despite the merging of the groups, a dash was used due to the lack of test validity

Table 4 The frequency of different age groups based on the treatment method and organs involved in hydatidosis patients

	Up to 10	11–20	21–30	31–40	41–50	Over 50	*p* value
Treatment							
Surgery	3	6	7	17	11	11	0.071
Medicinal	6	2	2	5	3	9	
Surgery & medicinal	10	9	20	14	22	26	
Organs involved							
Liver	10	9	17	25	23	29	0.437
Lung	4	3	5	5	3	3	
Liver & lung	3	3	2	3	1	3	
Abdominal	1	2	2	3	3	5	
Other organs	1	0	3	0	6	6	

Statistical relationship between age groups with type of treatment and organ involved in hydatid cyst disease were examined. The statistical analysis was performed using chi-square. Significance level was $p < 0.05$. To examine the relationship between age groups and the type of treatment and the affected organ, group integration was used to provide test validity

with dogs. Likewise, the strength of the correlation in the post-hoc coefficient test was 0.303, showing that the duration of contact with dogs in rural areas was significantly longer ($p < 0.001$) than in urban areas. The strength of the correlation was 0.395 as reported by Cramer's V post-hoc test.

Moreover, no significant relationship was found between dog contact and variables such as organ involved, number of cysts, and type of treatment ($p > 0.05$). The use of detergent and disinfectants to wash raw vegetables were greater in urban than in rural areas ($p < 0.01$), with the correlation coefficient between location and how vegetables were washed equaling 0.249 in the Cramer's V post-hoc test. Patients who used only water to wash vegetables were reported to have significantly higher liver involvement than in other organs ($p < 0.01$), with the correlation between the raw vegetable washing and the organ involved in the Cramer's V post-hoc test equaling 0.202. Additionally, there was no statistically significant association between patient's age and their degree of contact with dogs ($p > 0.05$). However, a remarkable relationship was found between people's occupation and contact with dogs ($p < 0.001$). Of all the occupations, farmers and herders were more exposed to dogs than other occupations. The strength of the correlation between patients' occupations and their contact with dogs equaled 0.343 as reported by Cramer's V post-hoc test (Table 3).

The frequency of different age groups based on treatment method and organs involved in hydatidosis patients

Our findings revealed that patients aged 31–40 years received more surgical treatment than other age groups, while patients aged ≥ 50 years received more drug treatment and drug treatment with surgery than other age groups. Likewise, patients aged ≤ 10 years had the lowest rate of surgery.

The liver was also found to be the most involved organ in all age groups (Table 4).

The frequency of diagnostic methods used in HC treatment

As shown in Fig. 2 radiology was 78.68%, during surgery 5.46%, radiology with serology 1.63%, during surgery with radiology 1.06%, and immunofluorescence 0.54% of the diagnostic methods in HC patients. The diagnostic method was not mentioned in the file in 12.56% of the cases.

The frequency of radiology methods used in the diagnosis of HC

The radiology techniques used to diagnose the disease included: radiography, CT, MRI and ultrasound. The results
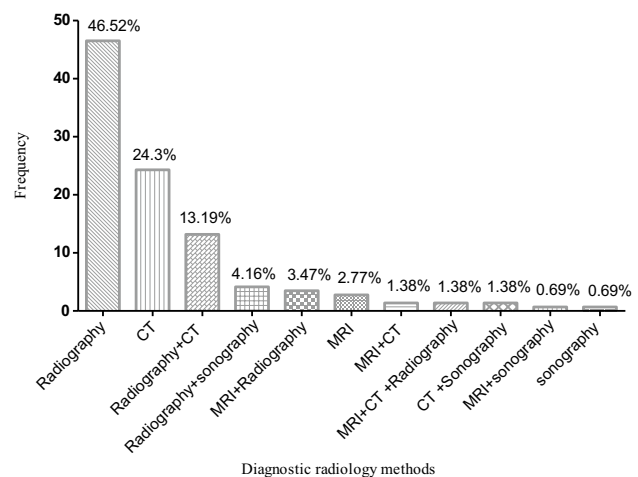
Fig. 3 The frequency of radiology methods used in the diagnosis of HC in patients admitted to hospitals in Khuzestan province, from 2011 to 2021

Table 5 Clinical symptoms of patients with hydatid cyst at the time of referral to medical centers

Percentage of incidence	Clinical symptoms
63.93	Abdominal pain
38.25	Hepatomegaly
27.32	Chest pain
23.49	Cough
7.1	Nausea and vomiting
6.01	Ague
4.91	Dyspnea
3.82	Anorexia and weakness
3.27	General body pain
2.73	Renal Colic
1.63	Back Pain
1.09	stomach ache
1.09	Jaundice
1.09	Edema
0.54	Pelvic Pain
0.54	Headache
0.54	Convulsions

showed how frequently they could diagnose HC as reported here: radiography 46.52%, CT 24.3%, radiography with CT 13.19%, radiography with ultrasound 4.16%, MRI with radiography 3.47%, MRI 2.77%, MRI with CT 1.38%, MRI with CT and radiography 1.38%, CT with ultrasound 1.38%, MRI with ultrasound 0.69% and ultrasound 0.69% (Fig. 3).

The incidence of clinical symptoms in patients with HC

It was found that abdominal pain had the highest incidence at 63.93%, followed by other symptoms including hepatomegaly 38.25%, chest pain 27.32%, cough 23.49%, nausea and vomiting 7.1%, ague 6.01%, dyspnea 4.91%, anorexia and weakness 3.82%, general body pain 3.27%, renal colic 2.73%, back pain 1.63%, stomach ache, jaundice, and edema 1.09%, pelvic pain, headache, and convulsions 0.54% (Table 5).

Discussion

The present study consisted of 183 HC patients hospitalized in Khuzestan province between 2011 and 2021. According to this study, the incidence of HC in women is 1.58 times that of men. Chal Chaleh also stated this ratio in his study as 1.17 (Chalechale et al. 2016). These findings are also consistent with those of previous studies conducted in different provinces of Iran (Aliabadi et al. 2015; Farazi et al. 2019; Ghabouli Mehrabani et al. 2014; Moosazadeh et al.

2017). However, the incidence of HC was higher in men than in women as reported in Gilan and Mazandaran provinces (northern Iran) and in Turkey and Italy. This difference is probably due to their farming occupation and cultural-environmental differences. (Conchedda et al. 2010; Mansour-Ghanaei et al. 2012; Mıman et al. 2010; Ziaei Hezarjaribi et al. 2017). Our results showed a high degree of correlation between HC patients' gender and occupation (0.818). Housewives were more likely to get HC than patients in other other occupations. This finding is consistent with those obtained in other studies in Iran (Aliabadi et al. 2015; Moosazadeh et al. 2017). The main roles of women in food preparation and cooking; contact with domestic animals, animal feeding, cleaning their living space; geophagy in pregnancy; and contamination by parasite eggs through cleaning and eating raw vegetables appear to be the reasons why most of the female patients are exposed to this infection (Ghabouli Mehrabani et al. 2014; Saki et al. 2019). Students had the highest HC incidence after housewives (12%). Teenagers spend much of their time away from home. Contact with contaminated soil and environment in schools and playgrounds may play a role in their infection.

The mean age of patients with HC was 37.7 ± 17 in women and 36.7 ± 19 in men. According to our findings, many patients are ≥ 50 years old. Studies in various communities have also revealed that the prevalence of CE rises with age (Rogan et al. 2006). Hydatidosis is a disease with a long commune period (20–30 years) and a slow growth rate in humans compared to animals. This may explain the disease's high prevalence in older people. The higher prevalence of HC among these age groups may be due to their previous lifestyle factors such as increased contact with livestock on farms, contact with vegetables, and dusty soil (Aliabadi et al. 2015).

Given the parasite's life cycle characteristics, hydatid disease is generally considered a rural one. We found that 65%, 33.9%, and 1.1% of our patients were urban, rural, and nomads, respectively. Regarding the population distribution in Khuzestan province, as the most recent statistics provided by the National Statistics Organization of Iran in 2016, Khuzestan province had a population of 3.554.205 people in urban areas and 1.151.596 people in rural areas (Iran 2021). The disease was found to affect 3.34 and 5.38 people per 100.000 living in urban and rural areas, respectively. This finding is consistent with those of previous studies (Chalechale et al. 2016; Ghabouli Mehrabani et al. 2014; Ziaei Hezarjaribi et al. 2017). Biramvand also stated that the prevalence of HC in Khuzestan province's rural population was 4.9%. (31). However, some studies have found that hydatid disease is increasing in urban areas (Moosazadeh et al. 2017; Saki et al. 2019). as reported by Aliabadi, 71% of the patients also lived in cities and lived a urban life (Aliabadi et al. 2015).

In this survey, 41% of people with HC had contact with dogs, and more than half of them lived in rural areas (52%). Agriculture and animal husbandry are the main occupations of rural residents in Khuzestan province. Their proximity to a dog, jackal, and fox population, as well as the free movement of dogs near nomadic tents and rural houses, justifies their more frequent and longer contact with dogs than those living in urban areas (Rafiei et al. 2007; Ziaei Hezarjaribi et al. 2017). How to wash vegetables is very effective in HC infection such that our results showed 55.7% of patients used only water to wash vegetables. In Farazi's study, the rate of raw vegetable washing with water was 64.4% (Farazi et al. 2019). Our results showed that the use of detergents and disinfectants to wash vegetables was greater among urban patients than in rural patients. So, in urban areas, factors such as lack of health, marginalization, cultural and economic poverty, high population density, presence of stray dogs, not burying or improper disposal of slaughterhouse waste seem to play an important role in their development of HC disease (Ghaffari 1999). Statistical analysis conducted on the method of washing vegetables and the type of organ involved in HC showed that people who used only water to wash vegetables had greater levels of liver involvement than other organs.

Geographical differences may play a role in the distribution of HC in body organs, which is related to some biological factor in the parasite or host. The liver and lungs are the most affected organs by this disease (Mansour-Ghanaei et al. 2012). Consistent with previous studies, our findings showed that the liver is the most common site of hydatid disease (62.3%), followed by the lungs (12.6%), abdomen (8.2%) and other organs (Aliabadi et al. 2015; Chalechale et al. 2016; Ghabouli Mehrabani et al. 2014; Moosazadeh et al. 2017), However, research conducted in northwestern Iran and Bulgaria revealed that the lungs were more severely affected than other parts of body (Aslanabadi et al. 2013; Jordanova et al. 2015).

Nevertheless, the pathophysiology of cyst anatomical diffusion remains unknown. Most liver involvement in these patients is probably the result of entering the gastrointestinal tract as most cysts are trapped by the liver through the portal system. The liver and lungs are the body's most important filters, and they are the first places a migratory parasite will encounter. When migratory echinococcus oncosphere (hexacant embryo) enters the portal vein, it involves the sequential filtration system of the liver and lungs before any other peripheral organ is involved (Chalechale et al. 2016; Mahmoudi et al. 2019; Saki et al. 2019).

In this study, most cases (85.79%) had only single-limb involvement. According to other studies (Chalechale et al. 2016; Ghabouli Mehrabani et al. 2014; Saki et al. 2019; Sarkari et al. 2010), 58% of patients had one cyst, which is consistent with studies performed in Italy, Yemen (Alghoury

et al. 2010), and other cities of Iran, i.e. Tehran, and Azerbaijan (Ahmadi and Badi 2011; Ghabouli Mehrabani et al. 2014; Mansour-Ghanaei et al. 2012). Like previous studies, the most common clinical symptoms were abdominal pain (63.93%), hepatomegaly (38.25%), chest pain (27.32%), and cough (23.49%) (Farazi et al. 2019; Ghabouli Mehrabani et al. 2014; Mansour-Ghanaei et al. 2012). However, Aslanabadi reported that the most common symptoms were chest pain and cough (Aslanabadi et al. 2013). The prevalence of clinical symptoms varies by region and the type of organs involved.

Diagnosis also varies on the basis of endemic area exposure history, laboratory research, radiographic imaging techniques (radiography, US, CT and MRI), and serological tests (specific IgG, complement fixation, indirect fluorescent antibody I) and ELISA (Mansour-Ghanaei et al. 2012). In our study, radiology (78.68%) was the diagnostic method with the highest degree of frequency. Of all these diagnosis techniques, radiography (46.52%) and CT (24.3%) was the most employed cases. Chest radiographs, US, CT, and MRI are all useful ways of detecting hydatid disease transdiaphragmatic migration. Both US and CT are recommended for cyst rupture with extensive connections on the account that CT best shows cyst wall calcification and infection, and moreover, US is useful for detecting cystic membranes, especially septa and hydatid sand. CT and MRI can also show cyst wall defects and how contents pass through them. CT accurately assesses bone lesions, while MRI is superior in showing nerve involvement and fluid-containing cysts (Brunetti et al. 2010; Pedrosa et al. 2000). In addition to their lower cost and availability, how these techniques visualize the characteristics and dimensions of space-occupying lesions for infection diagnosis is invaluable (Rogan et al. 2006). According to studies, radiology techniques diagnose pulmonary cysts with 100% and liver cysts with 85.7% precision (Mansour-Ghanaei et al. 2012). Likewise, they are the most used methods of HC diagnosis (Farazi et al. 2019; Moosazadeh et al. 2017).

Surgery is still a treatment option for HC disease in many parts of the world, including Iran. The WHO recommends that the five HC stages (CE1-CE5) be identified through an imaging-based classification system, and then the treatment intervention be determined. In stages E1 and CE3a, albendazole or albendazole are administered with PAIR technique as follows: (1) Perforation of the cyst percutaneously using US tips, (2) cyst fluid aspiration, (3) protoscolicidal injection for 10–15 min, and (4) fluid re-aspiration is recommended. As a treatment guide, no intervention is recommended during the surgical technique with albendazole in CE2 and CE3b stages, as well as in CE4 and CE5 stages, i.e. the period of cyst inactivity (Watch and Wait) (Brunetti et al. 2010). Pharmacotherapy is also available for patients with non-surgical disease, multiple cysts in two or more limbs, peritoneal

cysts, recurrent cysts, and incomplete surgery to prevent the secondary spread of echinococcal infection following cyst rupture or spontaneous aspiration (Michail et al. 2007). Our findings also revealed that surgical treatment combined with drug therapy was used in 55.2% of patients. Surgical and pharmacological treatment each accounted for 30.1% and 14.8% of treatment cases, respectively. Given the easier access to diagnostic centers, urban areas have a higher success rate in receiving medical treatment and surgery than rural areas (Ghaffari 1999). We discovered that the mortality rate in HC patients hospitalized in Khuzestan province over the last ten years was 0.5%, which is lower than the rate of 3.2% in Gilan province in 2012 (Mansour-Ghanaei et al. 2012). Patients' increased awareness, early access to medical centers, better access to imaging techniques, and early diagnosis and treatment are all factors that have led to lower mortality rates in recent years.

According to the data provided by the National Statistics Center of Iran, Khuzestan province population was 4.710.509, thereby the prevalence of the disease was 3.88 per 100.000 people. The province of Khuzestan is home to the country's largest nomadic population as 29% of light livestock in the country is provided by nomads (Iran 2021), which may explain the high prevalence of the disease in these area. In a serological study in 2007, Rafiei stated that the prevalence of HC among the nomadic population of southwestern Iran was 13.8% (Rafiei et al. 2007). Problems in the municipal sewage system, the presence of stray dogs in the city and their proximity to agricultural lands and vegetable planting sites, consumption of contaminated vegetables, marginalization, and domestic slaughter of sheep are all important factors that cause the disease's high prevalence in Khuzestan province.

Conclusion

This study investigated the epidemiological data on the prevalence of HC among people residing in various regions of Khuzestan province in the southwest of Iran. Epidemiological data was used to indicate the disease burden and assess the progress and success of control programs. It should be noted, however, that HC disease is one of the most overlooked conditions that generally affects people with low access to health care. Such studies could potentially serve as baseline data to monitor future infection progression and design hydatid disease control strategies and programs. Therefore, it is of utmost significance to collect comprehensive epidemiological data in this regard.

Declarations

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