

Incidence of alveolar echinococcosis in humans and animals in Kostanay region of the Republic of Kazakhstan

M.Zh. Aubakirov^{1*}, A.M. Abdybekova², M.K. Mustafin¹, B.K. Mustafin¹, A.M. Yergazina¹, G.K. Murzakayeva³, V.N. Domatsky⁴, A.B. Mendybayeva¹, L.V. Nalobina⁵

¹ NJSC A. Baitursynov Kostanay Regional University. Kostanay, Kazakhstan

² LLP "Kazakh Research Veterinary Institute". Almaty, Kazakhstan

³ Department of Veterinary Sanitation of the Ministry of Agriculture of the Republic of Kazakhstan, S. Seifullin Kazakh Agrotechnical University. Nur-Sultan, Kazakhstan

⁴ Northern Trans-Ural State Agricultural University, All-Russian Research Institute of Veterinary Entomology and Arachnology – branch of Tyumen Scientific Centre SB RAS, Russia.

⁵ Department of Epidemiological Surveillance of Especially Dangerous Infections of the Department of Consumer Protection of Kostanay region, Ministry of Health of RK "Scientific-Practical Centre of Sanitary-Epidemiological Examination and Monitoring". Kostanay, Kazakhstan

*Corresponding author E-mail: aubakirov_m66@mail.ru

Received: 07.11.2020. Accepted 10.12.2020

Our research aims to study the spread of alveococcosis in humans and animals in the Kostanay region of the Republic of Kazakhstan. Studies on the diagnosis of alveococcosis in humans were conducted in the branch of the Ministry of Health of the Republic of Kazakhstan, "Scientific-Practical Center of Sanitary-Epidemiological Examination and Monitoring," Kostanay, in 2010-2019. A pathoanatomic autopsy was performed on captured mouse-like rodents in the Kostanay region territory, where human alveococcosis cases were registered. The incidence among the population of various age groups in the region was analyzed based on the results of blood samples by enzyme immunoassay (ELISA) and liver ultrasound. It is established that alveococcosis is a common disease among people living in the Kostanay region and the Republic of Kazakhstan in general. The main definitive hosts in the development cycle of the pathogen infestation on the Republic of Kazakhstan's territory are foxes and dogs, intermediate hosts – 18 species of rodents. For humans, alveococcosis is one of the most dangerous helminthic diseases, since in most cases, it leads to death. Alveococcosis can be attributed to particularly dangerous infestations since the foci of infestation are formed not only in anthropogenic zones where the pathogen can devastate but also in natural biocenoses, where the primary sources of the pathogen's spread in the external environment are foxes (*Vulpes*) and corsac foxes (*Vulpes corsac*). The maximum number of alveococcosis cases in 2018-2020 was registered in intermediate hosts – mouse-like rodents, like common vole *Microtus arvalis*, the extent of *A. multilocularis* invasion was 3.1-3.5%. Based on the comparative analysis of the epizootic and epidemiological situation of alveococcosis in the Kostanay region territory, it should be noted that the risk of infection of the population with alveococcosis persists in all areas of the region.

Keywords: alveococcosis, rodents, morbidity indicators, human, invasion, carnivores

Introduction

Alveococcosis, or multilocular hydatid cyst (*E. multilocularis*), is an invasive disease of carnivores, mouse-like rodents, and humans. Alveococcosis is caused by the helminth *A. multilocularis* and is characterized by infiltrative growth of parasitic tissue, metastasis, late diagnosis, and high mortality (Shabdarbayeva, 2012). The sexually mature form of *A. multilocularis* is 1.6-4 mm long and consists of a scolex on the anterior end equipped with four suckers and a crown of hooks and 3-5 proglottids (Shabdarbayeva, 2012).

The economic damage caused by infestation is enormous. The development cycle of alveococcus is associated with a change of hosts. The definitive hosts of this disease are carnivorous animals (dogs, cats, foxes, and others) (Polyakov, 2008). In the intermediate host (field vole, ground squirrel, hamster – mouse-like rodents), the helminth's larval stage develops. Human infection with alveococcus oncospheres occurs through contact with infected dogs, skinning wild carnivores, and consumption of berries contaminated with the feces (Torgerson, 2003; Abdybekova, 2015).

The epidemiological significance of alveococcosis as socially dangerous helminthiasis is a critical health problem in the world. The incidence of alveococcosis in Russia is high. Thus, over six years (2007-2012), more than 200 cases of alveococcosis were

registered in 30 regions of the Russian Federation. At the same time, seven cases of alveococcosis were registered in children under 17 years of age. Rural residents accounted for 66% (148 cases) of diseases. The proportion of women was 57% (129 cases). Alveococcus infection in intermediate hosts (small mammals) was found in 2.2%, and in final hosts (foxes) – 30.6-53.6%. Since 1993, there has been a progressive increase in the number of foxes (2.6 times) – the primary final host of alveococcosis's causative agent – *A. multilocularis* (Seisembayev, 2012).

The increase in the number of small rodents, the population of foxes, their appearance in the city, and the inclusion of stray and domestic dogs in the transmission cycle of infestations creates prerequisites for the formation of new stable foci in nature but also mixed foci of infestation. In the United States and Northern Canada, foci are confined to Arctic foxes, Austria, Switzerland, and Southern Germany – to the red fox and other fox species in Japan. In recent years, widespread infestations, both among humans and dogs, have been noted in Kyrgyzstan (Gagarin, 1957; Aitbayev, 2008).

In Kazakhstan, alveolar echinococcosis was registered in 18 rodent species out of 37 studied. Common voles (*Microtus arvalis*) and great gerbils (*Rhombomys opimus*) actively participate in the formation of invasion foci (Polyakov, 2008).

In humans, alveolar echinococcosis is registered in Kazakhstan much less frequently than single-chamber echinococcosis. According to Schweiger (2007) and Bruzinskaite (2007), 102 patients with alveococcosis of the liver and its various complications were observed in the Department of Liver Surgery of A.N. Syzganov National Research Center of Surgery for 15 years (from 1996 to 2010). From them, 9 (8.8%) patients were admitted after previously ineffective (exploratory) operations, 38 females (37.3%), 64 males (62.7%), among them of 19-69 years, young and productive age – 76.5%.

Dogs, cats, foxes, and other carnivores are definitive hosts, carriers, and distributors of sexually mature forms. Intermediate hosts (small mammals) are mouse-like rodents (field mouse, muskrat, and others) and humans. Carnivores' infection with the ribbon-like form of alveococcosis occurs when eating the affected organs of rodents, most often field mice.

There is a lack of modern knowledge about the spread of *A. multilocularis* in wild animals in Kazakhstan and especially in the Kostanay region, where the rural population has long been engaged in hunting and has close contact with their pets (guard dogs, hunting dogs, and domestic cats). In this regard, we conducted a pathoanatomic autopsy of captured rodents, studied their infection with alveococcosis and the spread of alveococcosis in humans and animals.

Materials and Methods

The incidence of alveococcosis among the population in the regions of the Republic of Kazakhstan was analyzed according to the data of operational monitoring carried out in LLP "Kazakh Scientific Research Veterinary Institute" in 2016-2020. According to the Agency for Strategic planning and reforms of the Republic of Kazakhstan Bureau of National statistics, Kazakhstan's population is 18,800,000 people, as of October 1, 2020 (Fig.1).

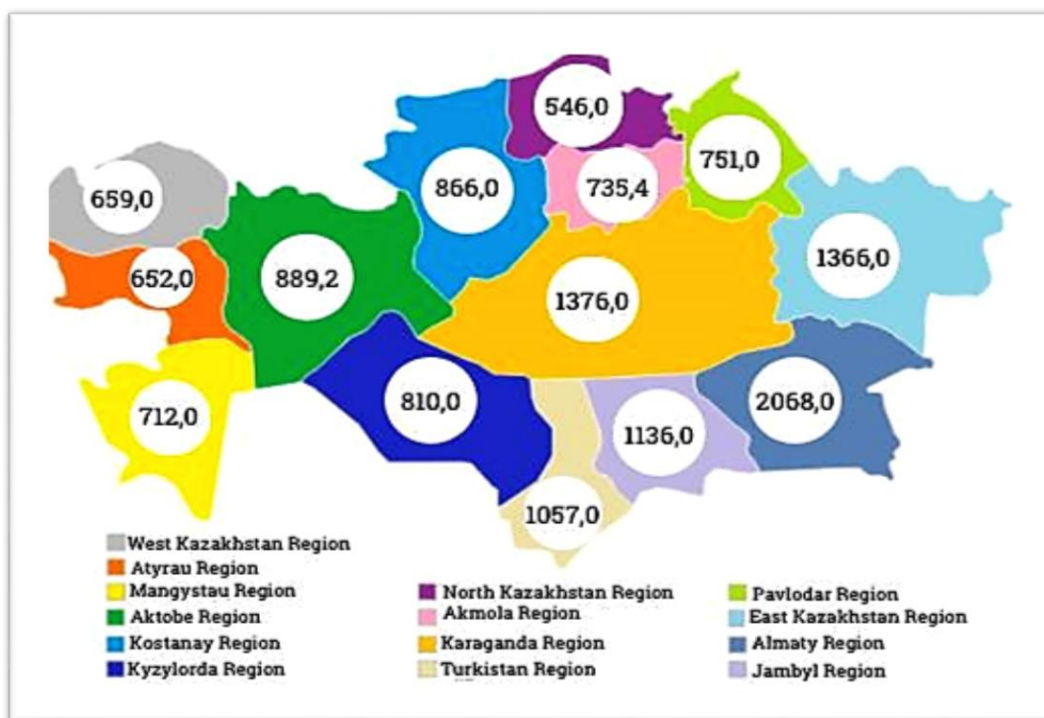


Fig. 1. Map of the population by regions of Kazakhstan (October 1, 2020)

The most effective in diagnosing alveococcosis was the enzyme immunoassay, which was used to determine antibodies (class G immunoglobulins) to helminth antigens (Hahorski, 2013; Afonso, 2015).

These reactions are based on the interaction of parasite antigens and specific host antibodies and confirm the presence of alveococcus invasion in humans. In order to establish the degree of invasion of alveococcosis among intermediate hosts (by complete helminthological autopsy according to K.I. Skryabin), a pathoanatomic autopsy was performed on various mouse-like rodents captured on the territory of Altynsarin, Amangeldy, Denisovka, Zhitikara, Kamysty, and Karasu districts of Kostanay region, where cases of human disease were registered in 2018-2020

Results and Discussion

We revealed that alveolar echinococcosis is a common disease among people of the Republic of Kazakhstan, including those living in the Kostanay region. According to the operational monitoring carried out in LLP "Kazakh Scientific Research Veterinary Institute," 20 cases of alveococcosis were registered in eight regions of the Republic of Kazakhstan from 2016 to 2019. Thus, in 2016 there were four cases in Almaty, East Kazakhstan, Karaganda, Kostanay regions, in 2017 – 5 cases (in Almaty, West Kazakhstan, Pavlodar regions – one case in each, in North Kazakhstan region – 2 cases). In 2018, two people were operated on with a diagnosis of alveococcosis in the Akmola region, three in the Almaty region, one in the Kostanay, one in Pavlodar one in North Kazakhstan regions. In 2019, a resident of the Almaty region and two North Kazakhstan residents were operated. In 2020, alveococcosis in humans had not been registered. The maximum number of positive reactions to alveococcosis was recorded in 2018 (Fig. 2).

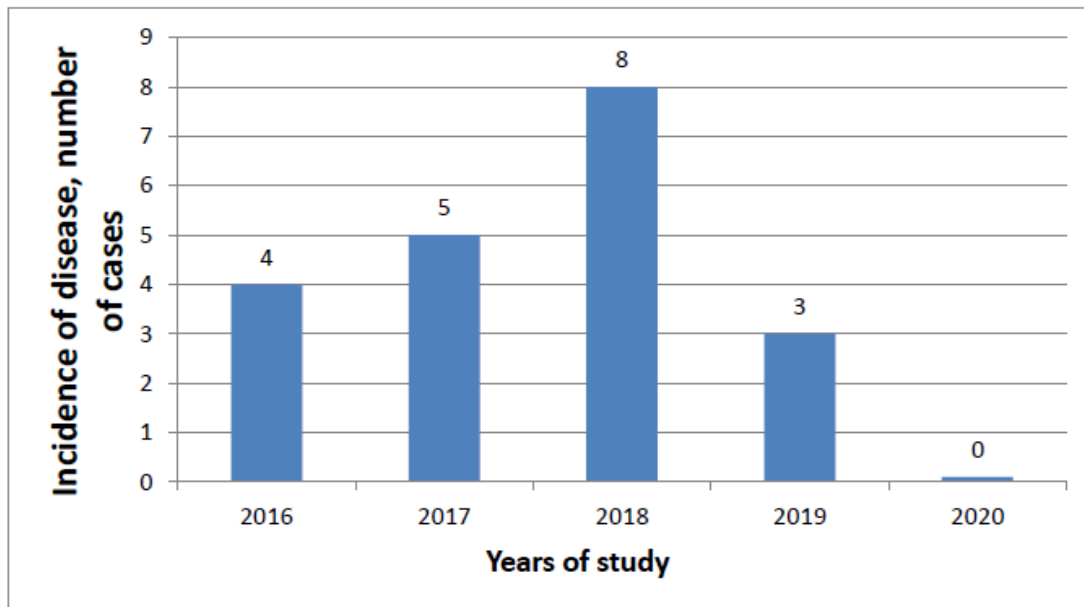


Fig. 2. Dynamics of human alveococcosis incidence in Kazakhstan

We established that alveococcosis infestation was not widespread in Kazakhstan. According to statistics, 122 patients with alveococcosis were operated on from 1996 to 2019. In 2020, no infestations were registered among the population of the Republic. In parallel with the data on immunological methods for diagnosing alveococcosis in Kazakhstan's population, in 2018-2020, the studies have been conducted for the presence of sexually mature forms of alveococcus in different regions of the Republic, including the Kostanay region. In 2019, in the Altynsarin and Amangeldy districts of the Kostanay region, among various rodent species (58 samples from 20 captured rodents with analyzed liver, spleen, and lungs), three individuals had nematode *Macracanthorhynchus* spp. The lesions of parenchymal organs with helminths in two individuals were discovered in the lungs and one individual – in the liver, whereas the larvae of alveococcus were not revealed (method of K.I. Skryabin complete helminthological dissections).

In September 2020, in Karasu district of Kostanay region, from 60 samples of 20 captured mouse rodents, *A. multilocularis* was found in 3 individuals (in two individuals – in the liver and one individual – in the lungs) when conducting a study on sexually mature forms of alveococcus. In total, 181 individuals (small mammals) of mouse-like rodents were captured and subjected to pathoanatomic autopsy in the Kostanay region, including 12 ground squirrels (*Spermophilus pygmaeus*), 15 large gerbils (*Rhombomys opimus*), 16 narrow-crusted voles (*Microtus gregalis*), 18 steppe pied pipits (*Lagurus lagurus*), and 120 common voles (*Microtus arvalis*).

The biomaterial was annually delivered to the laboratory of LLP "Kazakh Research Veterinary Institute" (20 samples of mouse-like rodents' parenchymal organs) to confirm the presence of helminthiasis. The alveococcus larvae were not identified among the other rodents, such as muskrat (*Ondatra zibethicus*), common vole, grey marmot (*Marmota baibacina*), and great jerboa (*Allactaga major*).

Conclusions

The epidemiological significance of alveococcosis as socially dangerous helminthiasis is a critical health problem in the world. We established that alveococcosis is an infestation that is not widespread in Kazakhstan. According to official statistics, 135 patients were registered with alveococcosis from 1996 to 2019; 122 or 90 % were operated on (based on ultrasound scanning and ELISA of patients' blood). In 2020, no infestations were registered among the population of the Republic. According to the monitoring data, a high degree of invasion extensiveness was established in wild animals. During the research, the main definitive hosts (foxes and dogs) and intermediate hosts (18 rodent species and humans) were identified. Thus, the authors concluded that the risk of infection of Kazakhstan population with alveococcosis persists everywhere.

We revealed that the main intermediate hosts in the development cycle of alveococcus in Kostanay region were mouse-like rodents – Northern red-backed vole (*Clethrionomys rutilus*), muskrat (*Ondatra zibethicus*), Ural field mouse (*Apodemus uralensis*), and great gerbil (*Rhombomys opimus*). The gray marmot, gray hamster (*Cricetulus migratorius*), and small five-toed jerboa (*Allactaga elater*) could also be the carriers and seeders of the alveococcosis larvae in this territory.

Acknowledgments

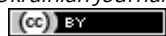
The article was prepared within the budget program framework "Ensuring veterinary and sanitary safety and epizootic well-being for echinococcosis and alveococcosis in Kostanay region" and the concluded agreement between A. Baitursynov KSU and LLP "Kazakh Scientific Research Veterinary Institute" No. 04/8-10-11 dated 28.02.2018.

References

- Abdybekova, A., Sultanov, A., Karatayev, B., Zhumabayeva, A., Shapiyeva, Z., Yeshmuratov, T., Toksanbayev, D., Shalkeev, R. & Torgerson, P.R. (2015). Epidemiology of echinococcosis in Kazakhstan: an update. *J. Helminthol*, 89, 647–650 (in Kazakh).
- Aitbayev, S.A. (2008). Alveococcosis in the Kyrgyz Republic and features of its surgical treatment: Thesis of Doctoral Dissertation. Bishkek (in Kyrgyz).
- Afonso, E., Knapp, J., Tête, N. (2015). Echinococcus multilocularis in Kyrgyzstan: similarity in the Asian EmsB genotypic profiles from village populations of Eastern mole voles (*Ellobiustancrei*) and dogs in the Alay valley. *J. Helminthol*, 89, (in Kyrgyz).
- Bruzinskaite, R., Marcinkute A., Strupas K., Sokolovas V., Deplazes P., Mathis A. (2007). Alveolar echinococcosis, Lithuania. *Emerg Infect Dis*, 13, 1618–9 (in Lithuanian).
- Gagarin, V.G., Steshenko, V.M., Tokobaev, M.M. (1957). Role of rodents in the distribution of helminth zoonoses. *Works Inst. Zool. Parasitol. Kyrgyz Acad. Sci.*, 6, 159–61 (in Kyrgyz).
- Hahorski, W.L., Knap, J.P., Pawlowski, Z.S., Krawczyk, M., Polanski, J., Stefaniak, J. (2013). Human alveolar echinococcosis in Poland: 1990–2011. *PLoS Negl Trop Dis*, 7, e1986.
- Polyakov, V.Ye. (2006). Multi-chamber echinococcosis (Alveococcosis). *Pediatrics. G.N. Speransky Journal*, 6, 88–93 (in Russian).
- Schweiger, A., Ammann, R.W., Candinas, D., Clavien, P.-A., Eckert, J., Gottstein, B. (2007). Human alveolar echinococcosis after fox population increase, Switzerland. *Emerg Infect Dis.*, 13, 878–82.
- Seisembayev, M.A., Toksanbayev, D.S., Baimakhanov, Zh.B. (2012). The choice of optimal tactics of surgical treatment of liver alveococcosis. *Bulletin of Surgery of Kazakhstan*, 1, 8–10 (in Kazakh).
- Shabdarbayeva, G.S., Abdybekova, A.M., Shapiyeva, Zh.Zh. (2012). Anthrozooses and measures of their prevention in the Republic of Kazakhstan. *Almaty. SN* (in Kazakh).
- Torgerson, P.R., Burtisurnov, K.K., Shaikenov, B.S., Rysmukhambetova, A.T., Abdybekova, A.M. & Ussenbayev, A.E. (2003). Modelling the transmission dynamics of *Echinococcus granulosus* in sheep and cattle in Kazakhstan. *Vet. Parasitol*, 114, 143–153 (in Kazakh).

Citation:

Aubakirov, M.Zh., Abdybekova, A.M., Mustafin, M.K., Mustafin, B.K., Yergazina, A.M., Murzakayeva, G.K., Domatsky, V.N., Mendybayeva, A.B., Nalobina, L.V. (2020). Incidence of alveolar echinococcosis in humans and animals in Kostanay region of the Republic of Kazakhstan. *Ukrainian Journal of Ecology*, 10(6), 203–206.



This work is licensed under a Creative Commons Attribution 4.0. License