

Determination of Factors Affecting Human Transmission of *Echinococcus granulosus* Parasite: A Case-control Study, Turkey

Echinococcus granulosus Parazitinin İnsana Bulaşmasını Etkileyen Faktörlerin Belirlenmesi: Türkiye’de Olgu-kontrol Tipinde Bir Araştırma

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ABSTRACT

Objective: Through this study we aimed to determine the risk factors affecting the transmission of *Echinococcus granulosus* to humans.

Methods: This case-control study included a study group comprising of 107 people who underwent surgery for hydatid cyst and a control group comprising of 107 people. Place of living, age, and sex were taken as matching factors. A chi-square analysis was used for paired comparisons in the study. The variables that were significantly related in paired comparisons were included in the logistic regression analysis.

Results: Hydatid cyst disease was seen 3.661 [confidence interval (CI) =1.650-8.123] times more often in individuals with an education period of 11 years or less compared to those with 12 years or above, 3.427 (CI=1.470-7.991) times more in those with a toilet outside the house compared to those with a toilet inside the house, and 5.540 (CI=2.088-14.697) times more in individuals who took a shower 8 times a month or less compared to those who take a shower 9 times or more.

Conclusion: Individuals with a low level of education and who do not pay attention to environmental and personal hygiene are at risk for hydatid cyst disease.

Keywords: *Echinococcus granulosus*, hydatid cyst, education level, bath, potable water

ÖZ

Amaç: Araştırmada; *Echinococcus granulosus*'un insanlara bulaşmasını etkileyen risk faktörlerini belirlemek amaçlanmıştır.

Yöntemler: Olgu-kontrol tipinde bir araştırmadır. Olgu grubu kist hidatik cerrahi operasyonu geçiren 107 kişi, kontrol grubu da 107 kişi olarak alınmıştır. Eşleştirme faktörleri olarak yerleşim yeri, yaş, cinsiyet alınmıştır. Araştırmada ikili karşılaştırmalarda ki-kare analizi kullanıldı. İkili karşılaştırmalarda anlamlı çıkan değişkenler lojistik regresyon analizine alındı.

Bulgular: Kist hidatik hastalığı eğitim süresi 12 yıl ve üzeri olanlara göre 11 yıl ve altı olanlarda 3,661 [güven aralığı (GA)=1,650-8,123] kat, tuvaleti evin içinde olanlara göre evin dışında olanlarda 3,427 (GA=1,470-7,991) kat, aylık banyo sayısı 9 ve üzeri olan kişilere göre 8 ve altı olan kişilerde 5,540 (GA=2,088-14,697) kat daha fazla bulunmuştur.

Sonuç: Eğitim düzeyi düşük olanlar, çevresel ve kişisel hijyene dikkat etmeyen kişiler kist hidatik hastalığı için risk grubudur.

Anahtar Kelimeler: *Echinococcus granulosus*, kist hidatik, eğitim düzeyi, banyo, kullanma suyu

INTRODUCTION

Cystic echinococcosis is a zoonotic disease, especially in animals, that causes significant public health problems (1,2) and serious economic losses in Turkey (1-3). Although it most commonly causes disease in the liver and lungs, it can also rarely cause disease in organs, such as eyes, bones, kidney, heart, and brain (4-6).

Cystic echinococcosis is commonly known as “cyst disease” among people in Turkey. The causative agent of the disease is a parasite called *Echinococcus granulosus* (1). The main sources of the parasite are meat-eating animals, such as wolves, foxes, and especially dogs. The parasite thrives in the small intestine of dogs and is transmitted to humans via eggs discarded through dog feces (7,8).



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The factors contributing to the transmission of the parasite are occupation, hobbies, living conditions, and education and socio-economic level of the people. The biggest risk group consists of people who are engaged in animal husbandry, such as sheep, goats, and cows who have contact with infected dogs that are not been treated for parasites (8,9).

This study aims to determine the risk factors related to demographic, economic, place of living, and hygiene characteristics that affect the transmission of *Echinococcus granulosus* to humans.

METHODS

Identification of the Region Where the Research Was Conducted

The region where the research was conducted is adjacent to Iran, Georgia, Nakhichevan, and Armenia. The primary occupation of the people of this region is agriculture and animal husbandry. The socio-economic development of this region is below the average of that of Turkey. Illiterate people comprise 11.7% of the total population of the region and those who have never finished school constitute 13.5% (10).

The region is below the average of Turkey in terms of the number of health personnel per thousand people. The mortality rate of the region is above the average of Turkey with 11.2 per thousand infant deaths and 24.5 per hundred thousand maternal deaths, respectively (The averages of Turkey are 6.8 per thousand infant deaths and 14.6 per hundred thousand maternal deaths, respectively) (11).

Type of study: Case-control.

Study group: The study group comprised of 107 patients with hydatid cyst who were treated in the general surgery clinic between 2012 and 2020.

Control group: The control group comprised of 107 individuals with approximately the same age and sex, who resided in the same settlement (village, town, neighborhood, main street, street, etc.).

Selection of the control group: Individuals of the same sex, who lived in the same residential area as that of the case group, the same age or with ± 3 years age difference were included. We ensured that the control group included individuals who lived at least two houses adjacent to the house of the case group individual. The control group individuals were first evaluated with an indirect hemagglutination test (IHA). Two people with positive IHA tests were not included in the study. Instead of these people, two different people living in the same settlement were taken.

We reached out to 81.3% (87) individuals of the case group and 95.3% (107) of the control group. The most important reasons for being unable to reach out to people were as follows: Migration (8 people), death (1 person), refusing to participate in the study (9 people), and unable to reach the person (7 people).

Matching factors: Place of living, age, and sex.

Preparation of data collection form: The data collection form of the research was prepared using the Turkey Demographic and Health Survey, the Turkey Zoonotic Diseases Action Plan and the website of the General Directorate of Zoonotic Diseases (1,2,12) of the Ministry of Health, General Directorate of Public Health. The data collection form included questions regarding demographic information and place of living of the individuals of the case and control groups.

Data collection: Written and verbal consent was obtained from the individuals before collection of data. The data were collected using face-to-face interview technique with people who agreed to participate in the study.

Definitions related to the variables: The number of baths per month was taken according to the median value.

Obtaining study permissions: Approval for the study was obtained from the Ethics Committee of the Kafkas University Faculty of Medicine, with the decision no: 80576354-050-99/02 and date: 09.03.2021 and written informed consent was obtained from all patients.

Statistical Analysis

SPSS version 20 for Windows was used for data analysis. Chi-square analysis was used in paired comparisons in the study. The variables that were significantly related in paired comparisons were included in the logistic regression analysis.

RESULTS

Among the socio-demographic and socio-economic variables, no statistically significant difference was found between the case and control groups in terms of place of living, sex, age, family type, number of people living at home, field of work, and total income of the household ($p=0.830$; $p=0.763$, respectively; $p=0.746$; $p=0.190$; $p=0.154$, $p=0.682$, $p=0.659$), while a statistically significant difference was found between the case and control groups in terms of duration of education of the individuals ($p=0.020$) (Table 1).

Considering variables with regard to place of living, while there was no statistically significant difference between the case and control groups ($p=0.136$; $p=0.283$) in terms of whether the toilet used is inside or outside the house, the toilet is connected to sewage or open/closed pit ($p=0.136$; $p=0.283$), the potable water is in the house or in the garden, there was a statistically significant difference between the case and control groups in terms of number of people per room ($p=0.030$; $p=0.006$) (Table 2).

Table 3 shows the distribution of hygiene characteristics according to the case and control groups. Accordingly, a statistically significant difference was found between the case and control groups in terms of the number of baths the person takes during a month, the number of hand washing per day, and the use of gloves ($p=0.002$; $p=0.002$; $p=0.004$, respectively).

In the study, no statistically significant difference was found between the case and control groups in terms of animal care characteristics, such as presence of a dog belonging to the family, taking care of the dog, veterinary care of the dog, giving parasitic drugs to the dog, animal butchering and feeding offal to dogs ($p=0.776$; 0.092 ; $p=0.314$; $p=0.055$; $p=0.523$; $p=0.877$) (Table 4).

Table 5 shows the results of the logistic regression analysis. On evaluation of the table, hydatid cyst transmission is 3.661 [confidence interval (CI)=1.650-8.123] times more often in those with an education period of 11 years or less compared to those with 12 years or above, 3.427 (CI=1.470-7.991) times more in those with a toilet outside the house compared to those with a toilet inside the house, and 5.540 (CI=2.088-14.697) times more in individuals who take a shower 8 times a month or less compared to those who take a shower 9 times or more.

DISCUSSION

More than 60.0% of the pathogens that infect humans are animal-borne zoonotic animal diseases and more than 75.0% of the new emerging infectious diseases are zoonotic (13). The World Health Organization shows Echinococcosis in the “neglected tropical diseases” group (14). Echinococcosis is one of the most overlooked public health problems in Turkey (15). Through this study, we aimed to determine the factors effective in catching hydatid cyst disease.

In the study, *Echinococcus granulosus* infection is 3.661 (CI=1.650-8.123) times more in individuals with education duration of 11 years or less than those with 12 years or more. In a meta-analysis, it was shown that the prevalence of hydatid cyst is higher in patients with low education level (16). In a study conducted with

milk producers in the region where the study was conducted, it was shown that people with a high level of education have more knowledge about echinococcosis and protection from parasites (17). The probable cause of this situation is thought to be health literacy. Health literacy is defined as having the knowledge, motivation, and competence to access, understand, evaluate, and use health information (18). In a study, it was shown that people with low education levels also have inadequate health literacy (19).

Hydatid cyst develops 3.427 (CI=1.470-7.991) times more in those who have potable water in the garden compared to inside the house. In a meta-analysis, it was stated that using water other than mains water increased the risk of hydatid cyst contagion by 1.8 times (20). In a case-control study conducted in Jordan, it was emphasized that even if the water comes from a tubular

Table 1. Distribution of socio-demographic characteristics by case and control groups

Socio-demographic and socio-economic characteristics		Case group	Control group	X ²	p
		n (%)*	n (%)*		
Place of living	Rural	66 (75.9)	76 (74.5)	0.046	0.830
	Urban	21 (24.1)	26 (25.5)		
Sex	Female	45 (51.7)	55 (53.9)	0.091	0.763
	Male	42 (48.3)	47 (46.1)		
Age	29<	43 (49.4)	48 (47.1)	0.105	0.746
	30≥	44 (50.6)	54 (52.9)		
Family type	Extended	26 (29.9)	22 (21.6)	1.714	0.190
	Nuclear	61 (70.1)	80 (78.4)		
Number of people living in the house	≤4	32 (36.8)	48 (47.1)	2.031	0.154
	≥5	55 (63.2)	54 (52.9)		
Education time	≤11	48 (54.0)	39 (38.2)	4.719	0.020
	≥12	39 (46.0)	63 (61.8)		
Field of work	Agriculture/animal	76 (87.4)	87 (85.3)	0.168	0.682
	Outside of agriculture	11 (12.6)	15 (14.7)		
Income of the household	Insufficient	39 (44.8)	49 (48.0)	0.195	0.659
	Sufficient	48 (55.2)	53 (52.0)		
Total		87 (100.0)	102 (100.0)		

* Column percentage

Table 2. Distribution of habitat characteristics by case and control groups

Characteristics of place of living		Case group	Control group	X ²	p
		n (%)*	n (%)*		
Toilet	Outside the house	71 (81.6)	91 (89.2)	2.219	0.136
	Inside the house	16 (18.4)	11 (10.8)		
Toilet drain	Sewage	73 (83.9)	91 (89.2)	1.152	0.283
	Open/closed pit	14 (16.1)	11 (10.8)		
Potable water	In the garden	25 (28.7)	16 (11.8)	4.707	0.030
	Inside the house	62 (71.3)	86 (84.3)		
Number of individuals per room	≥3	69 (79.3)	62 (60.8)	7.576	0.006
	<3	18 (20.7)	40 (39.2)		
Total*		87 (100.0)	102 (100.0)		

* Column percentage

Table 3. Distribution of hygiene characteristics by case and control groups

Hygiene characteristics		Case group	Control group	X ²	p
		n (%)*	n (%)*		
Number of baths per month	8≤	63 (72.0)	51 (50.0)	9.855	0.002
	9≥	24 (27.6)	51 (50.0)		
Hand washing per day	5≤	70 (80.5)	61 (59.8)	9.418	0.002
	6≥	17 (19.5)	41 (40.2)		
Glove	Not using	75 (86.2)	70 (68.6)	8.124	0.004
	Using	12 (13.8)	32 (31.4)		
Total*		87 (100.0)	102 (100.0)		

* Column percentage

Table 4. Distribution of animal care characteristics by case and control groups

Animal care and animal contact		Case group	Control group	X ²	p
		n (%)*	n (%)*		
Family dog	Yes	73 (83.9)	84 (82.4)	0.081	0.776
	No	14 (16.1)	18 (17.6)		
Dog care	Yes	63 (72.4)	62 (60.8)	2.835	0.092
	No	24 (27.6)	40 (39.2)		
Veterinary care of the dog	Yes	13 (14.9)	21 (20.6)	1.014	0.314
	No	74 (85.1)	81 (79.4)		
Dog parasite medicine	Given	9 (10.3)	21 (20.6)	3.689	0.055
	Not given	78 (89.7)	81 (79.4)		
Animal butchery	Yes	80 (92.0)	91 (89.2)	0.409	0.523
	No	7 (8.0)	11 (10.8)		
Feeding offal to dogs	Yes	77 (88.5)	91 (89.2)	0.024	0.877
	No	10 (11.5)	11 (10.8)		
Total*		87 (100.0)	102 (100.0)		

* Column percentage

Table 5. Logistic regression analysis results table

Independent variables	B	S.E.	Wald	Odds ratio	95% CI (smallest-largest value)*
Duration of education (years)	≤11	1.298	0.407	10.183	3.661
	≥12				1 (Reference)
Potable water	In the garden	1.232	0.432	8.129	3.427
	Inside the house				1 (Reference)
Number of baths per month	≤8	1.712	0.498	11.824	5.540
	≥9				1 (Reference)

* Smallest-largest value, CI: Confidence interval

system, if it is unprotected, it is an important risk factor (odds ratio: 13.22 CI: 2.91-83.7) in contagion of hydatid cysts (21). The main livelihood of the region where the study was conducted is animal husbandry and agriculture (10). As it is known, dogs, which are the main source of hydatid cyst, are an integral part of animal husbandry (approximately 8 out of 10 families have dogs as seen in Table 2). In addition, it is very difficult to say that there is sufficient water for pastures and fields in the region, as in the whole of Turkey (22). As a result, animals, dogs, and water are vital for the region.

A significant portion of the regions' population, especially those living in rural areas, uses potable water in the garden in order to use water more efficiently. They build a small pond right in front of the water source in the garden to meet the water needs of large and small cattle. They build a fruit and vegetable garden 10-20 meters away from the pond, where the pond water can flow through easily. Both the water pond and the fruit and vegetable gardens are also used by dogs. This water infected with the feces of animals and dogs, also flows into the fruit and vegetable gardens. Thus, especially vegetables that grow close to the ground

and fruits that fall on the ground are infected with the parasite. Considering that it is very difficult to clean fruits and vegetables that fall on the ground in the current living conditions, according to hygienic rules, people who eat these fruits and vegetables can also be infected with “parasites” (observations of researchers). In a study conducted on hydatid cysts in Iran, it was determined that only 6.7% of the participants washed vegetables according to hygienic washing principles (23).

In the study, personal hygiene was questioned in terms of number of daily hand washing, use of gloves in animal and/or agricultural occupations, and number of baths taken per month. While all three variables were found to be statistically significant in paired analyzes, only the number of baths taken per month was determined as a risk factor in logistic regression analysis. Accordingly, hydatid cyst disease is 5.540 (CI=2.088-14.697) times more in people who take 8 and less baths per month than those who take 9 and more baths per month. One of the most important problems of the region where the research was conducted is that it is the coldest region of Turkey. For example, in the year 2020, the temperature of 268 days was below 15 °C (24). “Animal excrement” (manure) is still used as a fuel for heating most households in the region, especially in rural areas. In majority of these households, a heating stove is installed in the largest room and people spend most of their time in the heated room. As a result of this, all parts of the house are not heated homogeneously. Therefore, less number of people take baths, especially in winter. In summer, there is no constant hot water, so heating water for a bath also creates a problem in terms of insufficient time left after work. As a result, body surfaces that come into contact with the parasite cannot be adequately cleaned and the person may eventually become infected (observations of researchers). In the region where the study was conducted, in a study on pediculosis in children, it was reported that the number of children who took bath 3 times a week was very low (25).

Study Limitations

The strength of this study is that it is the first case-control study conducted in Turkey where there are only a limited number of similar studies in the literature. However, the inclusion of only cases that underwent surgical treatment as a control group in the study is considered as a limitation.

CONCLUSION

Among the people with low education level, the use of potable water in common areas with animals and insufficient personal body hygiene are important risk factors for hydatid cyst disease. In this context, periodic national level training programs should be organized against zoonotic diseases in general and hydatid disease in particular.

*Ethics

Ethics Committee Approval: Approval for the study was obtained from the Ethics Committee of the Kafkas University Faculty of Medicine, with the decision no: 80576354-050-99/02 and date: 09.03.2021.

Informed Consent: Written informed consent was obtained from all patients.

Peer-review: Internally and externally peer-reviewed.

*Authorship Contributions

Surgical and Medical Practices: T.A., H.Ç., Concept: T.A., H.Ç., Design: T.A., H.Ç., Data Collection or Processing: T.A., H.Ç., Analysis or Interpretation: T.A., H.Ç., Literature Search: T.A., H.Ç., Writing: T.A., H.Ç.

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