Austin Journal of Veterinary Science & Animal Husbandry

Open Access

Austin Publishing Group

Review Article

Distribution of Echinococcosis in the South Caucasus and Transboundary Territories: Problems in Diagnosis, Control and Treatment

Siala I. Rustamova*
Institute of Veterinary Research, Boyuk Shor Settlement, Alley 8, Nizami Urban District, Azerbaijan Republic.

***Corresponding author:** Siala I. Rustamova, Institute of Veterinary Research, Boyuk Shor Settlement, Alley 8, Nizami Urban District, Azerbaijan Republic
Email: siala.rustamova@gmail.com

Received: February 04, 2025;
Accepted: February 25, 2025;
Published: March 03, 2025

Abstract

The presented article analyzes data on the distribution, diagnostic methods, and treatment of diseases caused by representatives of the genus *Echinococcosis* in the territory of the South Caucasus and transboundary territories. Conducted epidemiological studies demonstrate the widest prevalence of larval hydatidosis in natural and anthropomorphized ecosystems in the North and South Caucasus, Turkey, and Iran. The most common diagnostic methods for diagnosing echinococcosis are fluorography and ultrasound. However, recently, immunological and molecular biological protocols have become increasingly widespread. Echinococcosis belongs to the so-called group of "neglected diseases". Thus, it is not given due attention, and this dangerous disease is not included in the list of diseases subject to epidemiological surveillance. Long-term public health education and veterinary measures such as control of import of domestic animals from abroad, improved slaughter hygiene and meat inspection, dog registration, and sanitary measures to interrupt transmission are proposed. Also, development of the recombinant vaccines is a promising method of combating larval echinococcosis in farm animals.

Keywords: Diagnosis; *Echinococcosis*; *Echinococcus*; Prevalence; Prevention; South Caucasus; Treatment

Introduction

At the beginning of the 21st century, parasitic diseases continue to cause significant damage to humanity. This concerns not only the negative impact on the health of people and animals. Also, parasitoses lead to appreciable economic losses associated with the reduction of the gross national product and society's costs for treatment and elimination of the consequences of the massive spread of invasive diseases. Amongst parasitic diseases, zoonoses are especially distinguished. This group of infectious diseases can be transmitted naturally from vertebrate animals to humans or from humans to vertebrate animals [44]. Among many zoonotic diseases, echinococcosis is recognized as a major helminthic zoonosis. At the beginning of the XXI century, about three million human echinococcosis cases worldwide are registered [42].

Also, echinococcosis is derived from neglected diseases, a group of infectious and parasitic diseases affecting predominantly marginalized human populations in Asia, Africa, and Latin America. The World Health Organization's main list includes seventeen diseases. Seven of them are caused by parasitic worms. Echinococcosis is one of the most dangerous diseases induced by parasitic worms [41]. This zoonosis can cause great loss to agriculture with inadequate veterinary control. In addition, echinococcosis has great significance in medicine.

The hydatid worm (*Echinococcus granulosus* Batsch, 1786) is the most dangerous causative agent of cystic and alveolar echinococcosis. All tapeworms from the cyclophyllid cestodes (Platyhelminthes: Cyclophyllidea) have a unique life cycle, greatly facilitating their dissemination in the environment and infection of new perspective hosts. Six species of hydatid worms have been recognized, but only four are dangerous for humans and farm animals. Two other species were described as being from wild nature, and their zoonotic potential remains undecided [40].

Investigation of the genetic variation of 25 hydatid worm isolates from five countries proved that Central Eastern Europe is an endemic region for cystic echinococcosis [52]. In addition, echinococcosis has wide-spread distribution in the territories of Minor Asia, oriental countries, Iran, and Caucasus [3,8,27,36,45,47,52].

Despite the wide spread of echinococcosis in the territories mentioned above, problems with the correct diagnosis, prevention of this most dangerous disease, and the cure of sick animals and people aren't yet solved [4,10,30-34,45,47,54-56]. Our review is devoted to the analysis of these problems.

Citation: Siala I.Rustamova. Distribution of Echinococcosis in the South Caucasus and Transboundary Territories: Problems in Diagnosis, Control and Treatment. Austin J Vet Sci & Anim Husb. 2025; 12(1): 1162.

Brief Description of Hydatid Worm and its Life Cycle

Echinococcosis has been known in Europe for about two millenniums. The first description of cystic echinococcosis was given by Hippocrates and Galen [Eckert, 2007]. The famous Roman physician Galen (129-circa 200 BC) tied the observation of Hippocrates with hydatid cysts, the contents that spread in the abdominal cavity. Also, he found cysts in the abdominal space [23].

The scientific name of the hydatid worm is *Echinococcus granulosus* (synonyms: *Taenia Echinococcus*, *Taenia granulosa*). The translingual name of the genus derives from the Ancient Greek words ἐχῖνος, *ekhînos* — "sea urchin, prickle" and κόκκος, *coccus* — "grain, seed". The species' name is borrowed from the Latin *granulosus* — "having small grains" [57]. Thus, the scientific name of the hydatid worm demonstrates the distinguishing features of this parasite — hooks in scolex and granular cysts.

It was only in 1658 that Francesco Redi suggested the animal origin of echinococcosis [7]. Marcello Malpighi found that echinococcal cysts are living things. Only in 1801, when the mature form of the parasite was isolated, Karl Asmund Rudolphi first used the term "*Echinococcus*" (from the Greek "hedgehog berry"), calling the disease *Echinococcus granulosus*. Until the middle of the 19th century, nothing was known about the origin of the parasite. Subsequent studies demonstrated that human echinococcosis proceeds in the same way as in animals, and an intermediate host is required for the full development of the parasite [56].

The tapeworm's body has a pear-shaped head (scolex) about 0.3 mm in diameter. In addition, the strobila of adult worms has three, rarely four segments (proglottids) and ranges in length from 3 to 6 mm. The scolex is armed with a retractable rostellum with a double row of hooks and four suckers. The total number of hooks ranges from 28 to 50. The head connects to a short and narrow neck. The first segment of strobila is asexual, and the second one is hermaphroditic. The last segment is the widest and longest (2 x 0.6 mm). It has the uterus containing from 500 to 800 invasive eggs. The genital holes in the last two segments are arranged irregularly. The pore-free saccular uterus has small lateral protrusions. The fragile vitelline membrane is usually destroyed when the eggs leave the uterus. The ovoid embryophora is similar in structure to the embryophora of other cestodes [57].

The development of the *E. granulosus* occurs with a change of hosts. In the adult stage of tapeworm, it lives in the small intestine of dogs, wolves, and jackals; raccoon dogs are easily infected experimentally [41]. Also, wild dogs (*Lycaon pictus*), dingoes (*Canis lupus dingo*) spotted hyenas, and some representatives from the Felidae family (lion) would be served as definitive hosts for hydatid worm [20,30,46].

In 2.5-3 months after infection, canid hosts begin to excrete mature proglottids with eggs. The clinical signs of the disease in canines (dogs) depend on the intensity of the invasion and the stage of the disease. Until the proglottids of tapeworm begin to fall off, outward symptoms of the disease with a weak and moderate infection are usually not observed. However, with the appearance of proglottids in feces, disorders of the overall health are possible: depression, ruffled coat, mucopurulent discharge from the eyes, fatigue, progressive emaciation, diarrhea during the first five days of invasion [9].

Like the segments of the unarmed tapeworm, proglottids of hydatid worms possess active mobility and spread eggs capable of infecting intermediate parasite hosts. *E. granulosus* has a truly fantastic quantity of intermediate hosts: humans, cattle and small domesticated ruminants, pigs, horses, donkeys, domestic water buffaloes, camels, monkeys, ground squirrels, and many other omnivores and ruminants [20,46].

Eggs of hydatid worms, ingested by an intermediate host, hatch in the stomach. The hatched larvae of the hydatid worm are called metacestodes or oncospheres [20,40]. The released oncosphere enters the mucous membrane of the upper part of the small intestine and enters the liver through the portal venous system. If the oncospheres are not settled here, they are carried by the bloodstream through the right ventricle of the heart into the lungs, where they can pay and continue their development. However, it often happens that oncospheres enter the systemic circulation in the lungs and then can reach all organs. Partially migration of larvae from the intestine can also occur through the lymphatic system, followed by the flow of oncospheres through the thoracic lymphatic duct and the postcaval vein into the right atrium [40,**57**].

It is believed that in humans, the last route of migration of *Echinococcosis* is of secondary importance. In surgical statistics, liver echinococcosis in humans is observed in 49.4-75% of cases, and the lungs are damaged in 10-38.53% [9,57]. The brain (2.09%), muscles (1.25%), and spleen (0.98%) are damaged much less frequently [Benchabiles, cited in [9]]. The *Echinococcus* cysts can be found extremely rare in the orbit of the eye, uterus, thymus, ovary, in the pancreas, hyoid, and thyroid glands, in veins and arteries, intestines, and other completely unexpected and exotic places [9].

The liver echinococcosis is most common in the following intermediate hosts: in horses (94%), pigs (74%), and monkeys (48%). Less commonly, the liver is damaged in sheep (42%), cattle (27%), and squirrels (0.2%). The frequency of pulmonary echinococcosis in these animals is as follows: squirrels (98%), cattle (69%), sheep (52%), monkeys (49%), pigs (16%), and horses (5%). The kidneys are most often damaged in rabbits (60%) [57].

Although the life cycle of *Echinococcus granulosus* was studied satisfactorily, many aspects in transmission of the pathogen and its persistence in intermediate hosts are still enigmatic. Having considered those mentioned above brief literary review, we can conclude that *Echinococcus*, being successful helminth genera, can infect a wide range of definitive and intermediate hosts, causing great damage to agriculture and leading to a high mortality rate in humans, especially in countries with developed livestock breeding [9,14,18,20,40]. In addition, disadvantaged and poorly educated populations in developing countries are especially vulnerable, as are at-risk housewives, retirees, and veterinarians [53].

Geographical Peculiarities of the Caucasus, and Their Correlations with the Prevalence of Echinococcosis

The Caucasus is situated between the Black Sea and the Caspian

Sea. This large mountainous region has its distinct natural boundaries. To the north of the Caucasus stretches the vast East European Plain. The Kumo-Manych depression lies in the territory from the Caspian Sea to the Azov and the Kerch Strait and is considered the northern border of the Caucasus. The border can be conditionally drawn along this region's former state cordon of the USSR. These are the borders of independent countries: Georgia, Armenia, and Azerbaijan.

The Caucasus lies on the borders of subtropical and moderate natural zones. Its high mountains are a climate-forming factor. Its ridges reliably shelter the southern slopes from cold winds. At the same time, the northern foothills absorb the entire impact of low temperatures.

Altitudinal zonation is observed in the mountainous regions of the Caucasus. There is snow on the peaks all year round. Below, the zone of lichens and mosses is replaced by alpine meadows and coniferous and deciduous forests. The valleys are home to lush evergreen subtropical vegetation [5,13].

During 2016–2018 the study implemented by A. Jamshidi et al in northwestern Iran demonstrated that cystic echinococcosis could cause serious medical and economic problems in endemic foci. Northwestern Iran is close in climatic characteristics to the South Caucasus and is an important endemic region for the prevalence of hydatidosis. A GIS-based study conducted by Iranian scientists showed that areas with lower evaporation were the main risk areas for hydatidosis. Despite all these facts, Iranian scientists are convinced that forests with lower temperatures and more humid, elevations and slopes should be a priority for medical and veterinarian consideration for hydatidosis control programs in mountainous areas [29].

Echinococcosis in Azerbaijan

The distribution of echinococcosis in Azerbaijan was studied by Samadov AG, Petrov AM, Jafarov MK, Guliyeva RO, Ismailov GD, Elchuev MS, Ibrahimova RSh, Rzayev NM, Fataliev GG, Chobanov RJe, Mamedli GM, Gusejnzade ShN, Agayeva AN, Rustamova SI [3,4,26-28,47,48]. RM. Agayev investigated diagnosing and treating hydatid cysts in Azerbaijan [2].

Aisel N. Agayeva studied the distribution of echinococcosis in sheep on the territories of the Absheron peninsula and neighboring Khizi province. The spread of the causative agent of this disease along the high-altitude zones was studied. Investigation showed a high extensiveness of invasion in the low-mountain (45.1%) zone compared to the high-altitude zone. The author noted that the control measures of helminth pathogens in farms of the provinces mentioned above, as a rule, were not put into effect [3].

RSh. Ibrahimova and GG. Fataliev carried out a study on the prevalence of various helminth parasites in canines in the territory of Azerbaijan Republic. Basing on long-term research, the infection by dog tapeworm species (*Echinococcus granulosus*) of foxes, jackals, and stray dogs living in natural, modified, and urbanized landscapes is ascertained. Also, the authors noted that stray dogs play a key role in spreading these dangerous helminths in urban sites [26].

Subsequently RSh. Ibragimova and NM. Rzayev conducted a special study on the prevalence of helminths in various groups of dogs, depending on the keeping condition. At the same time, the most diversity of parasites in rural stray dogs (39 species) was found. In the authors' opinion, urban stray dogs pose the greatest danger. As opposed to rural stray dogs, urban stray dogs, besides household waste, feed on ejected infected offal of slaughtered animals in uncontrolled points for butchering of the domestic animals. For this reason, these stray dogs are infected by helminths, dangerous for humans and domestic ruminants, such as *Echinococcus granulosus*, *Multiceps multiceps*, and *Taenia hydatigena* [27].

The jackal (15% prevalence) and the wolf (25.7% prevalence) are the most common definitive hosts of dog tapeworms in the territory of Azerbaijan. In a fox (4.7% prevalence), *Echinococcus granulosus* was found in all ecosystems, except mountainous. Also, this parasite was recorded in semi-desert areas of the Lesser and Greater Caucasus and low-lying regions, except Absheron peninsula. Human, domestic, and wild ungulates, including camels, can be served as intermediate hosts for helminth species *Taenia solium*, *T. hydatigena*, *T. ovis*, *Multiceps multiceps*, *Echinococcus granulosus*, *Alveococcus multilocularis* [22].

In 2020, Siala Rustamova compared the indicators of the extensiveness and intensity of invasion in livestock for slaughter from four regions of Azerbaijan by hydatid tapeworm. Slaughtered cattle's carcasses and internal organs were examined for larval cyst identification. As a result of the examination of the 100 carcasses from each district, the prevalence of disease increased with cattle age recorded. Thus, the extensiveness and intensity of invasion by larval cysts in adult cattle were 2.5 times and 2.3 higher respectively than in young animals [47].

Methods of preventing the prevalence of echinococcosis through mathematical modeling were studied by Ibrahimova in 2022. The researchers considered the effect of various factors on the epidemiological situation in the Azerbaijan Republic. According to data processing results, minimizing the number of stray dogs will only slightly affect the spread of *E.granulosus* in the following years, as *Echinococcus* eggs can survive outside the intermediate host for quite a long time. The main method of controlling echinococcosis is to close illegal butcher shops, which throw away the internal organs of animals into the environment, thus supporting the life cycle of *Echinococcus*. Based on the mathematical model, such actions will contribute to the almost complete elimination of echinococcosis in the region for a couple of years [28].

Echinococcosis in the Russian Federation

In Russia, this pathology is characterized by a focal invasion of the population of the southern regions. One of these centers is the North Caucasus including the territory of Stavropol province. The dismantling of dispensary observation in the risk group (livestock breeders and members of their families) has led to an increase in the registration of pulmonary echinococcosis cases. Also, the diagnosis of this form of disease has become possible only by the appeal of patients. Therefore, complicated forms of pathology have become diagnosed frequently. The main method for diagnosing pulmonary echinococcosis at the initial treatment of patients in Russia remains radiological. To confirm this diagnosis, a serological test in combination with computed tomography, ultrasound, and MR-imaging is standard [55].

BM. Makhiev, MV. Shamkhalov and VM. Shamkhalov studied

cattle echinococcosis distribution and age dynamics in the foothill zone of Dagestan and the Chechen Republic. At the same time, cattle infection in Dagestan amounted to 20.1% in young animals and 79.8% in adults. In the Chechen Republic, infection of cattle with *Echinococcus* was 26.4% [36].

Echinococcosis in Turkey

Turkish scientists have widely used new immunological methods to detect cystic stages of echinococcosis since the early nineties [25]. Over time, these studies have expanded to include molecular biological studies [8,43,51]. As a result of these studies, several species of the hydatid worm were isolated in humans and animals, such as *E. multilocularis*, *E. granulosus*, which cause damage to both the digestive tract and the lungs [8,43].

In isolated villages surrounding Kars, the population was screened by ultrasound for the presence of echinococcal cysts in both the liver and the lungs. A total of 2001 people were screened, of whom 5 had evidence of aborted echinococcal cysts and 7 had true cysts. 2 patients of these 7 had leishmaniasis, one had cystic echinococcosis 1 (CE 1), one more had CE2, two suffered from CE3, and there was one patient with CE4. Among these patients, one had alveolar echinococcosis while all others had cystic echinococcosis. This prevalence of helminthic diseases is associated with poor public awareness of helminthic diseases, failure to observe all sanitary norms during agricultural work, and feeding dogs with slaughter waste [6].

From 2000 to 2010, 162 cases of alveolar echinococcosis were reported in Turkey, of which 83 of them occurred in Erzurum [38]. According to the literature, the reason for this prevalence is the presence of a large number of wild hosts of *E. multilocularis* such as red foxes in this area. In Erzurum, the intestines of 50 red foxes found dead next to a main road were tested for *Echinococcus* larvae. In this study, 42% of these foxes were infected with the above-mentioned helminths, and the fecal contamination of the environment with *E. multilocularis* in Erzurum reached 10.5%; this may explain the high prevalence of AE in humans in this location. Surprisingly, animals were more likely to suffer from echinococcosis in central districts (48.6%, 17/35) than in peripheral counties (26.7%, 4/15) [8].

Echinococcosis in Iran

Echinococcosis is considered endemic in Iran. Based on the study of authentic databases in the period from 1996-2009, MB. Rokni ascertained that human hydatidosis is the cause of approximately 1% of surgical wards, and the rate of human infection is 0.6-1.2/100000. Among farm animals, in addition to sheep (88% of fertilized eggs), camels (70%), and cattle (19%) play an important role in transition the to hydatidosis. During 1946-1993 *E. multilocularis*, another agent of human hydatidosis was reported in Iran. So, 37 cases of human alveolar echinococcosis were reported from northwestern Iran. As elsewhere in the world, in Iran, dogs play a crucial role in the development of echinococcosis. *E. granulosus* infection rates among stray dogs show a prevalence of 5% to 49% in various parts of the country [Rokni 2009]. These data also confirm the research conducted by scientists in Elam, Western Iran [1].

Khodashenas et al. in 2022 have conducted extensive research to analyze the genotypes of cystic echinococcosis in different regions of the country in various animals. *E. granulosus* strains such as G1 (sheep strain), G2 (Tasmanian sheep strain), G3 (buffalo strain), and *E. Canadensis* strains such as G6 (camel strain) and G7 (pig strain) were studied. A total of 125 publications were reviewed, of which only 28 presented distribution percentages of the different *Echinococcus* genotypes. The highest prevalence of *Echinococcus* and diversity of genotypes was observed in the western and north-western parts of the country, which have mountain terrain and are known as major livestock farming regions. After analyzing the data, it became clear that the most common genotype was the first (G1) and the least common was the third one (G3). The different genotypes were also examined in correlating animal susceptibility with age. The sheep genotype showed a high correlation, while the Tasmanian genotype had a lower association with age. Analyses of the studies revealed that the prevalence of genotypes depends on the region, landscape, and the distribution of certain animals in the area. The most studied genotype of *Echinococcus* in Iran is the first genotype, and the most studied animals are sheep and goats [32].

Echinococcosis in Georgia and Armenia

Data on echinococcosis published in Georgia and Armenia in the recent period are poor and insufficient. The reason for this may be the poor development of transhumance in these countries and the general economic decline, which provoked a crisis in the field of scientific research in applied parasitological studies. During the 2000-2016, Anna Khachaturian collected the materials of 1 470 patients in ten age groups in the Republic of Armenia. So, the average annual death rate from echinococcosis was comparatively low (0.007 per 10,000 population). The mortality was equal to 1.29 (per 100 patients). The highest mortality occurred in elderly people. Mortality from echinococcosis was recorded among the inoperable children. The author ascertained that the insufficient qualification of doctors in helminthology and the latent course of echinococcosis often provoked diagnostic errors [31].

A cross-sectional study on echinococcosis in surgical cases was conducted in the Aragatsotn region of Armenia in 2014. The highest rates of surgical cases were recorded in this region between 2008 and 2014 yy. According to the results, infectivity rates were 3.4%. From the surveyed population 74% used the meat of sick animals to feed their animals without thermally processing it. Dog ownership in the surveyed population was recorded in 81 % of Yezidis and 48 % of Armenians [30].

In 2017 y., studies on clinical and epidemiological features of cystic echinococcosis in children based on the treatment materials of Georgia were conducted. Thirteen 5-17-year-old children with echinococcosis were studied. In 10 of them, cysts infected the liver, two suffered from alveolar echinococcosis, and one had cysts in both the liver and lung. All patients had surgery and then had intensive treatment. Through UV, the physicians monitored the recovery of patients after surgery. During the observation period in all cases, positive dynamics of the disease were revealed, and there were no relapses. Despite the presence of macropreparation, serological tests give negative results in single cases [37].

Discussion

Examining the above-mentioned facts reveals a clear trend.

The representatives of the genus *Echinococcus* are the evolutionarily advanced parasites of a wide range of mammals. They have managed to withstand the test of time and today they successfully survive in a wide variety of biotopes within their historical range [49].

Social changes in the countries of the former USSR have led to certain difficulties in the timely diagnosis and treatment of echinococcosis. During the Soviet period, clinical examination of persons at risk of infection with echinococcosis (livestock breeders and their family members) was applied. At the same time, regular fluorographic studies of the lungs and ultrasound screening of the abdominal organs were carried out. This practice made it possible to identify echinococcosis in the early stages of the disease. Patients with severe clinical manifestations of echinococcosis, with large cysts in the liver, complications of pulmonary echinococcosis began to apply to medical institutions in the last years of the Soviet period. Diagnostic delay and late access to medical care negatively affect treatment quality, duration, and treatment results [11].

In all countries, echinococcosis is spread to areas with extensive livestock farming. Canines play a significant role in the emergency of echinococcosis in the countries of the South Caucasus and in adjacent territories: both wild (foxes, jackals, wolves), and synanthropic and domestic (stray and domestic dogs) [12].

Since the USSR collapse, new sensitive and reliable diagnostic methods against echinococcosis have been developed worldwide. Unfortunately, most of them have applied in restricted way due to systemic science and technology crisis in the New Independent States [48].

Despite the progress in the surgery of echinococcosis over the past decades, the treatment of this dangerous disease continues to be a difficult problem. During the period of observations in the territory of the Russian Federation high level of cases of postoperative complications (6.7–47.5%), a significant relapse rate of the disease (3.3–54%), and a considerable mortality rate (up to 4.5–10.2%) are confirmed [55].

The most common method of surgical intervention remains echinococcectomy. Also, minimally invasive technologies are becoming increasingly widespread in treating patients with liver echinococcosis. Even 10 years ago, such technologies in the treatment of patients with liver echinococcosis were met with clear disapproval and outright opposition from surgeons. However, a clear trend has been towards a more favorable perception of these methods in recent years. Although this has to some extent done a disservice to the methods themselves, the number of intraoperative complications has increased. Thus, severe complications after percutaneous echinococcectomy occur in 3% - 25% of cases [50].

Problems with the Diagnosis of Echinococcosis in the Studied Area

All types of echinococcosis are considered neglected tropical diseases [39]. Despite this, the problem of its spreading in Azerbaijan is quite serious. The conditions of the Republic of Azerbaijan are ideal for the spreading of echinococcosis for several reasons. The agriculture is based on livestock farming and the local population actively breeds small cattle and livestock. However, synanthropic animals (stray dogs and cats) are not dewormed. This factor potentially contributes to the emergence of echinococcosis in humans [48].

Unfortunately, echinococcosis is usually diagnosed only at late stages. Identification is quite difficult due to the disease's asymptomatic incubation period. In addition, most medical personnel are not aware of the diagnosis of this disease, which leads to errors and loss of time [17].

The main method for diagnosing echinococcosis worldwide is ultrasound investigation. Modern ultrasound devices can detect echinococcal cysts at early stages of development. CT and MRI are usually used to detect alveococcosis [58]. Serological methods, in combination with other methods, are popular in veterinary medicine in some regions of Russia.

There are no commercial kits for detecting echinococcosis in canines, and hydatidosis in small cattle and livestock in Azerbaijan. Also, these kits are not imported regularly. Rustamova et al. conducted research on the production of domestic kits against larval echinococcosis in cattle. For this purpose, enzyme-linked immunosorbent assay (ELISA) test was used. The blood serum samples were taken as a positive result from the cattle before slaughter, in which cysts were found in the liver after slaughter. The samples from the healthy cows from closed-type farms were used as a negative control. In the ELISA-test the levels of antibodies to *Echinococcus* were defined. The efficacy of the ELISA test was determined by comparing its results with the autopsy results after cattle slaughtering. According to the ELISA-test analysis, 42 out of 80 heads of cattle were infected with *Echinococcus*. The autopsy confirmed only 32 animals suffering from echinococcosis. From this, it follows that the accuracy of this method makes 68%. False positive results are explained by the presence of other helminthic diseases in the animals studied and, consequently, due to cross-reactivity of the serum samples used as the primary antibodies. These results showed insufficient specificity of the developed method. The ways of its improvement conclude in obtaining the antigens strictly specific to *E. granulosus* [48].

The following problems are currently of concern in Azerbaijan. The service for catching stray dogs (the definitive hosts and main carriers of echinococcosis in the environment) does not examine the feces of caught dogs or their biological fluids for the presence of antibodies to these parasites. This fact contributes to the spread of echinococcosis and many other helminthic diseases.

The lack of regular monitoring for the presence of hydatid worms in wild canids, especially in anthropomorphized ecosystems, is of particular concern. At the same time, literary data indicate that wild canids can be carriers of echinococcosis. The spread of other species from the genus *Echinococcus*, in addition to *E. granulosus*, is poorly studied. The spread of echinococcosis in other mammals, additional hosts for dog tapeworm, has also not been studied. All these problems are not specific to Azerbaijan alone, but are inherent in epidemiological surveillance in many countries worldwide [16].

The dog is the definitive host of *E. granulosus*, but wild canids can also participate in the parasite's life cycle in some regions of the South Caucasus. In recent years, the role of wild canids has increased rapidly in places where their shooting is prohibited. As a result, the abundance of jackals and foxes has improved significantly in rural

areas. This fact requires veterinary and sanitary services to organize special measures to prevent infection of synanthropic main hosts with *E. granulosus*. Having a tiny size, the parasite penetrates deep into the villi of the host's small intestine, and most often does not cause any pathogenic effects even in animals with a severe infection [19]. Thus, the final hosts of the parasite are often asymptomatic carriers of the parasite. Small proglottids, parasite eggs, cannot be detected without brightfield microscopy. All these circumstances complicate the diagnosis of echinococcosis in the main host. Differential diagnosis of echinococcosis by eggs found in feces is also difficult.

ELISA test for *E. granulosus* coproantigen demonstrates high diagnostic value, combining sufficient sensitivity and specificity. This makes it an ideal screening method for both individual examinations of dogs and mass studies of populations. The high throughput of the method (about 200 samples per day) makes ELISA test a cost-effective and effective tool in the fight against echinococcosis [15]. It is important to note that the sensitivity of ELISA may vary depending on the stage of infection, the age and immune status of the animal, as well as the quality of the reagents used.

False-negative results may occur in the early stages of invasion when the number of excreted helminth eggs is not yet high enough to be detected by the test. Therefore, other diagnostic data must be considered when interpreting ELISA results. Polymerase chain reaction (PCR) is used as a confirmatory method, especially when ELISA results are equivocal. PCR, with significantly higher sensitivity and specificity, allows the detection of even minimal amounts of parasite DNA in a stool sample. However, PCR is more labor-intensive and expensive than ELISA, requiring specialized equipment and highly qualified personnel. In addition, the effectiveness of PCR depends on the quality of DNA extraction from the sample, which may be difficult in the presence of amplification inhibitors in the feces. Specific circumstances, available resources, and the required diagnostic accuracy determine the choice between ELISA and PCR. In some cases, it may be appropriate to use a combined approach, starting with ELISA as a screening test and confirming positive results with PCR. Postmortem examination of definitive hosts (dogs) to detect *E. granulosus* requires more invasive methods [19]. It includes an autopsy, and a thorough examination of the small intestine to confirm the diagnosis. Although less sensitive than ELISA or PCR, microscopic examination of eggs excreted from feces can also be used. It is important to note that for the correct interpretation of the postmortem examination results, it is necessary to consider the dog's age, the history of the disease, and the epidemiological situation in the region. Other species from the genus *Echinococcus*, such as *Echinococcus multilocularis*, *E. vogeli*, and *E. oligarthru*, cause serious diseases in humans and animals that require specific diagnostic methods. The development of new diagnostic tools, including molecular techniques, aims to improve the sensitivity and specificity of echinococcosis diagnostics and will allow timely detection of the disease, preventing its spread and deworming of infected dogs. Moreover, diagnostic measures for synanthropic canines will promote the fight against the parasite.

Invasions caused by *E. granulosus* in intermediate hosts, particularly in farm animals, are usually asymptomatic. However, economic losses can be significant. There are no reliable methods for routine diagnostics of intravital invasion in animals. Rustamova SI, Sizov AA. (2023) [48] developed a diagnosis of echinococcosis in farm animals using the ELISA test. The authors demonstrated in their studies the high efficiency of this diagnostic method, which will allow timely detection of sick animals in herds and their timely culling or, if these are precious animals, carrying out therapeutic measures. The method provides for conducting mass studies on echinococcosis, timing them to other studies on infectious diseases, where blood samples are taken from animals for analysis.

In conclusion, controlling echinococcosis in animals and humans involves long-term public health education and veterinary measures such as improved slaughter hygiene and meat inspection, dog registration, and sanitary measures to interrupt transmission of the disease. Specific control measures include capturing stray dogs, registering all pet dogs, spaying female dogs, and treating all dogs with effective anticestodal anthelmintic every 2 months.

These measures are supplemented by improved meat quality control, slaughter hygiene, offal disposal, public education, and other measures. An up-and-coming method for controlling larval echinococcosis in the farm animals is the elaboration of vaccines. Heath DD, O. Jensen, and MW. Lightowlers (2003), Lightowlers MW. (2002) report on the successful use of a recombinant vaccine against *E. granulosus* metacercariae in sheep and cattle [24,35]. There is currently no information on using such vaccines in the South Caucasus. To date, there is also no information on the spreading of other species of *Echinococcus* of epidemiological significance, such as *E. vogeli* and *E. oligarthru*. It can be assumed that owing to the development of the exchange of wild animals between zoos, the obtaining by the population of the countries of the South Caucasus of domestic animals from different parts of the world, the possibility of introducing the pathogens mentioned above may occur or has already occurred.

References

1. Abdi J, Taherikalani M, Asadolahi K, Emaneini M. Echinococcosis/Hydatidosis in Ilam Province. Western Iran. Iranian Journal of Parasitology. 2013; 8: 417-422.
2. Aghayev RM. Echinococcus complicated with lesions of bile ducts in Azerbaijan. Eurasian Journal of Hepatic Gastroenterology. 2016; 6: 125-130.
3. Agayeva AN. Distribution of circulator echinococcosis (*Echinococcus granulosus*) of sheep in the territories of the Absheron peninsula and Khyzynsky district of the Azerbaijan Republic. Agrarian science. 2020; 1: 43-45.
4. Agayeva AN. Comparative Analysis of the Distribution of Helminths in Sheep in Different Ecological Zones. Proceeding of the Conference "Ways to restore Biodiversity in the Liberated Territories". 2022; 14-15: 66-69.
5. Ali MA, Akparov AI, Tagiyev R, Gaffarova S, Ibragimov A, Gricks T, et al. Country Study on Biodiversity of the Republic of Azerbaijan — First National Report to the Convention on Biological Diversity. 2004; Baku, 136.
6. Altintas N, Macpherson CNL, Gıcık Y, Yolasigmaz A, Kara M, Arslan MO. Investigation of echinococcosis in villages of Kars, eastern part of Turkey // Xth International Congress of Parasitology. 2006: 6-11.
7. Amici RR. The history of Italian parasitology. *Veterinary parasitology.* 2001; 98: 3-30.
8. Avcioglu H, Guven E, Balkaya I, Kirman R, Akyuz M, Bia MM, et al. Echinococcus multilocularis in Red Foxes in Turkey: increasing risk in urban. Acta Tropica. 2021; 216: 105826.

9. Bessonov AS. Cystic echinococcosis and hydatidosis. All-Russian Scientific Research Institute for Fundamental and Applied Parasitology of Animals and Plant. 2007; 672.

10. Canda SM, Gulayı M, Canda T, Astarchioglu H. The Pathology of echinococcosis and the current echinococcosis problem in Western Turkey (A Report of Pathologic Features in 80 Cases). Turkish Journal of Medical Sciences. 2003; 33: 369-374.

11. Chobanov RE, Mamedli GM, Guseinzade ShN. Effect of migration processes on urban population helminthofauna and character of helminthoses mobility//"Biodiversity and Ecology of Parasites of Terrestrial and Water Cenoses", The Proceedings of International Symposium dedicated to the 130-th Anniversary of acad. KI. Skrjabin. 2008: 424-427.

12. Craig PS, Hegglin D, Lightowlers MW, Torgerson PR, Wang Q. Chapter Two — Echinococcosis: Control and Prevention. Advances in Parasitology. 2017; 96: 55-158.

13. Caucasus: Region and mountains, Eurasia. Encyclopaedia Britannica. 2024.

14. Dakkak A. Echinococcosis/Hydatidosis: A Serve Threat in Mediterranean Countries. Veterinary Parasitology. 2016; 174: 2-11.

15. Deplazes P., Dinkel A., Mathis A. Molecular tools for studies on the transmission biology of *Echinococcus multilocularis*. Parasitology. 2003; 127: 53-61.

16. Deplazes P, Rinaldi L, Rojas CA, Torgerson PR, Harandi MF, Romig T, et al. Global distribution of alveolar and cystic echinococcosis. Advances in parasitology. 2017; 95: 315-493.

17. Domashenko ON, Shatalov AD, Paniyeva DS. Liver echinococcosis: diagnostics, treatment tactics. News of higher educational institutions. Volga region. Medical sciences. 2016; 3: 35-40.

18. Dorjsuren T, Ganzorig S, Dagvasumberel M, Tsend-Ayush A, Ganbold Ch, Ganbat M, et al. Prevalence and risk factors associated with human cystic echinococcosis in rural areas, Mongolia. PLoS One. 2020; 15: e0235399.

19. Eckert J, Deplazes P, Craig PS, Gemmell MA, Gottstein B, Heath D, et al. Echinococcosis in animals: clinical aspects, diagnosis, and treatment. 2001; 72-99.

20. Eckert J, Deplazes P. Biological, Epidemiological, and Clinical Aspects of Echinococcosis, a Zoonosis of Increasing Concern. Clinical Microbiology Reviews. 2004; 17: 107-135.

21. Eckert J. Historische Aspekte der Echinococcose – einer uralten, aber noch immer relevanten Zoonose. Schweizer Archiv für Tierheilkunde. 2017; 149: 5-14.

22. Fataliev GG. Helminthofauna of wild canids in Azerbaijan and ways of its formation. Parazitologia. 2011; 45: 129-139.

23. Grove DI. A history of human helminthology. Wallingford, Oxon, C.A.B. International. 1990: 848.

24. Heath DD, O Jensen, Lightowlers MW. Progress in control of hydatidosis using vaccination — a review of formulation and delivery of the vaccine and recommendations for practical use in control programs. Acta tropica. 2003; 85: 133-143.

25. Hazrati K, Uner A, Ali OM. Application of the new methods in diagnosis of cystic Echinococcosis. Parasitology International. 1998; 47: 133-281.

26. Ibrahimova RSh, Fataliyev GH. Current State of Helminthofauna of Canids (Canidae) in Azerbaijan. Bulletin of the ANAS (biology and medicine sciences). 2015; 70: 35-38.

27. Ibrahimova RSh, Rzayev NM. Comparative analysis of helminthofauna of various dog groups in Azerbaijan. 2017, Bulletin of Zaporizhzhya National University. Biological sciences. 2017; 2: 20-26.

28. Ibrahimova RSh, Mammadov AA. Prevalence of *Echinococcus granulosus* in Azerbaijan and Study of its Prevention by The Mathematical Modelling Method. Egyptian Journal of Veterinary Sciences. 2022; 53: 157-162.

29. Jamshidi A, Haniloo A, Fazaeli A, Ghatee MA. Effects of geographical and climatic factors on cystic echinococcosis in south-western Iran. Journal of Helminthology. 2020; 94: e175.

30. Khachatryan R. Risk factors of alveolar and cystic echinococcosis in patients from medical institutions of Yerevan, Republic of Armenia. American University of Armenia, Yerevan, Armenia. 2015; 66.

31. Khachatryan AS. Analysis of Lethality in Echinococcal Disease Korean Journal of Parasitology. 2017; 55: 549-553.

32. Khodashenas S, Akbari M, Beiranvand R, Didehdar M, Shabani M, Iravani P, Abedi B. Prevalence of cystic echinococcosis genotypes in Iranian animals: A Systematic Review and Meta-Analysis. Journal of Parasitology Research. 2022; 1: 8197741.

33. Kilich S, Al, Jelebi FDB, Babur J. The investigation of the seroprevalence of cystic echinococcosis in veterinary surgeons. Turkiye parazitolojii dergisi. 2007; 31: 109-111.

34. Kilinch O, Doskaya M, Sakar A, Yorganjioglu A, Halilcholar H, Caner A, et al. Three atypical pulmonary hydatidosis lesions mimicking bronchial cancer from Turkey. New Microbiology. 2009; 32: 229-233.

35. Lightowlers MW. Vaccines for control of cysticercosis and hydatidosis: foundations in taeniid cestode immunology. 2002; 55: S39-43.

36. Makhieva BM, Shamkhalov MB, Shamkhalov BM, Magomedshapiev GM, Maksudova AS. Distribution and age dynamics of echinococcosis and cysticercosis of cattle in the foothills of Dagestan and Chechnya. Russian Parasitological Journal. 2012; 3: 56-61.

37. Melia K, Kokaia N, Manjgaladze M, Kelbakiani-Kvinikhidze T & Sulaberidze G. Clinical and epidemiological peculiarities of cystic echinococcosis in children. Georgian Medical News. 2017; 265: 79-83.

38. Miman Ö, Yazar S. Alveolar Echinococcosis in Turkey: in the light of the Literature. Turkish Journal of Parasitology. 2012; 36: 116-120.

39. Mitra AK, Mawson AR. Neglected Tropical Diseases: Epidemiology and Global Burden. Tropical Medicine and Infectious Disease. 2017; 2: 36.

40. Moro P, Schantz PM. Echinococcosis: a review. International Journal of Infectious Diseases. 2009; 13: 125-133.

41. Otero-Abad B, Torgerson PR. A systematic review of the epidemiology of echinococcosis in domestic and wild animals. PLoS neglected tropical diseases. 2013; 7: e2249.

42. Pal M, Dutta PMJB. Echinococcosis — an emerging and re-emerging cyclozoonosis of global importance. International Journal of Livestock Research. 2013; 3: 5-13.

43. Pektash B, Altintash N, Akpolat N, Gottstein B. Evaluation of the diagnostic value of the ELISA tests developed by using EgHF, Em2, and EmII/3-10 antigens in the serological diagnosis of alveolar echinococcosis. Mikrobiyoloji bulteni. 2014; 48: 461-468.

44. Rahman MT, Sobur MA, Islam MS, Ievy S, Hossain MJ, El Zowalaty ME, et al. Zoonotic diseases: etiology, impact, and control. Microorganisms. 2020; 8: 1405.

45. Rokni MB. Echinococcosis/hydatidosis in Iran. Iranian Journal of Parasitology. 2009; 4: 1-16.

46. Romig T, Deplazes P, Jenkins D, Giraudoux P, Massolo A, Greig PS, et al. Ecology and Life Cycle Patterns of Echinococcus species. Advances in Parasitology. 2017; 95: 213-314.

47. Rustamova SI. Monitoring of cattle echinococcosis on the results of post slaughter expertise of carcasses. Scientific Bulletin of the Lviv National University of Veterinary Medicine and Biotechnology named after S.Z. Gzhytsky. Biological sciences series: Veterinary sciences. 2020; 22: 116-122.

48. Rustamova SI, Sizov AA. Efficiency of sandwich enzyme immunoassay for the diagnosis of larval Echinococcus infection in cattle in the Republic of Azerbaijan. Russian Parasitological Journal. 2023; 3: 378-385.

49. Siracusano A, Delunardo F, Teggi A, Ortona E. Host-parasite relationship in cystic echinococcosis: an evolving story. Journal of Immunology Research. 2012; 1: 639362.

50. Sharipov RKh. Percutaneous transhepatic echinococcectomy: dangers, complications and ways of their prevention. Moscow, Dissertation for the degree of candidate of medical sciences. 2019; 84: 482-491.

51. Shabel V, Altintas N, D'Amelio S, Nakao M, Romig T, Yolasigmaz A, et al. Cystic echinococcosis in Turkey: genetic variability and first record of the pig strain (G7) in the country. Parasitology Research. 2009; 105: 145-154.

52. Shnabel V, Kuzmina T, Cavallero S, D´Amelio S, Georgescu SO, Szenasi Z, et al. A molecular survey of Echinococcus granulosus sensu lato in central-eastern Europe. Open Life Sciences. 2016; 11: 524-532.

53. Tamarozzi F, Akhan O, Cretu CM, Vutova K, Fabiani M, Orsten S, et al. Epidemiological factors associated with human cystic echinococcosis: a semi-structured questionnaire from a large population-based ultrasound cross-sectional study in eastern Europe and Turkey. Parasites Vectors. 2019; 12: 371.

54. Udovikova OI, Ivanishkina EV, Khibin LS, Podcheko PI, Stepanova NS, Kmetik EG. Echinococcosis in the practice of a doctor. Zemsky Doctor. 2015; 2: 51-54.

55. Vafin AZ, Popov AV, Aidemirov AN, Shushanov PA, Malanka MI, Daidkov AV, et al. The modern tendencies in diagnostics and treatment of lung echinococcosis. Medical Bulletin of North Caucasus. 2008; 1: 26-29.

56. Vetshev PS, Musayev GKh, Bruslik SV. Echinococcosis: the current state of problem. Ukrainian Journal of Surgery. 2013; 3: 196-201.

57. Voronkova OB, Ilyinskikh NN, Semenov AG, Sevostyanova NB, Starikova EG, Koroleva NA, et al. Medical parasitology. Tomsk, SubGMU publishing house. 2019; 177.

58. Wen H, Vuitton L, Tuxun T, Li J, Vuitton DA, Zhang W, McManus DP. Echinococcosis: Advances in the 21st Century. Clin Microbiol Rev. 2019; 32: 10.1128/cmr.00075-18.