



Prevalence of cystic echinococcosis in pigs and goats slaughtered at a municipal abattoir in northern Peru

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Abstract

Cystic echinococcosis remains a neglected parasitic disease of public health concern in many developing countries, particularly in areas where livestock production and inadequate sanitary conditions coexist. This study aimed to estimate the prevalence of cystic echinococcosis and to evaluate potential risk factors in pigs and goats slaughtered at the municipal abattoir of Paita, northern Peru. A post-mortem inspection was conducted through systematic palpation and detailed macroscopic examination of lungs, heart, liver, spleen, and kidneys to detect hydatid cysts. Inspections were carried out weekly from January to June 2022. Data were processed using Microsoft Excel and statistically analyzed with SPSS version 22. The results revealed a prevalence of cystic echinococcosis of 1.6% in pigs, while no cases were detected in goats. Female pigs showed a higher prevalence (1.0%) compared to males (0.6%). The chi-square test applied to the evaluated risk factors showed no statistically significant association with the presence of hydatid cysts. Although the prevalence observed was low, the detection of cystic echinococcosis in slaughtered pigs highlights the need for continuous abattoir surveillance and strengthened control strategies to reduce the potential risk of transmission and its impact on public health.

Key words: Cystic echinococcosis; abattoir surveillance; post-mortem inspection; pigs; goats; public health

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1. Introduction

Parasitic diseases continue to represent a major but often underestimated burden on public health, particularly in developing countries where sanitary infrastructure and disease surveillance remain limited. Many parasitic infections are characterized by asymptomatic or subclinical courses, allowing their persistence and silent transmission within human and animal populations. Among the main transmission routes are the consumption of contaminated food products, including meat harboring parasitic cysts or eggs, as well as close contact with infected animals. In this context, livestock-associated zoonoses constitute a significant concern for both public health and food safety.

In Peru, pig and goat farming has expanded considerably in recent years, largely through small-scale and backyard production systems. These systems play an important socioeconomic role in rural areas, functioning as a source of household income and savings. However, they are frequently characterized by the absence of technical guidance, inadequate sanitary management, and limited access to basic services such as potable water, sewage systems, and veterinary assistance. Such conditions increase the risk of infectious and parasitic diseases, particularly in informal or clandestine production settings where sanitary regulations are poorly enforced.

Among zoonotic parasitic diseases, cystic echinococcosis represents one of the most relevant neglected tropical diseases worldwide. The disease is caused by cestodes of the genus *Echinococcus*, which includes several species of zoonotic importance, such as *Echinococcus granulosus*, *E. multilocularis*, *E. oligarthrus*, and *E. vogeli*. In Peru, *E. granulosus* is the predominant species, although morphological and biochemical variability within the genus has been reported. Cystic echinococcosis has a global distribution and is present across diverse geographic regions, including Europe, Africa, the Middle East, Asia, Australia, and the Americas, influenced by

agricultural practices, livestock management, socioeconomic factors, and cultural behaviors.

The transmission cycle of cystic echinococcosis is closely associated with the presence of domestic dogs, which act as definitive hosts. In rural and peri-urban areas, the high density of dogs per household, together with inadequate practices of responsible pet ownership, favors the maintenance of the parasite's life cycle. Free-roaming and community dogs, lack of regular deworming, and the feeding of dogs with raw or improperly disposed viscera from slaughtered animals contribute significantly to environmental contamination and disease transmission. Additionally, limited awareness of preventive measures and low access to health education further exacerbate the persistence of this zoonosis.

Abattoirs and municipal slaughterhouses play a crucial role in the surveillance of animal health and zoonotic diseases. Post-mortem inspection conducted by veterinary professionals provides a reliable source of epidemiological information on parasitic infections circulating in livestock populations. The detection of hydatid cysts during meat inspection not only reflects the sanitary status of the production areas but also contributes to identifying endemic zones and potential public health risks. However, many municipal abattoirs in Peru face infrastructural and operational deficiencies, including inadequate facilities, poor hygienic conditions, and the presence of dogs during slaughtering activities, which may perpetuate the transmission cycle of cystic echinococcosis.

Beyond its public health implications, cystic echinococcosis also generates substantial economic losses due to the condemnation and destruction of infected organs such as liver and lungs during post-mortem inspection. These losses directly affect producers and traders, particularly those operating at small scales, and further highlight the need for effective control and prevention strategies.

Given the limited epidemiological information available for northern coastal Peru, particularly regarding pigs and goats slaughtered under municipal conditions, abattoir-based studies are essential to improve disease surveillance. Therefore, the present study aimed to determine the prevalence of cystic echinococcosis in pigs and goats slaughtered at the municipal abattoir of Paita, northern Peru, providing evidence to support future control measures and public health interventions.

2. Materials y Methods

Study area and study population

The study was conducted at the municipal abattoir of Paita, located in the province of Paita, Piura region, northern Peru. The study population included all pigs and goats slaughtered at the facility during the period from January to June 2022. Animals originated from local producers and traders operating within the surrounding rural and peri-urban areas.

Post-mortem inspection

Data were obtained through systematic post-mortem inspections performed on slaughtered pigs and goats. Each carcass underwent a detailed macroscopic examination based on visual inspection and manual palpation of major organs, including lungs, heart, liver, spleen, and kidneys, in order to detect the presence of hydatid cysts. When necessary, additional incisions were made in the organs to improve visualization and confirm suspicious lesions compatible with cystic echinococcosis.

Data collection

Information was recorded using structured data collection forms completed at the time of slaughter. For pigs, the following variables were documented: breed, sex, production category, origin, presence or absence of hydatid cysts, access to technical assistance, availability of basic services, presence of dogs on the farm, type of feeding, deworming practices for dogs and pigs, type of housing facilities, and prior knowledge of cystic echinococcosis. All information related to farm management and sanitary practices was provided by the animal owners or traders.

For goats, data collection followed a similar procedure and included breed, sex, production category, origin, presence or absence of hydatid cysts, affected organs, access to technical assistance, availability of basic services, presence of dogs, deworming practices for dogs and goats, type of feeding, housing conditions, and awareness of cystic echinococcosis. Information was obtained directly from producers or traders responsible for the animals.

Statistical analysis

Descriptive epidemiological analyses were performed to calculate prevalence, frequencies, and percentages. Data processing and graphical representation were conducted using Microsoft Excel (Microsoft Office 2013). Statistical analyses were performed using SPSS version 22. The association between selected risk factors and the presence of hydatid cysts was evaluated using the chi-square test. The assessed variables included animal category, sex, access to technical assistance, availability of basic services, presence of dogs, knowledge of cystic echinococcosis, type of feeding, deworming practices for dogs and livestock, type of housing infrastructure, production system, and origin. Statistical significance was assessed at a conventional confidence level.

3. Results

A total of pigs and goats slaughtered at the municipal abattoir of Paita during the study period were examined through post-mortem inspection.

The prevalence of cystic echinococcosis detected in the evaluated animals is summarized in Table 1. Hydatid cysts were identified exclusively in pigs, with an overall prevalence of 1.6%, whereas no cases were detected in goats.

Table 1

Prevalence of cystic echinococcosis in pigs and goats slaughtered at the municipal abattoir of Paita, Peru

Month	Pigs			Goats		
	Number examined	Positive cases	Prevalence (%)	Number examined	Positive cases	Prevalence (%)
January	69	1	0.2	26	0	0
February	95	4	0.8	32	0	0

March	64	3	0.6	29	0	0
April	118	0	0	89	0	0
May	67	0	0	81	0	0
June	77	0	0	65	0	0
Total	490	8	1.6	322	0	0

The distribution of cystic echinococcosis according to production category is presented in Table 2. Positive cases were observed only in pigs, while all examined goats were negative regardless of production category. These findings indicate a limited circulation of the parasite among the slaughtered animals evaluated in this study.

Table 2
Prevalence of cystic echinococcosis in pigs and goats according to production category at the municipal abattoir of Paita, Piura, Peru

Pigs	Production category	Number examined	Positive cases	Prevalence (%)	Negative cases	(%)
	Sow	143	1	0.2	142	29
	Boar	46	2	0.4	44	9
	Female grower	158	4	0.8	154	31.4
	Male grower	140	1	0.2	139	28.4
	Male piglet	3	0	0	3	0.6
	Female piglet	0	0	0	0	0
	Total	490	8	1.6	482	98.4

Goats	Production category	Number examined	Positive cases	Prevalence (%)	Negative cases	(%)
	Male kid	27	0	0	27	6.2
	Female kid	54	0	0	54	0.8
	Female kid (young)	42	0	0	42	3.8
	Buck	13	0	0	13	1.5
	Doe	177	0	0	177	80.8
	Wether	9	0	0	9	6.9
	Total	322	0	0	322	100

Regarding organ involvement, hydatid cysts were detected in specific organs of infected pigs, as detailed in

Table 3. No affected organs were recorded in goats due to the absence of positive cases. Organ-level findings were based on macroscopic inspection during post-mortem examination.

Table 3
Organs affected by cystic echinococcosis in pigs and goats slaughtered at the municipal abattoir of Paita, Piura, Peru

Organ	Pigs (%)	Goats (%)
Liver	62.5	0
Kidney	37.5	0
Total	100	0

The evaluation of potential risk factors associated with cystic echinococcosis is shown in Table 4. The chi-square analysis revealed no statistically significant association between the presence of hydatid cysts and the assessed variables, including sex, production category, access to technical assistance, availability of basic services, presence of dogs, feeding practices, deworming practices, housing infrastructure, production system, or origin of the animals.

Table 4.
Evaluation of potential risk factors for cystic echinococcosis in pigs and goats slaughtered at the municipal abattoir of Paita, Piura, Peru

Risk factor	Category	Pigs (n)	Goats (n)
Production system	Intensive	490	0
	Mixed	0	0
	Extensive	0	322
Housing material	Rustic	490	322
	Improved	0	0
Basic services	Yes	0	0
	No	490	322

Feeding type	Concentrated feed	0	0
	Natural pasture	0	322
	Kitchen waste	490	0
	Mixed	0	0
Deworming (livestock)	Yes	490	322
	No	0	0
Presence of dogs	Yes	490	322
	No	0	0
Dog deworming	Yes	0	0
	No	490	322
Technical assistance	Yes	490	322
	No	0	0
Knowledge of cystic echinococcosis	Yes	0	0
	No	490	322

The geographic origin of slaughtered pigs and goats is summarized in Table 5. Positive cases detected in pigs were distributed among animals originating from local production areas within the province of Paita, reflecting the sanitary conditions of the surrounding livestock systems.

Table 5

Geographic origin of pigs and goats slaughtered at the municipal abattoir of Paita, Piura, Peru

District of origin	Pigs (%)	Goats (%)
Paita	100	0
Lancones	0	94.6
Marcavelica	0	5.4

4. Discussion

Cystic echinococcosis remains a parasitic disease of considerable public health importance, particularly in regions where livestock production coexists with limited sanitary control. In the present abattoir-based study, a low prevalence of cystic echinococcosis was detected in pigs (1.6%), while no cases were identified in goats slaughtered at the municipal abattoir of Paita during 2022. Although the observed prevalence was low, the detection of hydatid cysts in slaughtered pigs confirms the presence of the parasite in the study area and indicates ongoing transmission, even within an urbanized coastal setting.

The identification of infected pigs in an urban context is epidemiologically relevant, as it suggests that cystic echinococcosis is not restricted to rural or highland areas traditionally considered endemic. If control and surveillance measures are not sustained, the current low prevalence could increase over time, potentially posing a greater risk to public health. Similar observations have been reported in other regions where apparently low infection levels masked persistent transmission dynamics.

The increasing demand for pork and goat meat in northern Peru has driven the expansion of livestock production systems, particularly pig farming. In the district of Paita, pig production is concentrated in designated production parks, which collectively house several thousand animals. While these systems offer economic benefits, they may also represent potential sanitary risk points if biosecurity and parasite control measures are insufficient. In the present study, pigs classified as female growers showed the highest prevalence, which may be related to their higher frequency of slaughter due to market demand, body weight, and commercial value. In contrast, no infections were detected in piglets, suggesting either lower exposure or effective management practices in younger animals.

The low prevalence observed in pigs contrasts with higher values reported in other regions. For example, studies conducted in Tingo María and Cuenca, Ecuador, reported prevalences of 8.99% and 5.01%, respectively, in slaughtered pigs. Conversely, other investigations have reported an absence of hydatid cysts in pigs or low prevalence in goats, highlighting the heterogeneity of cystic echinococcosis distribution across geographic and production systems. These differences may reflect variations in husbandry practices, dog management, environmental contamination, and effectiveness of control programs.

Organ-level findings in infected pigs revealed that the liver was the most frequently affected organ, followed by the kidneys. This pattern is consistent with the biological behavior of *Echinococcus granulosus* larvae and has been reported in previous studies. No affected organs were recorded in goats, in line with the absence of positive cases. Comparisons with studies conducted in other countries indicate that liver and lungs are typically the most commonly involved organs, although the relative distribution may vary among host species and regions.

The evaluation of potential risk factors did not reveal statistically significant associations with the presence of hydatid cysts. Nevertheless, descriptive analysis highlighted several epidemiologically relevant conditions. All pigs originated from intensive production systems within the district of Paita, while goats were sourced from extensive systems in rural areas of the province of Sullana. The presence of dogs was reported in all production units, reflecting their role in farm security and livestock management, particularly in goat herding systems. Although all producers reported regular deworming of dogs and livestock, this information was based on self-reporting and may be subject to reporting bias.

Dogs play a central role in the transmission cycle of cystic echinococcosis, and previous studies have demonstrated the presence of *Echinococcus* eggs in canine feces even

in communities reporting deworming practices. Additionally, inadequate disposal of viscera and feeding of dogs with raw offal remain key risk factors in many endemic areas. The absence of statistically significant associations in this study may be partly explained by the low number of positive cases, which limits the power of inferential analyses.

Technical assistance was reported for all production units, reflecting the sustained involvement of national animal health authorities and veterinary professionals in the region. This factor may have contributed to improved management practices, including feeding strategies and parasite control, potentially explaining the low prevalence observed. However, despite these improvements, the complete lack of knowledge about cystic echinococcosis among producers highlights a critical gap in health education. Similar levels of limited awareness have been reported in other Peruvian regions, where misconceptions about transmission routes and zoonotic risk persist even in areas with ongoing control programs.

Although no statistically significant risk factors were identified, the presence of cystic echinococcosis in slaughtered pigs underscores the need to maintain and strengthen surveillance, education, and control strategies. Abattoir-based monitoring remains a valuable tool for assessing the sanitary status of livestock populations and identifying areas where intervention is needed. Continued efforts to improve responsible dog ownership, proper disposal of slaughter waste, and public awareness are essential to prevent the re-emergence and expansion of this zoonotic disease.

5. Conclusions

This abattoir-based study revealed a low prevalence of cystic echinococcosis in pigs slaughtered at the municipal abattoir of Paita, northern Peru, with an overall prevalence of 1.6% (8/490), while no cases were detected in goats (0/322). Despite the low prevalence, the presence

of hydatid cysts in pigs confirms the circulation of the parasite in the study area.

Among pigs, the highest prevalence was observed in female growers (0.8%), whereas no cases were detected in male or female piglets. Female pigs also showed a higher prevalence (1.0%) compared to males (0.6%), which may be related to production and marketing patterns influencing slaughter frequency.

Organ-level inspection indicated that the liver was the most frequently affected organ (62.5%), followed by the kidneys (37.5%), consistent with the known biological behavior of *Echinococcus granulosus*. No affected organs were recorded in goats due to the absence of positive cases.

The statistical analysis showed no significant association between the evaluated risk factors and the presence of hydatid cysts. The assessed variables included production system, availability of basic services, presence of dogs, deworming practices, feeding type, access to technical assistance, sanitary knowledge, and geographic origin.

All pigs originated from intensive production systems within the district and province of Paita, whereas goats were sourced mainly from the districts of Lancones (94.6%) and Marcavelica (5.4%) in the province of Sullana. These findings reflect the sanitary conditions of the local livestock systems supplying the municipal abattoir.

Although no statistically significant risk factors were identified, the detection of cystic echinococcosis in slaughtered pigs highlights the importance of maintaining abattoir surveillance, strengthening health education, and sustaining control measures to prevent the persistence and potential expansion of this zoonotic disease.

7. Author Contributions

All authors made substantial contributions to the study, including (1) the conception and design of the research, data acquisition, and data analysis and interpretation; (2) drafting the manuscript and critically revising it for important intellectual content; and (3) final approval of the version to be published.

8. Conflict of Interest

The author declares that there are no conflicts of interest associated with this study.

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