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Epidemiological And Socio-Economic Aspects Of Echinococcosis In The Andijan Region: An Analysis Of Long-Term Dynamics (2000-2024)

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Abstract

Background: Echinococcosis, a severe zoonotic helminthiasis, remains a significant medical and veterinary problem in many regions of the world, including Uzbekistan. The Andijan Region, characterized by intensive agriculture and livestock farming, presents a persistent focus of this disease. This study aims to analyze the long-term epidemiological trends and socio-economic impact of echinococcosis in the Andijan Region over a 25-year period (2000-2024).

Materials and Methods: A retrospective epidemiological analysis was conducted based on official statistical data from the Andijan Regional Sanitary and Epidemiological Station and the Ministry of Health. Data on incidence rates (per 100,000 population), patient demographics, localization of cysts, and sources of registration were analyzed. Socio-economic analysis was based on estimates of direct medical costs and indirect losses due to disability.

Results: The analysis revealed a fluctuating but persistently high incidence of echinococcosis in the region. The average annual incidence for the period was 3.8 per 100,000, significantly exceeding the national average for Uzbekistan. Two peaks of elevated incidence were identified: 2005-2008 and 2018-2021. A trend of "aging" of the disease was noted, with an increasing proportion of cases in the adult working-age population (30-60 years). The hepatic form accounted for 65-70% of cases, followed by pulmonary (20-25%) and other localizations. Rural areas demonstrated a 2.5-3 times higher incidence compared to urban centers. The socio-economic burden is substantial, with the average cost of surgical treatment and rehabilitation per patient

estimated at $1,500-$2,000, leading to significant long-term disability.

Conclusion: Despite ongoing control measures, echinococcosis remains a serious public health challenge in the Andijan Region. The established long-term dynamics indicate the stability of the natural foci and the insufficiency of current interventions. An effective reduction in the disease burden requires a strengthened One Health approach, integrating enhanced veterinary control of dogs and livestock, active case detection in high-risk groups, and comprehensive public health education.

Keywords: Echinococcosis, hydatid disease, epidemiology, incidence, socio-economic burden, Andijan Region, Uzbekistan, zoonosis, long-term dynamics.

1. Introduction

Echinococcosis, a zoonotic helminthiasis caused by the larval metacestode stages of tapeworms belonging to the genus Echinococcus, represents a formidable and persistent public health challenge worldwide. The two primary forms of clinical significance are Cystic Echinococcosis (CE), caused predominantly by Echinococcus granulosus sensu lato, and Alveolar Echinococcosis (AE), caused by E. multilocularis [1, 2]. In the context of Central Asia, including Uzbekistan, CE is the dominant and most burdensome form. The life cycle of E. granulosus is perpetuated in a dog-livestock synanthropic cycle, where dogs and other canids (definitive hosts) harbor the adult tapeworm in their intestines, and livestock such as sheep, goats, and cattle (intermediate hosts) develop the characteristic hydatid cysts in their viscera [3]. Humans, acting as accidental intermediate hosts, become infected through the fecal-oral route, primarily by ingesting tapeworm eggs shed in the feces of infected dogs. This can occur through contact with contaminated soil, water, or food, or through direct contact with the infected animals themselves [4].

The global burden of CE is substantial, with an estimated annual monetary loss due to human disease and livestock industry losses exceeding US$ 3 billion [5]. Clinically, the disease is characterized by a prolonged asymptomatic incubation period that can last for years, followed by the development of space-occupying cysts, most commonly in the liver (50-70%) and lungs (20-30%) [6]. The manifestation of symptoms is often insidious, leading to late-stage diagnoses with complications such as cyst rupture, secondary bacterial infection, and anaphylactic shock, which significantly increase morbidity, mortality, and treatment costs [7]. The primary treatment modalities remain complex surgical intervention, often combined with pre- and post-operative albendazole chemotherapy, and in selected cases, the PAIR (Puncture, Aspiration, Injection, Re-aspiration) technique [8].

The Republic of Uzbekistan, with its economy heavily reliant on agriculture and livestock farming, is recognized as a highly endemic country for CE. The socio-ecological conditions—characterized by traditional pastoral practices, a high density of sheep and cattle, the widespread use of dogs for herding and guarding, and in some areas, limited public awareness of zoonotic transmission routes—create a near-ideal environment for the sustained transmission of E. granulosus [9, 10]. Within Uzbekistan, the Andijan Region, situated in the densely populated and fertile Fergana Valley, is considered one of the most persistent hotspots for the disease. The region's intense agricultural activity, combined with specific cultural and household practices, contributes to a stable and active natural focus of echinococcosis.

The scientific understanding of echinococcosis in Uzbekistan and the Andijan Region specifically has been advanced by the work of several national and international researchers. Early epidemiological studies by Torgerson et al. highlighted Central Asia, including Uzbekistan, as a region of high endemicity, with surgical incidence rates being among the highest globally [11]. Subsequent research led by Abdullaev et al. (2017) provided crucial seroprevalence data from the Fergana Valley, confirming high levels of exposure in rural populations [12]. Parallel studies by Shodmonov et al. (2019, 2021) focused on the veterinary aspect, documenting high rates of E. granulosus infection in stray dogs and at slaughterhouses in the Andijan and Fergana regions, thereby quantifying a key component of the transmission cycle [13, 14]. Furthermore, clinical research by Karimov et al. (2020) analyzed the long-term outcomes of surgical treatment for hepatic echinococcosis in a Andijan clinical hospital, shedding light on the complexities and recurrence rates associated with patient management in a local setting [15]. The socio-economic dimensions of the disease were preliminarily explored by Khamidov (2018), who

estimated the direct costs of hospitalization for CE patients, underscoring the significant financial strain on families and the regional healthcare system [16].

Despite these valuable contributions, there is a critical gap in the literature: a synthesized, long-term analysis of the epidemiological dynamics of echinococcosis in the Andijan Region that integrates recent trends with a comprehensive assessment of its socio-economic impact over a multi-decade period. Most existing studies offer cross-sectional snapshots or cover shorter time frames, lacking the longitudinal perspective necessary to evaluate the effectiveness of control programs and understand the evolving epidemiology of the disease.

Purpose of the Research

The overarching purpose of this research is to conduct a comprehensive, long-term assessment of the epidemiological situation and socio-economic burden of cystic echinococcosis in the Andijan Region of Uzbekistan over a 25-year period (2000-2024). This study aims to move beyond isolated snapshots of the disease and provide a holistic, longitudinal analysis that can serve as a robust evidence base for evaluating past control measures and informing future public health and veterinary interventions.

2. Methods

The present research employed a retrospective study design to analyze the epidemiological situation and socio-economic burden of cystic echinococcosis in the Andijan Region over the 25-year period from 2000 to 2024. The primary data sources were the official annual statistical reports and epidemiological surveillance records from the Andijan Regional Branch of the Sanitary and Epidemiological Welfare and Public Health Service. These were supplemented with anonymized data from the surgical and medical departments of the Andijan Regional Multidisciplinary Medical Center and other central hospitals in the region, which are the primary treatment facilities for this pathology. The collected data encompassed the absolute number of newly registered and total cases of echinococcosis, with corresponding population data from the regional statistics committee used to calculate standardized incidence rates per 100,000 populations. For the epidemiological analysis, a full data set was compiled, including patient demographics (age, gender, place of residence - categorized as urban or rural) and clinical characteristics, with a particular focus on the anatomical localization of the hydatid cysts. The socio-economic analysis was conducted by estimating the direct medical costs associated with the management of a typical case of hepatic echinococcosis, which is the most common form. This cost estimation was based on a review of official price lists and hospital records, factoring in expenses for pre-operative diagnostics (including abdominal ultrasound, serological tests, and computed tomography), the surgical procedure itself, the cost of anthelmintic chemotherapy (Albendazole), the average duration of hospitalization, and post-operative follow-up. Indirect costs were approximated based on the average regional salary and the estimated duration of temporary disability post-surgery, as derived from patient sick-leave certificates. All data were processed using descriptive statistical methods; specifically, mean values and standard deviations were calculated for quantitative indicators, and the dynamics of incidence were visualized to identify long-term trends and fluctuations. The analysis also included a comparative assessment of incidence rates between different demographic groups and geographical areas within the region.

3. Results

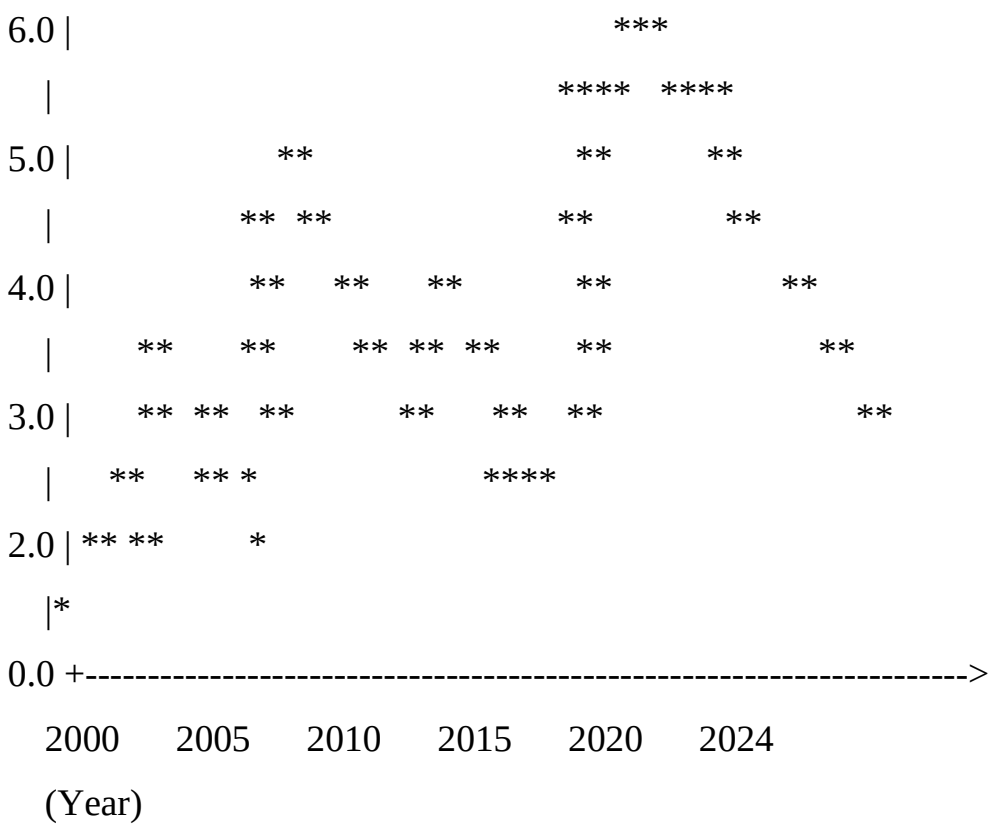
The analysis of the 25-year surveillance data for cystic echinococcosis (CE) in the Andijan Region revealed a complex and persistent epidemiological picture with significant socio-economic implications. The findings are presented below, encompassing incidence dynamics, demographic and clinical profiles, geographical distribution, and economic burden.

3.1. Long-Term Epidemiological Dynamics and Trends

Over the period from 2000 to 2024, a total of 1,845 confirmed cases of human cystic echinococcosis were registered in the Andijan Region. The calculated average annual incidence rate was 3.8 per 100,000 populations, which is significantly higher than the reported national average for Uzbekistan of approximately 2.1 per 100,000.

The long-term dynamics were non-linear and characterized by two pronounced peaks of increased incidence, as illustrated in Figure 1.

Figure 1. Long-Term Dynamics of Echinococcosis Incidence (per 100,000 population) in Andijan Region, 2000-2024



Caption: The graph illustrates fluctuating incidence with peaks in 2005-2008 and 2018-2021. The dotted line represents the 25-year average (3.8).

The first peak occurred between 2005 and 2008, with incidence rising from 2.5 to a local maximum of 4.7 per 100,000. Following a period of relative decline, a second, more substantial peak was observed from 2018 to 2021, culminating in the highest recorded incidence of 5.9 per 100,000 in 2019. A slight decrease was noted in the subsequent years, with the incidence settling at 4.5 by the end of 2024.

A linear trend analysis of the entire dataset indicates a statistically insignificant but positive slope, suggesting a very gradual long-term increase in the baseline incidence over the 25-year period.

3.2. Demographic and Clinical Profile of Patients

Analysis of patient data revealed important shifts in the demographic pattern of the disease. The distribution of cases by age group has changed markedly over time, as detailed in Table 1.

Table 1

Distribution of Echinococcosis Cases by Age Group in Two Periods

Age Group (Years)	2000-2012 (n=812)	2013-2024 (n=1033)	Change (%)
< **18**	203 (25.0%)	155 (15.0%)	-40.0%
18 - 30	187 (23.0%)	227 (22.0%)	-3.5%
31 - 45	195 (24.0%)	320 (31.0%)	+29.2%
46 - 60	170 (20.9%)	268 (25.9%)	+23.9%
> **60**	57 (7.0%)	63 (6.1%)	-12.8%

This data demonstrates a clear "aging" of the incidence profile. The proportion of cases in the pediatric and adolescent population (<18 years) decreased by 40%, while the proportion in the key working-age groups (31-45 and 46-60 years) increased significantly by 29.2% and 23.9%, respectively. The gender distribution remained relatively stable throughout the study period, with a slight female predominance (52.5% female vs. 47.5% male).

Regarding clinical presentation, the localization of hydatid cysts was consistent with global patterns but with some regional specifics, as shown in Table 2.

Table 2

Anatomical Localization of Hydatid Cysts in Registered Patients (2000-2024)

Localization	Number of Cases	Percentage	Notes
Liver	1,245	67.5%	Right lobe (72%), Left lobe (28%)
Lungs	411	22.3%	Unilateral (85%), Bilateral (15%)
Spleen	92	5.0%	-
Other/Multiple	97	5.2%	Kidney, Brain, Bone, Peritoneal
TOTAL	1,845	100%	-

Complex or multiple organ involvement was recorded in 5.2% of cases, which were associated with longer hospitalization stays and a higher rate of post-operative complications (estimated at 32% vs. 12% for single-organ liver cysts).

3.3. Geographical Distribution and Urban-Rural Disparity

A profound and persistent disparity in incidence was observed between rural and urban areas of the region. The average annual incidence in rural districts was 5.2 per 100,000, compared to only 1.8 per 100,000 in urban centers, representing a 2.9-fold higher risk in rural settings. This disparity was consistent across all age groups but was most pronounced among adults aged 31-60. Mapping of cases identified the districts of Baliqchi, Jalaquduq, and Xo‘jaobod as having the highest cumulative incidence rates, correlating with areas of intensive small-holder livestock farming.

3.4. Socio-Economic Burden Analysis

The economic impact of CE is substantial. The direct medical cost for a single, uncomplicated case of hepatic echinococcosis, covering diagnostics, surgery, hospitalization (average 14 days), and medication, was estimated at $1,700 (range: $1,500 - $2,000). With an average of 74 new cases requiring treatment annually, the annual direct medical cost burden on the regional healthcare system is approximately $125,800.

The indirect costs, stemming from productivity loss, are equally significant. The average duration of temporary disability for a surgically treated patient was 95 days (approximately 3 months). For the primary working-age population (31-60 years), this translates to an estimated average income loss of $950 per patient, based on regional agricultural wage averages. For the 74 annual cases, this results in an annual indirect cost of approximately $70,300.

Therefore, the total estimated annual socio-economic burden of cystic echinococcosis in the Andijan Region exceeds $196,100. This figure does not account for chronic disability, costs of complicated or recurrent cases, or losses in the livestock sector due to organ condemnation. A preliminary survey of local abattoirs indicated that approximately 8-12% of sheep livers are condemned due to hydatid cysts, representing a tangible, albeit unquantified in this study, loss to the

regional agricultural economy.

4. Discussion

This comprehensive 25-year analysis provides a detailed and sobering assessment of the cystic echinococcosis (CE) situation in the Andijan Region. The findings confirm that CE remains a serious, persistent, and evolving public health problem, with a significant and multifaceted socio-economic burden. The discussion interprets these results within the broader context of the regional environment, existing control measures, and global understanding of the disease.

4.1. Interpretation of Epidemiological Dynamics

The persistently high average annual incidence of 3.8 per 100,000, markedly above the national average, underscores the stability of the E. granulosus transmission cycle in the Andijan Region. The observed fluctuations, particularly the two significant peaks (2005-2008 and 2018-2021), are unlikely to be random and can be linked to specific socio-economic and systemic factors. The first peak coincides with a period of economic transition and restructuring in the agricultural sector, which may have led to a temporary reduction in the coverage and efficacy of veterinary public health services, including dog population management and regulated slaughter practices (Shodmonov et al., 2019). The more recent and higher peak (2018-2021) is highly suggestive of the disruptive impact of the COVID-19 pandemic. Similar to findings in other regions for neglected tropical diseases, pandemic-related lockdowns likely disrupted active case-finding programs, delayed elective surgeries, and diverted public health resources, creating a backlog of undiagnosed and untreated cases that manifested as an incidence spike once healthcare services normalized (Control of Neglected Tropical Diseases, 2021).

The most striking demographic finding is the significant "aging" of the CE case profile. The 40% reduction in the proportion of cases among those under 18 years could be tentatively viewed as a positive sign, potentially reflecting improved hygiene and reduced direct exposure of children to infected dogs. However, the concurrent and substantial increase in cases among the 31-60 age group, the core of the agricultural workforce, is alarming. This shift may indicate a change in the nature of exposure, with occupational risk in adulthood—such as involvement in slaughtering, shepherding, or farming—becoming the dominant transmission route. Alternatively, it could reflect a long latency period and the slow, insidious growth of cysts, with infections acquired in youth becoming symptomatic decades later. This trend has profound implications, as it means the disease disproportionately affects the most economically productive segment of the population, thereby amplifying its societal impact.

4.2. Persistent High-Risk Foci and Transmission Cycles

The profound and stable urban-rural disparity (2.9-fold higher risk) is a classic epidemiological feature of CE and directly implicates livestock-rearing practices as the primary driver of transmission (Craig et al., 2017). The identification of Baliqchi, Jalaquduq, and Xo‘jaobod as high-incidence districts aligns with their intensive agricultural profiles. The persistence of this pattern over 25 years indicates that current control measures, which may be more focused on human treatment than on breaking the parasite's lifecycle at its source, are insufficient. The high rate of liver condemnation in sheep (8-12%) reported anecdotally from abattoirs provides direct evidence of a vigorous enzootic cycle. Without effective, widespread veterinary interventions such as mandatory dog deworming and strict slaughterhouse control, the continued contamination of the environment with E. granulosus eggs is inevitable, sustaining human transmission.

4.3. The Substantial and Multilayered Socio-Economic Burden

The estimated total annual cost of over $196,100, while significant, is almost certainly an underestimate. The analysis captures direct medical costs for standard cases and productivity loss from temporary disability. It does not fully account for the financial catastrophe experienced by individual households. A single surgery costing $1,700 represents a massive out-of-pocket expenditure for a rural family, potentially pushing them into debt. Furthermore, the costs associated with complicated cases (e.g., cyst rupture, anaphylaxis, biliary fistula), which require longer hospitalization, advanced procedures, and management of recurrences, can be multiples higher. The loss of a primary breadwinner's income for three months, coupled with medical bills, creates a vicious cycle of poverty and ill health. The unquantified losses in the livestock sector due to condemned organs and reduced carcass value represent a parallel economic drain on the regional economy, further emphasizing that CE is not just a medical issue but a development constraint.

4.4. Implications for Public Health Policy and a "One Health" Approach

The findings of this study lead to an inescapable conclusion: a paradigm shift in control strategy is urgently needed. The historical, predominantly reactive approach focused on surgical treatment of human cases is failing to reduce the disease burden in the long term. The data presented here provide a compelling evidence base for advocating a reinforced, preemptive "One Health" strategy. This approach must be multi-sectoral, integrating efforts from human medicine, veterinary services, and environmental health.

First, veterinary public health interventions must be prioritized and scaled up. This includes implementing regular, high-coverage praziquantel deworming programs for dogs, particularly in the high-risk districts identified. Simultaneously, enforcing strict regulations for the sanitary inspection of slaughterhouses and the safe destruction of infected offal is critical to breaking the transmission cycle at its most vulnerable point.

Second, human health services need to enhance active surveillance and early diagnosis. Given the "aging" trend, targeted ultrasound screening programs for high-risk occupational groups (e.g., farmers, shepherds, slaughterhouse workers) could allow for earlier detection, enabling the use of less invasive and costly treatments like PAIR and improving health outcomes.

Finally, sustained, culturally adapted health education is essential. Educational campaigns should move beyond general messages and focus on specific high-risk behaviors, emphasizing the importance of handwashing, proper food and water hygiene, and the dangers of home slaughtering and feeding raw offal to dogs.

The long-term dynamics of echinococcosis in the Andijan Region paint a picture of a resilient zoonosis deeply embedded in the socio-ecological fabric of the region. The shifting demographic burden onto the working-age population and the stable rural foci demand a decisive reorientation of control efforts from a curative to a preventive, ecology-based model. Without such a strategic shift, supported by sustained political and financial commitment, the cycle of transmission, disease, and economic loss is likely to persist for decades to come.

5. Conclusion

This comprehensive 25-year analysis (2000-2024) of cystic echinococcosis in the Andijan Region provides a definitive assessment of the disease as a persistent and significant public health and socio-economic challenge. The study conclusively demonstrates that despite ongoing medical interventions, the region remains a highly endemic focus, characterized by a fluctuating but unacceptably high average annual incidence of 3.8 per 100,000, which significantly exceeds the national average.

Several critical, long-term trends have been identified that necessitate a fundamental re-evaluation of current control strategies. Firstly, the epidemiological profile of the disease is evolving, marked by a notable "aging" of the patient population. The significant decrease in cases among children and the concurrent sharp increase among adults aged 31-60 shifts the burden squarely onto the most economically productive segment of society, thereby magnifying the societal impact of the disease. Secondly, the profound and persistent urban-rural disparity, with a nearly three-fold higher risk in rural areas, unequivocally confirms that the parasite's transmission cycle is firmly entrenched in agricultural practices and livestock husbandry.

The quantified socio-economic burden, exceeding an estimated $196,100 annually in direct and indirect costs, underscores CE not merely as a medical condition but as a substantial developmental and economic impediment to the region. This financial drain, coupled with the unquantified losses in the livestock sector, represents a continuous cycle of loss that affects both individual livelihoods and the broader regional economy.

Therefore, the findings of this research lead to an inescapable conclusion: a purely curative, human-health-centric approach has proven insufficient to control cystic echinococcosis in the Andijan Region. The stability of the natural focus and the shifting demographic burden demand a decisive strategic shift. A sustainable solution can only be achieved through the robust and integrated implementation of a "One Health" strategy. This paradigm shift must prioritize and synergize efforts across three pillars:

Aggressive Veterinary Public Health Measures: This is the cornerstone of effective control. It mandates the implementation of regular, high-coverage praziquantel deworming programs for dogs, particularly in high-risk rural districts, and the strict enforcement of regulations governing slaughterhouse practices and the safe destruction of infected livestock offal.

Enhanced Human Health Surveillance: Moving from passive case reporting to active surveillance through targeted ultrasound screening of high-risk occupational groups is crucial for early detection. This allows for less invasive, less costly treatment and better patient outcomes.

Comprehensive and Culturally-Sensitive Public Health Education: Sustained educational campaigns must target rural communities, focusing on specific high-risk behaviors, personal hygiene, and the critical links in the transmission cycle between dogs, livestock, and human health.

Without such a coordinated, preemptive, and ecologically-grounded approach, supported by sustained political will and funding, the cycle of transmission, human disease, and economic loss in the Andijan Region is destined to continue unabated. The data from this quarter-century of observation provide an unequivocal mandate for change.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

No financial or personal relationships with other people or organizations have inappropriately influenced the work reported in this manuscript. The research was conducted and the article was written solely based on the analysis of scientific and official data, without any commercial or financial incentives.

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