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Echinococcus Infection: The Effects of Echinococcosis on Public Health and Economy

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Abstract

The term echinococcosis refers to the disease caused by any species of the genus *Echinococcus*. It is a parasitic disease that has been known since the 17th century and continues to be an important problem to human and animal health as well as economic losses caused by the disease. In livestock, the economic loss caused by organ destruction due to echinococcosis is not the only drawback; the reduction in meat, milk and fleece quality and yield, decreased fertility, and low birth weight should also be taken into account. In humans, the infection causes high economic losses due to hospitalization, loss of labor and diagnostic and therapeutic requirements. Therefore, it is apparent that prevention and control programs should be implemented effectively to prevent or minimize the adverse consequences of echinococcosis, as it is well known that economic losses associated with human health and animal husbandry are immense. In this review, we aimed to contribute to the understanding of the transmission dynamics of *Echinococcus* species, to present current data on this topic, and to obtain information about the current status of echinococcosis in terms of zoonotic potential.

Keywords: *Echinococcus* species, economic losses, control, preventive medicine, zoonosis.

INTRODUCTION

Echinococcosis is a zoonotic infection caused by the genus *Echinococcus* while it is in the adult and/or metacestode stages of development. *Echinococcus* exhibit some unique characteristics that put it apart from the other large general of the *Taenidae* family. Despite some progress in the control of echinococcosis, in many countries, the zoonosis is still an important public health problem due to the lack of policies focused at prevention and eradication (Eckert and Deplazes, 2004; Thompson, 2008).

The classification of the genus *Echinococcus* has been discussed for a long time. The first studies on the identification of *Echinococcus* subspecies were based on morphological and biochemical differences. Over the past 40 years, both laboratory and field observations have shown successful results in the separation of *Echinococcus* species and subspecies. With the studies carried out to date, there are five accepted species, including *Echinococcus granulosus, Echinococcus multilocularis, Echinococcus oligarthrus, Echinococcus vogeli* and *Echinococcus shiquicus*, while controversy continues as to whether *E. granulosus sensu stricto* (G1-3), *E. equinus* (G4), *E. ortleppi* (G5), *E. intermedius* (G6/7), *E. canadensis* (G8/10) and *E. felidis,* are species or strains (Table 1) (Thompson, 2008; Thompson and McManus, 2002; Brozova et al., 2017).

As with all *Cestodes*, *Echinococcus* species require two different hosts to complete their life cycle. The definitive hosts harboring the adult form in the small intestine are carnivores of the dog and cat family (*Canidae* and *Felidae*). Intermediate hosts are a wide variety of domestic / wild mammal species which harbor larval forms of the parasite after hatching (Eckert and Deplazes, 2004; Brozova et al., 2017). The development of the parasite is shaped by the nutritional relationship (Figure 1) (Eckert and Deplazes, 2004; Wen et al., 2019). Humans do not play a role in the life cycle of the parasite, but are defined as random hosts. However, if the disease is not treated, it has serious morbidity and mortality, as well as significant social and economic consequences. Estimated data on the global distribution of the disease suggest that cystic echinococcosis affects 2-3 million people and that there are 200,000 new cases annually. Additionally, it is estimated that there are around 0.3-0.5 million cases of alveolar echinococcosis with up to 18,000 new cases being diagnosed annually. It is difficult to evaluate the socio-economic effects caused by the disease with these estimated data, but it should be concluded that it is still a neglected zoonotic when the chronic course of the disease and its negative consequences on quality of life are evaluated (Torgerson et al., 2010).

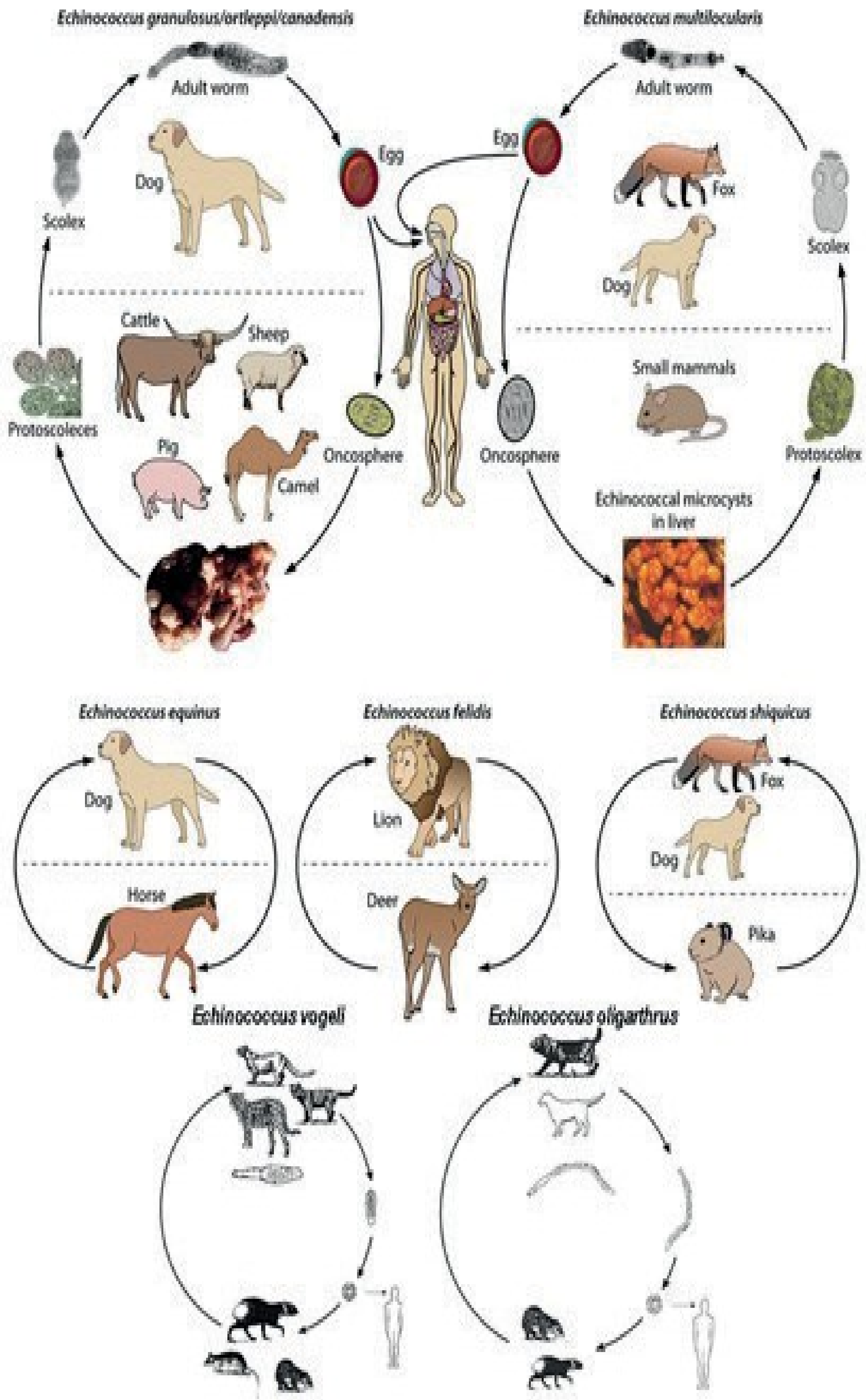

Figure 1. Life cycle of *Echinococcus* species. (Eckert and Deplazes, 2004; Wen et al., 2019)

Table 1. Definitive host, intermediate hosts and geographical distribution of different strains of *Echinococcus* species (Thompson, 2008; Thompson and McManus, 2002; Brozova et al., 2017; Xiao et al., 2006; Altıntaş et al., 2009).

Species/Strain	Intermediate Host	Definitive Host	Human infectivity	Geographical Distribution	Recommended Taxonomic Naming
E. granulosus					
Sheep (G1)	Sheep, goat, cattle, camel, pig, buffalo, yak, equids	Dog, fox, dingo, jackal, hyena	Infective	North, Central and South America, Europe, Africa, Middle East, China, Australia, New Zealand, Russia	*E. granulosus (sensu stricto)*
Tasmania (G2)	Sheep, cattle	Dog, fox	Infective	Tasmania, Argentina, Romania, India	
Buffalo (G3)	Buffalo, cattle, sheep, goat	Dog, fox	Infective	Asia, Europe	
Horse (G4)	Horse and other equids	Dog	Low or not infective	Europe, Middle East, South Africa, New Zealand, America	*E. equinus*
Cattle (G5)	Cattle	Dog	Infective	Central Europe, Russia, South Africa, India, Sri Lanka	*E. ortleppi*
Camel (G6)	Camel, goat, cattle, sheep	Dog	Infective	Middle East, Africa, Argentina, China	*E. canadensis*
Pig (G7)	Pig, wild boar, cattle, goat	Dog	Infective	Europe, Russia, Central America	*E. canadensis*
Deer (G8)	Deers	Wolf, dog	Infective	North America, Eurasia	*E. canadensis*
Human (G9)	Human	(?)	Infective	Poland	*E. granulosus?*
Fennoscandian deer (G10)	Deers	Canides	Asymptomatic	Finland	*E. canadensis*
Lion	Wild boar (Buffalo, zebra?)	Lion	(?)	Africa	*E. felidis*
E. multilocularis					
European genotype (M1)	Rodents, domestic and wild boar, monkey	Fox, dog, cat, raccoon	Infective	Europe	*E. multilocularis*
Asian genotype (M2)	Rodent	Dog, fox, cat	Infective	China	*E. multilocularis*
North American genotype (M2)	Rodent	Dog, fox, cat, coyote	Infective	North America, Alaska	*E. multilocularis*
E. shiquicus					
Undeclared	Ochotona	Tibetan fox	(?)	Tibetan Plateau (China)	*E. shiquicus*
E. vogeli					
Undeclared	Rodent	Bush dog	Infective	South America	*E. vogeli*
E. oligarthrus					
Undeclared	Rodent	Wild felines	Infective	South America	*E. oligarthrus*

(?): Uncertain; requires reference and / or research.

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In this review, we aimed to contribute to the understanding of the transmission dynamics of *Echinococcus* species, to present current data on this topic, and to obtain information about the current status of echinococcosis in terms of zoonotic potential.

Prevalence of *Echinococcus* Species

Echinococcus granulosus extends to a wide geographical region and is present in almost all continents around the world (Figure 2). The regions with high prevalence are Europe, Asia, Africa, Australia and some parts of South America. Infection can be detected sporadically as well as in areas where it is endemic, and no interference is observed in Greenland and Iceland (Torgerson and Budke, 2003; Rodriguez-Morales et al., 2015). The most commonly observed life cycles (harboring organisms) of *Echinococcus granulosus* with regard to geographic region are as follows: in Europe, particularly neighboring Mediterranean countries like Spain, Italy, Yugoslavia, Greece, Turkey and outskirts of Russia: between dogs and sheeps, in Western Europe and Ireland: between dogs and horses. In some countries of Europe, such as Belgium, Germany and Switzerland: the majority of cycles involve dogs and cattle, while dog and pig cycles are more common in some Eastern European countries, such as Poland and Hungary, and in Russia (Eckert and Deplazes, 2004; Torgerson and Budke, 2003; Rodriguez-Morales et al., 2015; Eckert et al., 2001).

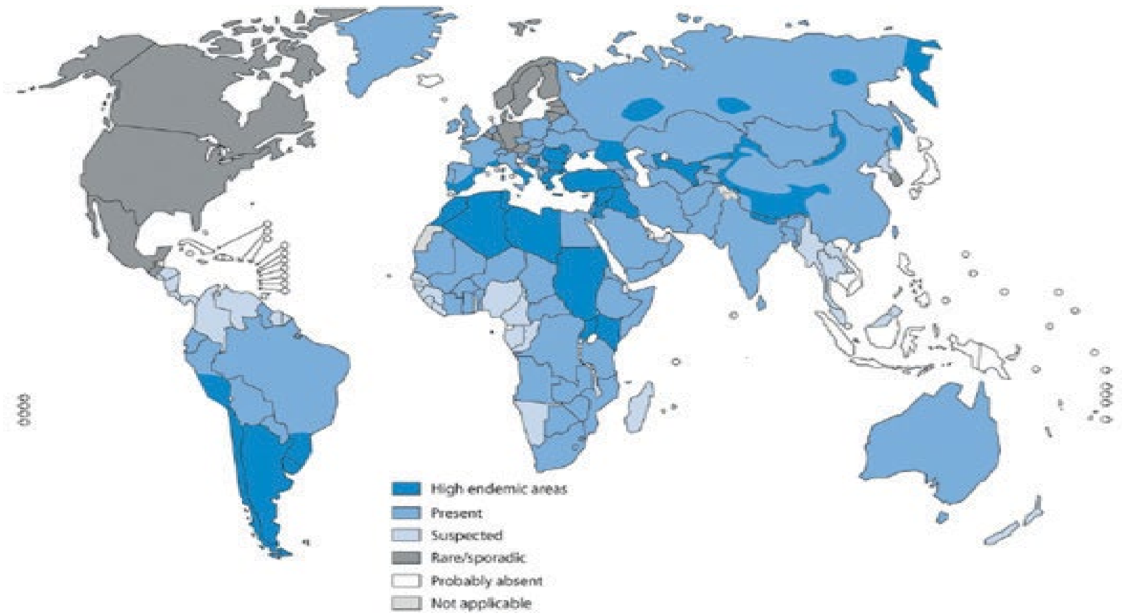

Figure 2. *Echinococcus granulosus* and cystic echinococcosis distribution (Rodriguez-Morales et al., 2015).

In Turkey, between 1990 and 2005, according to official reports of the Health Ministry, more than 52,000 patients had cystic echinococcosis. The average annual incidence of cystic echinococcosis in Turkey is estimated to be 0.8 to 2 in 100000 population. However, in some regions, up to 6.4 times higher incidence rates have been recorded. Based on hospital records between 2001-2005, most patients with cystic echinococcosis were from Turkey's Central Anatolia (38.6%) and the Aegean / Mediterranean regions (33.0%). Diagnostic studies have also reported similar results. For instance, the prevalence of cystic echinococcosis was found to be 0.3% via ultrasound scan of children in Manisa, while seroprevalence in the same age group was reportedly 8.9% and 10.1% using ELISA and IHA methods, respectively. Another ultrasound study in Elazığ and Manisa showed that 0.2% and 0.15% of children had cystic echinococcosis. In Aydın, an ultrasound-based study in all age groups recorded a prevalence of 0.47% (Deplazes et al., 2017). According to the Turkish Statistical Institute data from 2017, the epidemiology of *Echinococcus granulosus* predominantly shows a dog-sheep biological cycle, and the reason for *Echinococcus granulosus* being widespread in our country is due to various factors, including the fact that 18.3% (Öztürk, 2018) of the active population is engaged in agriculture and animal husbandry, the practice of uncontrolled slaughtering in rural areas, the high number of stray dogs and the lack of effective infection programs. In studies performed on dogs, the prevalence of *Echinococcus granulosus* is reported to range from 0.32-40% (Altintaş, 2003). As a result of the literature review, the prevalence among farm animals was found to vary between regions. In the Burdur region prevalence rates were: 13.5% in cattle, 26.6% in sheep, 22.1% in goats (Umur, 2003); in Kırıkkale: 3.2% in lambs, 50.9% in sheep, 14.17% in cattle(Yildiz and Tuncer, 2005); 29.47% in cattle in Afyonkarahisar(Kose and Kirkali, 2008); 3.5% in sheep and 11.6% in cattle in Thracian region (Ulutas and Tuzer, 2007); and 35.68% in cattle in Sivas (Acioz et al., 2008).Also, in a study carried out in Samsun, Ordu and Amasya between 2006 and 2010, the infection was found to be present in 10.24% of Asian buffaloes (Beyhan and Umur, 2011; Deplazes et al., 2017; Dakkak, 2010).

The prevalence of alveolar echinococcosis caused by *Echinococcus multilocularis* depends on the presence of small mammals such as rodents and several other animals, especially foxes and cats, and is particularly common in northern and central parts of Central Europe, Europe and Asia (Figure 3). The infections in Russia (and neighboring countries), Turkey and Iran also show an endemic trend, it is widely seen in the western and central regions of China, Hokkaido Island in Japan, North America and especially North Africa (Rodriguez-Morales et al., 2015; Eckert et al., 2001; Deplazes et al., 2017).

Figure 3. Distribution of *Echinococcus multilocularis* and alveolar echinococcosis (Rodriguez-Morales et al., 2015) .

Alveolar echinococcosis is reported to be widespread in Eastern and Southeastern Anatolia due to its proximity to endemic areas in the Caucasus region. In these regions, besides the cold climate, the fact that agriculture and animal husbandry are primary sources of income is a cause of the frequency of the disease. Alveolar echinococcosis in humans in our country was first documented in 1939. *Echinococcus multilocularis* was detected in a fox in 1963 during a survey conducted by Merdivenci in Thrace for the first time in our country (Merdivenci, 1963). Recent studies in Erzurum have reported the presence of *E. multilocularis* in foxes and alveolar cysts in intermediate host rodents (Deplazes et al., 2017; Avcioglu et al., 2017; Avcioglu et al., 2016). 162 cases of alveolar echinococcosis have been reported from the 2000s to the present, and 24 cases have been reported in the literature as case reports. With studies covering an 11-year period, the infection rate was determined to be 89.02% in people from Eastern and Southeastern Anatolia. Turkey is considered to be endemic for *E. multilocularis*, according to studies in the literature. This suggests that, in order to investigate the prevalence of *E. multilocularis* in intermediate hosts and final hosts, large-scale studies should be performed initially in the Eastern and Southeastern Anatolia regions (Deplazes et al., 2017).

To date, the spread of *Echinococcus vogeli* has been reported to occur in humans and rodents in Costa Rica, Panama, Colombia, Ecuador, Venezuela, Brazil and Bolivia. The spread of *Echinococcus oligarthrus* from the north of Costa Rica to the south of Argentina has been identified. *Echinococcus shiquicus*, shows a limited spread in the Tibet region, west of Chinese territory (Xiao et al., 2006; Rodriguez-Morales et al., 2015).

Echinococcosis and Public Health

Echinococcosis is a common disease in Turkey and it is difficult to diagnose and treat this disease and efforts for prevention and eradication remain limited, even though it may result in death. Therefore, it is one of the most important neglected diseases. Echinococcosis is observed throughout the country, especially in rural areas where animal husbandry is widespread and uncontrolled, and in regions where the population of stray dogs is dense. The distribution of cases of human echinococcosis seen between 2007 and 2017 by years is shown in Table 2, but the data in the table are generally drawn from confirmed results and do not include individuals who have received medical treatment for the disease, followed with a wait-and-see approach, and those with likely contact but had not been assessed due to lack of symptoms; thus, the actual prevalence is estimated to be much higher (Xiao et al., 2006; Altıntaş and Doğanay, 2009; Akkaş, 2018; Nakao et al., 2013; Romig et al., 2015; Eckert et al., 2001; Altıntaş, 2015; Sağlık Bakanlığı, Halk Sağlığı Genel Müdürlüğü, 2019). When studies related to the prevalence of echinococcosis in Turkey were analyzed, it was feasible to suggest that about one out of every 150-200 people (0.5-0.6%) were infected with echinococcus. Furthermore, the results of the HERACLES project, which assessed echinococcosis frequency with screening methods among 8618 people from six provinces (Ankara, Aksaray, Balıkesir, Bitlis, Edirne, Şanlıurfa), found that 53 (0.6%, 1/163) of the participants had echinococcosis (Altintas et al., 2006). This is also an indication that the disease appears to be one of the most important health problems in Turkey.

In Turkey, studies conducted to investigate the prevelance of *E. granulosus* among dogs found that the ratio varied between 32-40% (Sağlık Bakanlığı, Halk Sağlığı Genel Müdürlüğü, Zoonotik ve Vektörel Hastalıklar Dairesi Başkanlığı, 2019). Farm animals that serve as intermediate hosts in the life cycle of *Echinococcus* spp. are also very important. In studies conducted to investigate the incidence of echinococcosis in farm animals in our country, it has been found that the frequency of disease varies between 3-81.3% (Sağlık Bakanlığı, Halk Sağlığı Genel Müdürlüğü, Zoonotik ve Vektörel Hastalıklar Dairesi Başkanlığı, 2019). This huge discrepancy among studies with similar characteristics suggests that data collection is inadequate, as these differences cannot be solely explained by geographic differences. Hence, it is believed that data reported by different ministries do not fully reflect the actual burden of disease. Therefore, studies that suggest the presence of a higher rate of infection are most probably correct. To address these problems, more accurate and reliable epidemiological data should be obtained. Furthermore, the identification of descriptive surveillance data for intermediate and definitive hosts, including humans, in the control of disease makes it possible to estimate the infection burden or frequency of infection and to model the possible consequences of a control intervention (Torgerson and Heath, 2003).

Table 2: Cystic Echinococcosis in human in Turkey, case number and year of 2008-2017 morbidity / mortality rate (Sağlık Bakanlığı, Halk Sağlığı Genel Müdürlüğü, 2019).

Years	Population	Number of Cases	Morbidity Rate (per 100.000)	Number of Deaths	Mortality Rate (per 100.000)
2008	71.517.100	408	0,57	1	0,01
2009	72.561.312	434	0,6	0	0
2010	73.722.988	381	0,52	0	0
2011	74.724.269	579	0,77	0	0
2012	75.627.384	572	0,76	0	0
2013	76.667.864	616	0,8	0	0
2014	77.695.904	449	0,58	0	0
2015	78.741.053	544	0,69	0	0
2016	79.814.871	787	0,99	0	0
2017	80.810.525	1728	2,14	1	0,01

Economic Burden of Echinococcosis

Parasitic infections adversely affect food intake, digestion and consequently, various physiological events in the animal body. These alterations adversely affect animal quality and produce, which, in turn, endangers human nutrition. In the field of public health, annual loss caused by echinococcosis is estimated to be around $193,529,740 anually, while the global livestock industry loss is estimated to be over $ 2 billion a year (Elelu et al., 2019; Köroğlu and Şimşek, 2004). Because the infection is well tolerated by many animal species and the fact that animals are usually slaughtered before the pathogenic and clinical manifestation of the cysts, cases of echinococcosis are usually detected in slaughterhouses. Therefore, economic losses caused by hydatid cysts in livestock; total quality and quantity of meat, milk and fleece, the decreases in birth rate, delay in growth, destruction of infected organs and costs pertaining to destruction, prohibition of export of infected animals, and consequent economic losses and costs should be examined as a whole (Nur et al., 2017). It has been determined that, due to echinococcosis, milk yield decreases by 7-10%, total carcass weight by 5-20%, fleece production by 10-40%, and birth rate by 20-30%, in infected sheep (Dakkak, 2010; Nur et al., 2017). Annual yield losses from echinococcosis in farm animals worldwide are estimated at $ 141,605,195, carcass losses at $ 241,525,979, wool and fleece losses at $ 34,871,148, decrease in milk production at $ 378,722,717, and fertility losses at $ 453,141,617 (Budke et al., 2006).

Based on the view that hydatid cyst causes an average loss of milk yield of 7% in sheep, and calculations based on the assumption that 75% of sheep were infected and each sheep produced 120 liters of milk, it was found that a total of 9 liters of milk loss per sheep could occur (Köroğlu and Şimşek, 2004). In a study conducted in Uruguay, it was emphasized that 960.000 sheep are slaughtered annually and a 2.5% decrease in carcasses causes $ 720.000 loss on carcass alone, while an additional 5% decrease in economic value results in $ 1.140.000 of loss per year. In the same study, it was determined that the fleece obtained in the infected sheep will reduce by 20% leading to an annual loss of $ 1.418.560, and as a result of the decrease in lamb birth rate, a loss of 2.151.052 $ will occur (Köroğlu and Şimşek, 2004; Torgerson et al., 2000).

Hydatid cysts have been reported to decrease carcass weight in cattle by 2.5-5%, milk yield by 2.5-10% or annually by 100kg per animal (Köroğlu and Şimşek, 2004). Considering the effect of hydatid cyst on yield losses in cattle, it is determined that if the average carcass weight is taken as 300kg, a carcass loss of 2.5% will be approximately 2,040,000kg and its economic cost will be $ 3,264,000 per year. In case of loss of 10% of the total annual milk yield, the loss of milk yield in cattle has been calculated as 19.862.800 liters with a material value of $3,535,578, annually. A loss of 100 liters of milk per animal will lead to a total of 6.800.000 liters lost, and a total of around $1.210.400 (Köroğlu and Şimşek, 2004; Torgerson et al., 2000).

The most important economic loss in terms of animal production is the destruction of consumable organs, especially the liver. All or part of the infected organs are destroyed according to the laws and regulations determined by the country administrations. In this context, the measurement of economic losses caused by hydatid cyst- infected organs depends on the laws of that country and the number of slaughtered animals under the supervision of a veterinarian (Köroğlu and Şimşek, 2004; Torgerson et al., 2000). In Uruguay, since the organs to be destroyed are directed for use in the pharmaceutical industry, the annual value of 770,000 livers is estimated at $ 146,000, although economic loss is relatively reduced due to their regulations (Köroğlu and Şimşek, 2004; Torgerson et al., 2000).

The economic losses caused by hydatid cysts in Turkey are generally calculated based on the destruction of organs detected after postmortem examination conducted by veterinarians in slaughterhouses. In a study conducted by Umur in 2003, the carcass depletion caused by the destruction of liver and lungs with hydatid cysts was found to be $7.5 per cattle, $ 3.2 per sheep and $ 2.9 per goat. The minimum economic loss of 183 cattle, 58 sheep and 23 goats included in the study is reported to be $ 583 at 2002 market prices (Umur, 2003). According to the study conducted by Sarıözkan and Yalçın in 2008, annual losses due to hydatid cysts are calculated at $32.4 million for cattle, $ 54.1 million for sheep and $ 2.7 million for goats. In Turkey, the production losses due to hydatid disease across the country in 2008 was estimated as $89.2 million (Sarıözkan and Yalçın, 2009). It has been reported that an economic loss of $ 240 was calculated in relation to the liver and lungs destroyed in sheep and $ 165 in bovine liver. As a result of the calculations, an economic loss of $ 1 per slaughtered sheep and $ 0.5 per slaughtered cattle is generalized for Kayseri (16,000 slaughtered sheep / year and 30,000 slaughtered cattle) / year), animal production losses and human health expenditures, excluding the healthcare loss due to hydatid cyst, is estimated to reach $ 31.372 annually in Kayseri alone (Düzlü et al., 2010). Demir and Mor, in 2011, reported that a total of 203 livers were destroyed (an average of 5kg of beef) in 2011. In this study, hydatid cyst-related liver loss was reported to cause a total of $ 7.708 annually. When these calculations are generalized for Kars; (6,523 slaughtered cattle / year) It is reported that the economic loss caused by hydatid cysts in one year is $ 13,079 and the loss of production caused by carcass, milk yield and birth loss is calculated as $ 769,859, excluding animal production losses and human health expenditures (Demir and Mor, 2011).

Protection and Control

In order to prevent health-related and economic problems caused by Echinococcosis in domestic animals and humans, it has been determined that control studies against *Echinococcus* and eradication programs are much-needed interventions in order to prevent the transmission of disease to humans and prevent losses in animal husbandry (Eckert et al., 2004; Craig et. al., 2017). The first successful control program took place in Iceland, where one in every six people suffered the disease 130 years ago. Echinococcosis was completely eliminated and the program succeeded with the keywords "strict control" and "prevention of illegal slaughters". A highly effective training campaign was carried out to prevent illegal slaughter and transmission through infected offal was gradually eliminated. It was emphasized that the program, which was initially based on voluntarism, continued with the laws passed later (Eckert and Deplazes, 2004; Craig et. al., 2017; Yaman, 2011). For the control of the disease, an applicable control mechanism must be structured. Since parasitic life cycle mostly occurs between dogs and sheep, it is emphasized that the measures to be taken against these animals will be beneficial in controlling the disease. In this context, first of all, it is stated that various measures should be taken, such as registration of all dogs, adoption of stray dogs in shelters or collection of parasitic treatments, performing slaughtering operations under the control of veterinarians in slaughterhouses, preventing illegal and uncontrolled slaughtering, appropriate destruction of cystic organs after slaughtering, and prevention of dogs from entering slaughterhouses, parks and gardens. As a result of the experiences in various countries, it is emphasized that this kind of control program show that the control of *E. granulosus* should be continued in a long period, and this program can be successful within 15 years if enough legal and financial support is provided. For example, Argentina's control program has been reported to last for 20 years and the disease has decreased from 61% to 18% in sheep and from 40% to 2-3% in dogs (Eckert and Deplazes, 2004; Yaman, 2011). For the control of the parasite, the main method of treating dogs is by the application of anthelmintics. Regardless of whether or not infected dogs are registered and controlled, it would be beneficial to administer anthelmentics every 6 weeks if possible and at least 4 times a year if not possible. The point to be considered here is to keep the dogs in quarantine for 2-3 days following the administration of the drug and to take precautions to prevent environmental contamination and ensure that infectious agents become inactive (Eckert and Deplazes, 2004; Craig et. al., 2017). A sustainable, reliable and cost-effective method for eradication of *Echinococcus multilocularis* with the sylvatic cycle has not been reported. For the control of alveolar echinococcosis, in Germany, successful results have been achieved with feed traps, each containing 50 mg of praziquantel, which are established once a month per km² for foxes. Initially, it was found that the prevalence of *E. multilocularis* was significantly reduced in the fox population, but this was extremely difficult and expensive for long-term applications in large areas within the sylvatic cycle of *E. multilocularis* (Eckert and Deplazes, 2004; Craig et. al., 2017). The applicable mass treatment of *E. multilocularis* in dog and cat populations in endemic areas is still unclear, a conservation strategy and cost assessment for the prevention of alveolar echinococcosis in humans has not been performed; but regular praziquantel treatment is recommended for dogs and cats with access to infected rodents over a period of four weeks. Emphasis is placed on the need to develop new options for control strategies, disseminate the use of mass screening techniques for cat and dog populations against *E. multilocularis*, and provide better data flows for regular drug therapies, and develop serious control programs (Eckert and Deplazes, 2004; Torgerson and Budke, 2003).

Due to the complex transmission chain of the disease, education plays an important role in the control of transmission. It is known that echinococcosis is often endemic in underdeveloped societies where education is inadequate and literacy levels are low (Ito et al., 2003). In a study conducted in Aydın, 84% of the population did not know about the disease (Ertabaklar et al., 2012). As can be inferred from the case of Iceland, increasing the level of knowledge about echinococcosis is important in preventing the spread of the disease. Education about unhygienic / illegal slaughters and risky dog contact can both reduce the risk of contamination and lead to voluntary participation in long-term echinococcosis control programs. Since the disease threatens the whole society, training programs and educational approaches aimed at the whole society such as dog owners, livestock farmers, slaughterhouse workers, butchers, farmers, treated patients and their relatives, then school children and parents should be organized (Altıntaş, 2015).

CONCLUSION

A general approach to accurately determine the geographical distribution and prevalence of *Echinococcus* species will contribute to the understanding of biological cycles and transmission dynamics in various parts of the world. However, due to the lack of published data and the fact that some data are only available through databases, it is not possible to clearly identify the current situation of parasite prevalence in some countries or regions. Therefore, in addition to reporting its estimated global burden, which may at least provide some basic information on the magnitude of the problem, this study demonstrated the need for more accurate reporting of infected humans and animals, especially in Turkey. We hope that the identification of significant economic harm associated with echinococcosis in both the public health and livestock sectors will encourage a closer examination of the national / international impacts of cooperation between these two key elements. First, it will be crucial to ensure as much coordination as possible between veterinarians and human physicians, and to increase the awareness for echinococcosis in terms of public health, even in non-endemic areas, and to make multidisciplinary decisions for diagnosis and treatment.

For the control and eradication of echinococcosis, the primary goal should be to break the chain of infection between the final host and the intermediate host, taking into account the biological cycle of the parasite. In *Echinococcus* spp., especially the participation of wild animals in the life cycle of the parasite remains an important obstacle to controlling the spread of infection. However, significant improvements in molecular-based tests to detect *Echinococcus* species in hosts and the environment potentially make it possible to fully identify endemic species / genotypes and monitor the effectiveness of control programs. Therefore, the use of molecular-based tests in the identification of *Echinococcus* species / genotypes should be made widespread and financial support for epidemiological studies should be provided. Taking into account the successful eradication programs carried out to date, preventing the spread of infection is reliant of correctly establishing the lifecycle of parasites in wildlife, preventing transmission to humans, and establishing eradication programs by legal sanctions, and developing effective vaccines if possible.

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