



CYSTIC ECHINOCOCCOSIS IN THE REPUBLIC OF MOLDOVA (2011-2024): EPIDEMIOLOGICAL CHARACTERISTICS AND THE IMPORTANCE OF THE ONE HEALTH APPROACH

Antonina DUMITRIU¹, Diana SPĂTARU², Oxana CONSTANTINOVA³

¹ Technical University of Moldova, Republic of Moldova

² Nicolae Testemitanu State University of Medicine and Pharmacy, Republic of Moldova

³ National Agency for Public Health, Chisinau, Republic of Moldova

Corresponding author: Antonina Dumitriu, e-mail: antonina.dumitriu@sasp.utm.md

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ABSTRACT

Introduction	Cystic echinococcosis (CE) is a zoonotic parasitic disease that affects both human and animal health, causing considerable socioeconomic losses. This study aimed to assess the epidemiological trends and distribution of CE in humans and livestock in the Republic of Moldova from a One Health perspective.
Materials and methods	A retrospective descriptive study was conducted using data from the National Agency for Public Health (NAPH) and the National Agency for Food Safety (NAFS). Human CE surgical cases reported during 2011–2024 (n=995) and CE cases detected in slaughtered animals during 2014–2023 (n=95,898) were analyzed. Indicators included incidence, demographic and territorial distribution, and cyst localization.
Results	Human CE incidence decreased from 2.2 to 1.87 cases per 100,000 population during 2016–2024, while animal prevalence declined from 24.5% in 2014 to 4.7% in 2024. The highest incidence rates were recorded in Ceadăr-Lunga (12.6), Drochia (6.2), Taraclia (6.1), Florești and Basarabeasca (6.0), and Leova (5.7) per 100,000 population, exceeding the national average (1.9). Adults aged 31-60 years accounted for 59.0% of human cases. Sheep had the highest prevalence among livestock species (7.3%).
Conclusions	Although declining trends were observed in both humans and animals, CE remains a significant public health and veterinary concern in the Republic of Moldova. Strengthened surveillance and intersectoral collaboration within the One Health framework are essential to reduce transmission and improve disease control.
Keywords	Cystic echinococcosis, One Health, human health, farm animals.

ECHINOCOZOZA CHISTICĂ ÎN REPUBLICA MOLDOVA (2011-2024): CARACTERISTICI EPIDEMIOLOGICE ȘI IMPORTANȚA ABORDĂRII „O SINGURĂ SĂNĂTATE”

Introducere	Echinococoza chistică (EC) este o boală parazitărilor zoonotică ce afectează atât sănătatea umană, cât și cea animală, generând pierderi socioeconomice considerabile. Studiul a avut ca scop evaluarea tendințelor epidemiologice și a distribuției EC la om și animale de fermă în Republica Moldova, din perspectiva conceptului <i>OneHealth</i> .
Materiale și metode	A fost realizat un studiu retrospectiv descriptiv, utilizând date furnizate de Agenția Națională pentru Sănătate Publică (ANSP) și Agenția Națională pentru Siguranța Alimentelor (ANSA). Au fost analizate cazurile umane de EC confirmate chirurgical, raportate în perioada 2011–2024 (n=995) și cazurile de EC depistate la animalele sacrificate în perioada 2014–2023 (n=95.898). Indicatorii analizați au inclus incidența, distribuția demografică și teritorială, precum și localizarea chisturilor.
Rezultate	Incidența EC la om a scăzut de la 2,2 la 1,87 cazuri la 100.000 populație în perioada 2016-2024, iar prevalența la animale s-a redus de la 24,5% în anul 2014 la 4,7% în anul 2024. Cele mai înalte rate de incidență au fost înregistrate în raioanele Ceadăr-Lunga (12,6), Drochia (6,2), Taraclia (6,1), Florești și Basarabeasca (6,0), precum și Leova (5,7) la 100.000 populație, depășind media națională de 1,9. Adulții cu vârsta cuprinsă între 31 și 60 de ani au reprezentat 59,0% din totalul cazurilor umane. Dintre speciile de animale, ovinele au prezentat cea mai înaltă prevalență a infecției (7,3%).
Concluzii	Deși au fost observate tendințe descrescătoare atât la om, cât și la animale, echinococoza chistică rămâne o problemă importantă de sănătate publică și sănătate animală în Republica Moldova. Consolidarea supravegherii și a colaborării intersectoriale în cadrul abordării <i>OneHealth</i> este esențială pentru reducerea transmiterii și îmbunătățirea controlului bolii.
Cuvinte-cheie	Echinococoza chistică, OneHealth, sănătate umană, animale de fermă.

INTRODUCTION

Echinococcosis is a zoonotic helminth infection caused by cestodes of the genus *Echinococcus*, affecting humans as well as domestic and wild animals and generating substantial public health, veterinary, and economic burdens (1–5). According to the World Health Organization (WHO), cystic echinococcosis (CE), caused by *Echinococcus granulosus sensu lato*, is classified as a neglected tropical disease and remains one of the most important foodborne parasitic infections worldwide (5).

The One Health approach, which recognizes the interconnectedness of human, animal, and environmental health, has become increasingly important for the prevention and control of CE. Recent international frameworks emphasize the need for integrated surveillance and coordinated interventions across human, animal, and environmental sectors to achieve sustainable control of zoonotic diseases, including cystic echinococcosis (6–8). Inadequate surveillance systems, insufficient control of definitive and intermediate hosts, and limited coordination between public health and veterinary sectors contribute to the persistence of transmission in endemic areas (5, 9–11).

Because of its progressive, often asymptomatic, but often with dramatic consequences that are difficult to detect and hardly detectable, echinococcosis is a typical example of a disease characterised by the „iceberg phenomenon” (1).

The two forms of echinococcosis of greatest public health importance are CE and alveolar echinococcosis (AE). CE is the most prevalent form globally and is associated with considerable morbidity and socioeconomic impact (2–5, 12). The genus *Echinococcus* currently includes several species of medical and veterinary importance, including *Echinococcus granulosus sensu lato*, *Echinococcus multilocularis*, *Echinococcus shiquicus*, *Echinococcus vogeli* and *Echinococcus oligarthrus* (13).

Echinococcus granulosus has a worldwide distribution and is present on all inhabited continents except Antarctica. In contrast, AE is largely restricted to the Northern Hemisphere, particularly in parts of China, the Russian Federation, and several countries in Europe and North America (5).

The burden of CE extends beyond its direct health consequences. In livestock, infection results in the condemnation of affected organs, reduced productivity, decreased milk yield, impaired fertility, and economic losses for farmers and the livestock industry (1, 5, 12).

In the European Union (EU), 540 cases of echinococcosis were reported in 2021, corresponding to a notification rate of 0.16 cases per 100,000 population. In 2022, the number increased to 731 cases, with a notification rate of 0.19 per 100,000 population (14–16). A recent study by Casulli et al. reported 64,745 human CE cases across 40 European countries between 1997 and 2020, with an average annual incidence of 0.64 cases per 100,000 population (13). Recent European assessments have confirmed that, despite overall reductions in incidence, cystic echinococcosis remains an important public health concern in several countries of southeastern and eastern Europe, where surveillance and control activities continue to face important challenges (11, 13).

In the Republic of Moldova, CE remains an important public health concern. It ranks among the most frequently reported helminth infections and continues to cause significant health and economic consequences (17, 18). Annual fluctuations in reported cases may reflect both changes in transmission dynamics and improvements in diagnostic capabilities, including advances in imaging and laboratory investigations (19).

Human echinococcosis accounted for 0.5%–0.9% of all reported helminth infections during 2021–2024, with an average proportion of approximately 0.8% in the last two years of observation (19). Dogs (*Canis lupus familiaris*) serve as the principal definitive hosts of *E. granulosus* and play a central role in maintaining transmission as definitive hosts of *E. granulosus*, contaminating the environment through the excretion of parasite eggs (5, 14–16, 20–22).

Several factors contribute to the persistence of CE transmission in Moldova, growing livestock populations, particularly sheep, the presence of free-roaming and inadequately dewormed dogs, and insufficient control measures in rural settings (22). Recent global burden estimates indicate that CE continues to impose a substantial health and economic burden worldwide, particularly in endemic regions where transmission cycles remain active (23).

Due to its slow progression, chronic nature, and frequently asymptomatic clinical course, cystic echinococcosis is often diagnosed at a late stage in humans, while in livestock it is commonly detected only during routine post-mortem inspection at NAFA-authorized slaughterhouses.

The working hypothesis of the study was that cystic echinococcosis remains endemic in the Republic of Moldova despite ongoing control measures, as reflected by persistent occurrence in both human and animal populations and by heterogeneous geographical distribution patterns.

The aim of this study was to assess the epidemiological situation of human and animal cystic echinococcosis in the Republic of Moldova and to identify its temporal, demographic, and geographical characteristics within a One Health framework.

MATERIALS AND METHODS

Study Design

A retrospective descriptive observational study was conducted in the Republic of Moldova to assess the epidemiological trends and distribution of cystic echinococcosis (CE) in humans and livestock within a One Health framework. The study covered the period 2011–2024 for the human component and 2014–2024 for the veterinary surveillance component, while prevalence analyses requiring denominator data were restricted to 2014–2023.

Human Surveillance Data

For the human component, data on surgically confirmed cases of cystic echinococcosis reported by healthcare institutions to the National Agency for Public Health (NAPH) were analyzed. A total of 995 human cases registered between 2011 and 2024 were included. Cases were characterized according to age, sex, place of residence (urban/rural), administrative territory, cyst localization, and disease form (primary or recurrent). Data were extracted from the national epidemiological surveillance system using Form No. 1 – *Statistical Report on Parasitic Disease Morbidity*.

Human incidence rates were calculated per 100,000 population using official population estimates provided by the National Bureau of Statistics of the Republic of Moldova. Incidence was analyzed by year, age group (children and adults), place of residence, and administrative territory. The geographical distribution of cases was assessed at district and municipality levels to identify areas with increased disease incidence.

Veterinary Surveillance Data

Veterinary data were obtained from the National Agency for Food Safety (NAFS). Two complementary surveillance datasets were used. The first dataset comprised annual records of cystic echinococcosis cases detected during post-mortem inspection of slaughtered animals and was available for 2014–2024. The second dataset included the total number of animals slaughtered in NAFS-authorized slaughterhouses, stratified by species (cattle, sheep, pigs, and horses), and was available only for 2014–2023.

Since prevalence estimation requires both the number of infected animals and the total number examined, prevalence calculations and species-specific analyses were limited to the period 2014–2023. During this period, 4,169,323 animals were inspected, of which 95,898 were diagnosed with cystic echinococcosis. Annual prevalence was calculated as the proportion of infected animals among all examined animals and was further analyzed by animal species.

Data quality and comparability were considered acceptable because veterinary inspections were performed according to standardized veterinary-sanitary procedures.

Statistical Analysis

Temporal trends in human incidence and animal prevalence were evaluated using simple linear regression models. Pearson's correlation coefficient was calculated to assess the relationship between the annual number of human cases and animal cases during the period 2014–2024.

Data management and statistical analyses were performed using Microsoft Excel 2021. Human incidence rates were expressed per 100,000 population, whereas animal prevalence was expressed as the percentage of infected animals among those examined. Veterinary prevalence estimates were additionally interpreted according to animal species and annual slaughter volumes.

Ethical Considerations

The study was based exclusively on secondary, anonymized, aggregated surveillance data; therefore, informed consent was not required. Data processing complied with national regulations on confidentiality and personal data protection.

This study was conducted within the framework of the Field Epidemiology Training Program (FETP-Intermediate) of the Eastern Europe and Central Asia (EECA) Regional Office of the Centers for Disease Control and Prevention (CDC).

RESULTS

Surveillance and monitoring of CE in humans

Analysis of epidemiological surveillance data showed that the incidence of CE was consistently higher among adults than among children throughout the study period (2011–2024). In adults, incidence increased during the early years of observation, reaching a peak of 4.2 cases per 100,000 population in 2012–2013, followed by a gradual decline until 2016. A further decrease was observed in 2020, after which incidence increased again, reaching approximately 3.0 cases per 100,000 population in 2022–2023.

In contrast, incidence among children remained substantially lower during the entire study period. Rates increased from 0.9 cases per 100,000 population in 2011 to a peak of 2.5 cases per 100,000 population in 2014, followed by a marked decline to 0.7 cases per 100,000 population in 2016. From 2017 onwards, incidence remained very low, reaching nearly zero in 2020 and 2022. A slight increase was observed in 2024, when the incidence reached 0.4 cases per 100,000 population (Figure 1).

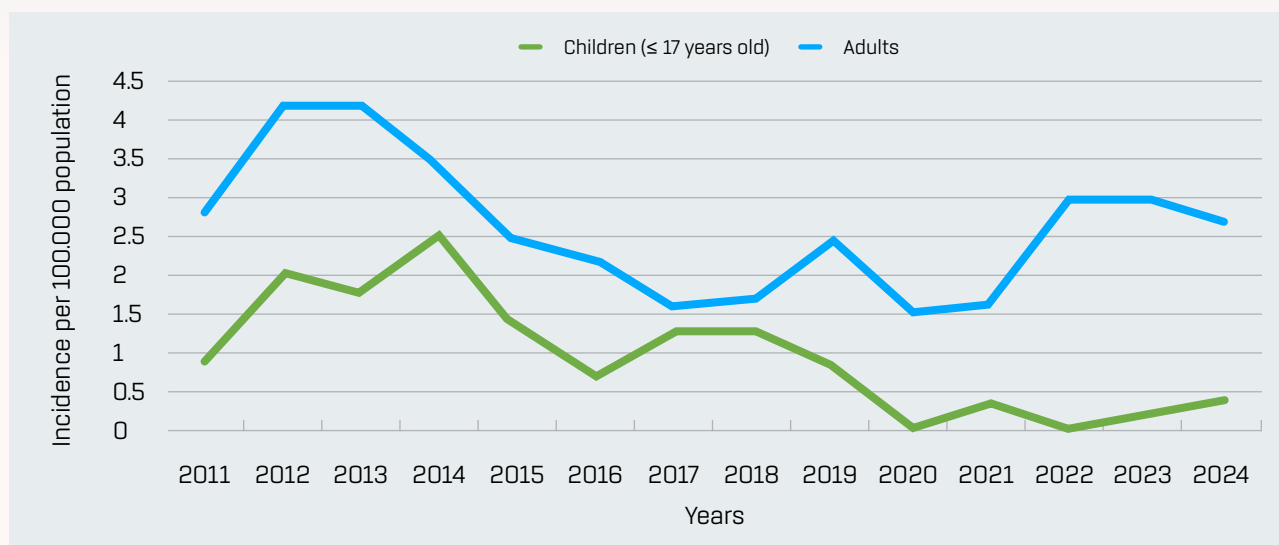


Figure 1. Incidence of echinococcosis by age group (children ≤17 years and adults), Republic of Moldova, 2011–2024.

The age distribution of cases showed that the most affected groups were individuals aged 51–60 years (23%), followed by 61–70 years (19%) and 41–50 years (17%). Overall, adults aged 31–60 years accounted for the majority of cases, representing 59% of all patients. The mean age of patients was 30 years.

No cases were recorded among children aged 0–2 years. Among children, the highest number of cases was observed in the 3–6-year age group ($n = 9$), representing 34.6% of all pediatric cases, while 17 cases were reported among children aged 7–17 years.

According to data reported to the NAPH, a total of 995 patients underwent surgical treatment for cystic echinococcosis in the Republic of Moldova between 2011 and 2024. Figure 2 illustrates the annual number of surgically confirmed cases recorded during the study period. The annual number of cases showed an overall decreasing trend between 2011 and 2020, reaching a peak of 149 cases in 2013 and declining to 32 cases in 2020, representing a reduction of more than fourfold over seven years. From 2021 onwards, the number of reported cases increased, reaching a secondary peak of 60 cases in 2023, followed by a slight decline to 45 cases in 2024.

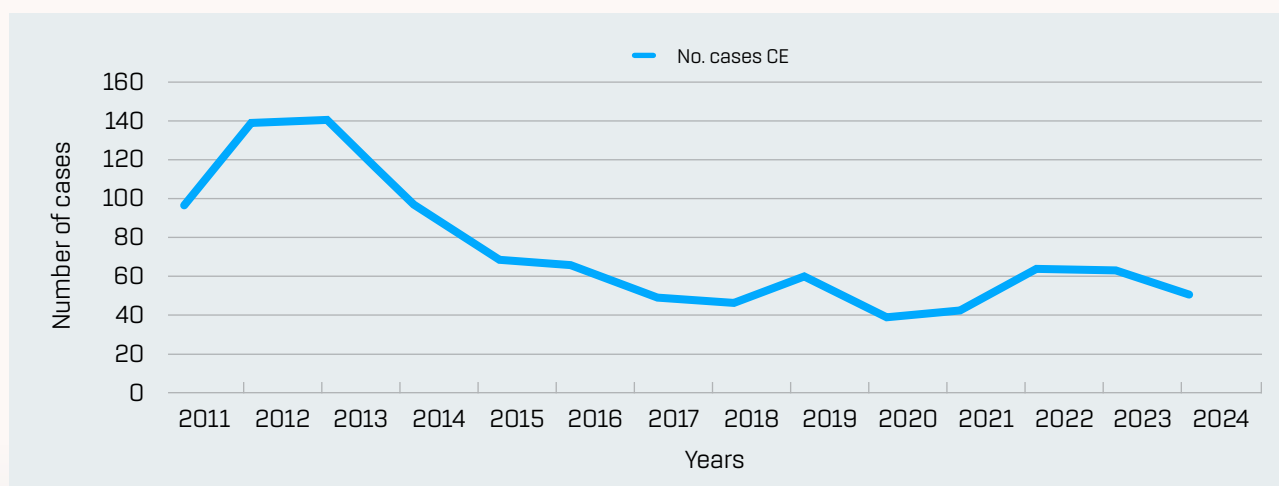


Figure 2. Distribution of CE cases in the human population, Moldova, 2011–2024, $N = 995$

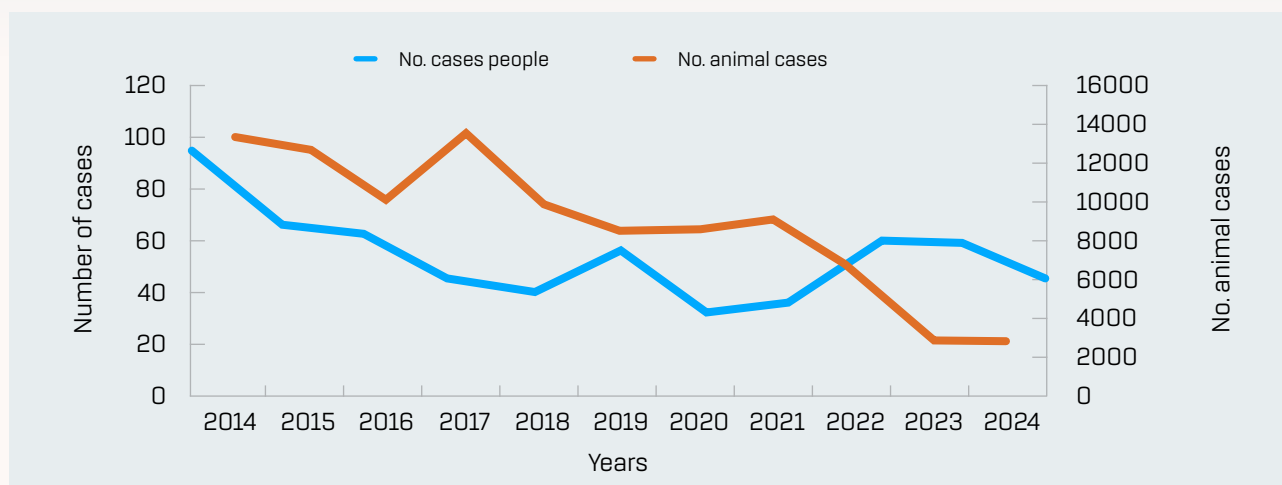


Figure 3. Distribution of CE cases in humans and livestock, Moldova, 2014-2024

Analysis of veterinary surveillance data revealed a substantial decline in the number of CE cases detected in slaughtered animals during 2014–2024. In 2014, 13,444 positive cases were identified, representing 24.5% of all animals examined, whereas in 2024, 2,820 positive cases were recorded, corresponding to a prevalence of 4.7%. Overall, the number of positive animal cases decreased approximately fivefold during the study period (Figure 3).

In contrast, the number of human CE cases showed greater temporal variation. Following a declining trend between 2014 and 2020, when the annual number of cases decreased from approximately 90 to 32, an increase was observed from 2021 onwards. The number of reported cases reached 60 in 2023, followed by a slight decline to 45 cases in 2024.

Pearson's correlation analysis between annual human surgical cases and animal cases detected during 2014–2024 revealed a weak positive association ($r = 0.29$). However, this correlation was not statistically significant ($p = 0.392$), indicating that annual fluctuations in human and animal cases were not directly correlated during the study period.

Of the 995 cases included in the sex-specific analysis, 470 (47%) occurred among males and 525 (53%) among females (Table 1). Although the distribution of cases was relatively balanced between sexes, females exhibited a slightly higher average incidence rate (2.0 per 100,000 population) compared with males (1.7 per 100,000 population).

Table 1. Distribution of cases of CE among individuals by sex, 2011-2024, n=995.

Sex	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
M	46	71	64	49	33	32	17	14	32	18	17	26	29	22	470
F	51	77	85	47	34	31	28	26	25	14	19	34	31	23	525
T	97	148	149	96	67	63	45	40	57	32	36	60	60	45	995
M%	47	48	43	51	49	50	38	35	56	56	47	43	48	49	47
F%	53	52	57	49	51	49	62	65	44	43	53	57	52	51	53

Regarding anatomical localization, the liver was the most frequently affected organ, accounting for 76% of cases, followed by the lungs (17%). Less common localizations included the spleen, brain, kidneys, bones, muscles, and pelvic cavity. Multiple-organ involvement was also observed, including combinations such as liver and spleen or liver and lung. Primary forms of the disease represented 89% of cases, whereas recurrent infections accounted for 11%.

Analysis by place of residence revealed that most patients originated from rural areas (77.8%). The average incidence in rural populations was 1.8 cases per 100,000 inhabitants, compared with 0.5 cases per 100,000 inhabitants in urban areas. This pattern is consistent with the epidemiology of cystic echinococcosis, which is closely associated with livestock breeding and exposure to domestic animals involved in the parasite life cycle. In 2024, the highest incidence rates were recorded in Ceadr-Lunga (12.6 per 100,000 population), Drochia (6.2), Taraclia (6.1), Basarabeasca and Florești (6.0 each), Leova (5.7), Ocnița (4.8), and Telenești (4.3). These values considerably exceeded the national incidence rate of 1.7 cases per 100,000 population, indicating the persistence of areas with elevated disease burden.

Surveillance and monitoring of CE in animals

The epidemiological assessment of cystic echinococcosis (CE) in animals was based on official data obtained from the databases of NAFS (Table 2).

Table 2. Number of animals slaughtered and structure of cases of CE registered in the Republic of Moldova, 2014-2023.

No. anim. Slaughtered	Cattle			Sheep			Horse			Pigs		
Year	Total No. anim.	No. cases CE	%	Total No. anim.	No. cases CE	%	Total No. anim	No. cases CE	%	Total No. anim.	No. cases CE	%
2014	32636	2519	7.7	32724	4834	14.8	551	3	0.5	309309	6091	2.0
2015	36001	2442	6.8	23120	4143	17.9	514	12	2.3	261815	6237	2.4
2016	38177	2755	7.2	34917	3163	9.1	597	4	0.7	292124	4094	1.4
2017	41890	3026	7.2	96035	6539	6.8	1210	11	0.9	267132	4250	1.6
2018	40197	2367	5.9	96534	3942	4.1	1141	4	0.3	344943	3635	1.1
2019	31155	1439	4.6	74463	4595	6.2	1512	1	0.1	322379	2519	0.8
2020	25880	3032	11.7	71461	2013	2.8	1401	8	0.6	380865	3611	0.9
2021	24282	899	3.7	59017	6640	11.2	683	9	1.3	378550	1670	0.4
2022	20103	786	3.9	28288	4358	15.4	367	0	0.0	391457	1423	0.4
2023	20719	511	2.5	46942	896	1.9	114	4	3.5	338118	1413	0.4
Total	311040	19776	6.4	563501	41123	7.3	8090	56	0.7	3286692	34943	1.1

Note: Total animals slaughtered: n=4,169,323

Total CE cases in animals: n=95,898

The analysis included post-mortem inspection records from veterinary-authorized slaughterhouses in the Republic of Moldova during the period 2014-2023. A total of 4,169,323 animals were examined during the study period. Pigs represented the largest proportion of slaughtered animals (78.8%), followed by sheep (13.5%), cattle (7.5%), and horses (0.2%). The overall number of animals slaughtered increased over time, primarily due to a growing number of pigs processed in authorized slaughterhouses.

Overall, 95,898 cases of CE were identified, corresponding to an average prevalence of 2.3% among all examined animals (Table 2). These findings indicate the continued circulation of *Echinococcus granulosus* within livestock populations in the Republic of Moldova.

The highest average prevalence was recorded in sheep (7.3%), followed by cattle (6.4%), pigs (1.1%), and horses (0.6%). Among cattle, prevalence decreased from 7.7% in 2014 to 2.5% in 2023, representing an approximately threefold reduction during the study period. A temporary increase was identified in 2020, when prevalence reached 11.7%.

Among sheep, prevalence showed greater annual variability. The highest values were recorded in 2015 (17.9%) and 2022 (15.4%), whereas a substantial decline was observed in 2023, when prevalence decreased to 1.2%.

In pigs, a consistent downward trend was observed throughout the study period. Prevalence decreased from 2.4% in 2015 to 0.4% in 2023, representing a reduction of more than fivefold. Similar decreasing trends were observed in the other livestock species, although the magnitude of change varied between species (Figure 4).

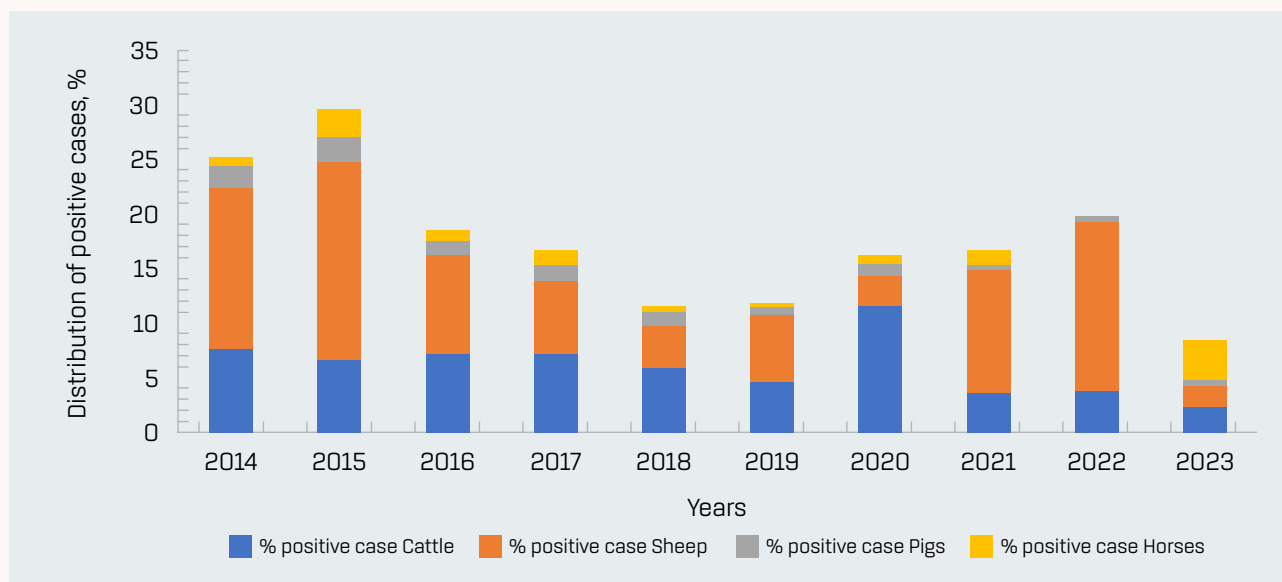


Figure 4. Distribution of echinococcosis cases %, among slaughtered farm animals, Moldova, 2014-2023

Overall, the declining prevalence observed in livestock suggests a reduction in the occurrence of cystic echinococcosis among slaughtered animals during the study period. Nevertheless, the continued detection of positive cases across all major livestock species indicates the persistence of the parasite cycle and highlights the importance of maintaining veterinary surveillance and control measures.

DISCUSSION

The present study demonstrates that CE remains endemic in the Republic of Moldova, despite a declining trend in both human cases and animal prevalence over the study period. Although the annual number of surgically confirmed human cases decreased substantially between 2011 and 2020, a resurgence was observed after 2021. Similarly, the prevalence of CE in slaughtered livestock declined markedly between 2014 and 2024, suggesting improvements in disease control at the animal level.

The incidence rates observed in Moldova remain considerably higher than those reported in the European Union. While EU/EEA notification rates ranged between 0.16 and 0.19 cases per 100,000 population in 2021–2022 (14, 15) the incidence in Moldova reached 2.9 cases per 100,000 population in 2023. These findings are consistent with reports identifying southeastern Europe as one of the remaining endemic regions for cystic echinococcosis (13).

The predominance of cases among adults, particularly those aged 31–60 years, is consistent with the natural history of CE. Due to the slow growth of hydatid cysts and the prolonged asymptomatic phase of infection, diagnosis frequently occurs years after exposure (5). The occurrence of cases among children indicates continued transmission of the parasite and ongoing exposure in some communities. The marked predominance of cases in rural areas (77.8%) and the higher incidence observed among rural populations (1.8 vs 0.5/100,000) are consistent with previous studies demonstrating the close association between CE transmission, livestock farming, and contact with domestic dogs, the definitive hosts of *Echinococcus granulosus* (5, 21, 24–26). The heterogeneous geographical distribution observed across the country further suggests the existence of local epidemiological factors that may influence transmission dynamics.

The predominance of hepatic (76%) and pulmonary (17%) involvement corresponds to the classical clinical presentation of CE reported in the literature, where the liver and lungs represent the primary filtering organs for parasite larvae following intestinal absorption (5). The proportion of recurrent cases (11%) reflects the chronic nature of the disease and the need for long-term follow-up.

The veterinary component of the study demonstrated a substantial reduction in CE detection among slaughtered animals, from 24.5% in 2014 to 4.7% in 2024, particularly in sheep and cattle, which are recognized as the main intermediate hosts in the transmission cycle. Similar slaughterhouse-based methodologies have been used to monitor CE in endemic regions (22). However, the continued detection of infected animals across all major livestock species indicates that transmission has not been completely interrupted. The discrepancy between declining animal prevalence and the persistence of human cases may be explained by the long incubation period of CE, differences in surveillance systems, and the cumulative effect of exposures acquired years before diagnosis.

The temporary increase in human incidence after 2021, despite declining livestock prevalence, may reflect reporting variability, time-lag between infection and surgery, or differences between regulated and informal livestock systems (5, 14).

The correlation analysis between annual human and animal cases revealed a weak positive but statistically non-significant association ($r = 0.29$; $p = 0.392$). This result is not unexpected considering the biological and epidemiological characteristics of CE. Human cases frequently represent infections acquired many years before diagnosis, whereas animal cases detected at slaughter reflect more recent transmission events.

Although dogs are biologically recognized as definitive hosts in CE transmission (5, 20, 21) this study did not include dog-related indicators; therefore, their specific contribution cannot be quantified from the present data. Future One Health evaluations should integrate definitive host surveillance and community-level practices to better explain territorial clustering and temporal trends (16). These findings highlight the complexity of CE transmission and underscore the importance of integrated surveillance systems encompassing both human and animal health sectors. Recent One Health frameworks advocate the integration of epidemiological, veterinary, environmental, and laboratory data to improve the detection, monitoring, and control of zoonotic diseases, including cystic echinococcosis (6-8). The limited availability of integrated human-animal surveillance data remains a challenge in many endemic countries and has been identified as an important barrier to effective CE control programs (8, 11).

STUDY LIMITATIONS

This study has several limitations that should be considered when interpreting the results:

- The use of aggregated surveillance data limited the possibility of performing individual-level risk factor analyses and more advanced multivariable statistical modelling. Therefore, the findings should be interpreted primarily as descriptive and exploratory.
- The veterinary data were derived exclusively from animals slaughtered in NAFS-authorized slaughterhouses, which may not fully represent the epidemiological situation in backyard or informal slaughter settings.
- There was a lack of detailed data regarding the anatomical localization of cysts in slaughtered animals, limiting the possibility of comparative analysis with human clinical forms.
- The absence of disaggregated data on the territorial distribution of animal cases (by districts) restricted the ability to perform a comprehensive spatial analysis and direct correlation with human incidence patterns.
- The study did not include data on definitive hosts (dogs), which play a key role in the transmission of *Echinococcus granulosus*, thus limiting the comprehensive assessment of transmission dynamics within the One Health framework.
- Potential underreporting in human cases, may have led to an underestimation of the true burden of disease.

CONCLUSIONS

Cystic echinococcosis remains an endemic zoonotic disease in the Republic of Moldova, with incidence consistently higher among adults than children, though continued cases among children and adolescents point to ongoing exposure in certain communities. The geographical distribution is heterogeneous, with several districts exceeding the national average in 2024, and most cases (77.8%) originating from rural areas, where incidence significantly surpasses urban settings, underscoring a strong association with rural living environments.

Human cystic lesions predominantly affect the liver and lungs, although complex forms involving multiple sites or vital organs, including the spleen, kidneys, brain, and bones were also documented; the occurrence of relapses

further emphasizes the need for sustained clinical follow-up and appropriate medical and surgical management. On the veterinary side, sheep showed the highest prevalence of infection, followed by cattle and pigs, although slaughterhouse data, limited to NAFS-authorized facilities, likely underrepresent informal or household-level slaughter practices.

Taken together, these findings highlight the need for strengthened intersectoral collaboration under a One Health framework, with future efforts focused on integrated surveillance, improved data exchange between human and veterinary sectors, targeted prevention in high-incidence areas, and further research into the community-level drivers of transmission.

CONFLICT OF INTEREST The authors declare no conflict of interest.

ETHICAL APPROVAL Ethical approval was not required, as the study used anonymized, aggregated surveillance data and did not involve direct contact with human participants or animals.

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Antonina DUMITRIU, WoS Researcher ID: RCX-5093-2026

Diana SPĂȚARU, WoS Researcher ID: ACV-6419-2022, SCOPUS ID: 58642868700