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Research Article

Detection of Echinococcus Granulosus and Mycobacterium Tuberculosis Co-Infection among Patients Attending Some Selected Hospitals In Gusau, Zamfara State

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Abstract: Cystic Echinococcosis (CE) and tuberculosis (TB) are significant public health concerns globally, particularly in endemic regions. CE is caused by Echinococcus granulosus, and TB is caused by Mycobacterium tuberculosis, which both poses substantial health risks and economic burdens.This study investigated the prevalence of Echinococcus granulosus, Mycobacterium tuberculosis (MTB), and their co-infection among patients, with emphasis on demographic and associated factors. A total of 185 participants were screened using serological and molecular techniques, including ELISA for E. granulosus and GeneXpert for MTB. The findings revealed a prevalence of 12.97% for E. granulosus, 14.05% for MTB, and 2.16% for co-infection. Females and participants within the 21–40 years age group were more affected, indicating that gender and age may be important determinants of infection. Risk factors such as close contact with livestock, poor hygiene, overcrowding, and socioeconomic status contributed significantly to infection rates. The co-infection rate, though relatively low, highlights a clinically important overlap between parasitic and bacterial pathogens that share common risk environments. This interaction may complicate diagnosis and treatment outcomes, particularly in endemic regions where healthcare resources are limited. The study underscores the need for integrated diagnostic approaches and public health interventions that target both zoonotic and bacterial diseases simultaneously. To the best of current knowledge, this is the first cross-sectional study in the region to report the detection of human cystic echinococcosis and tuberculosis co-infection. The findings contribute to the understanding of disease burden, potential immunological interactions, and epidemiological trends of these pathogens. Strengthening surveillance, promoting community health education, and improving diagnostic capacity are recommended to reduce the impact of these infections.

Keywords: Echinococcus granulosus, Mycobacterium Tuberculosis, Co-infection, Prevalence, Zoonotic Transmission, Risk Factors, Pathogen

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1. Introduction

Echinococcus granulosus,the causative agent of cystic echinococcosis (CE) is classified among major neglected tropical zoonotic diseases by the World Health Organization (Hogeaet al, 2023) and is one of the helminthic diseases with the widest geographic distribution, existing in all continents of the world and more so in Nigeria, with the exception of only Antarctica (Prasad et al, 2020). As reported E. granulosus infection lowers the body immune system making it more susceptible to secondary infections

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(Kakkoset al., 2001). The life cycle is complex, involving two hosts and a free-living egg stage. The dynamics of the transmission of the parasite are determined by the interaction of factors associated with these two hosts and with the external environment. Some of the factors that perpetuate cystic echinococcosis in humans may include farming activities involving livestock and dogs as well as home-slaughtering practices and dogs scavenging within abattoir premises (Wahlers et al., 2011). Cystic echinococcosis is regarded as a global public health concern and is endemic in many parts of the world including sub-Saharan Africa (Pal et al., 2022). Echinococcus granulosus has a worldwide geographic distribution and occurs in all continents with high prevalence in parts of Asia, Africa, Australia and South America (Ali et al., 2024). Cystic echinococcosis (CE) has been identified as a zoonotic infection especially in rural livestock-raising areas where humans cohabit with dogs which feed on raw livestock offal and poorly disposed carcass of herbivores intermediate host (Pukumaet al., 2023). Feeding dogs with raw viscera of infected animals contributes to perpetuating the life cycle of Echinococcus granulosus (Tamarozziet al., 2020). Human infection can develop cystic lesions, principally in liver and lungs after several years (Govindasamyet al., 2023). Tuberculosis (TB) has existed for over 4,000 years with evidence of its presence found in ancients civilizations (Roberts et al., 2020). Globally, the best estimate is that 10.0 million people (range, 9.0–11.1 million) developed TB disease including 5.8 million men, 3.2 million women and 1.0 million children. There were cases in all countries and age groups, but overall, 90 % were adults (aged ≥15 years), 9 % were people living with HIV (WHO, 2018).Nigeria is classified among the 14 high burden countries for TB/HIV and MDR-TB. In its incidence rating of all forms of TB, it was 219/100,000 population (WHO, 2018). A total of 432 Nigerians dies daily from TB with estimated 115,000 dying each year with its case detection rate of 24% and an estimated 500,000 new cases with only 104,904 cases notified to the NTBLCP (WHO, 2018). Tuberculosis programmes use direct smear examination of sputum but, if resources permit, culture is desirable. Reliable susceptibility testing is a luxury few developing countries can afford, although it is especially desirable for purposes of re-treatment. Rapid methods of culture and susceptibility testing are widely available in the wealthier nations. Molecular techniques have provided quick, sensitive, and specific tests for Mycobacterium tuberculosis—such as polymerase chain reaction (NCCC, 2006).

2. Methodology

The study was cross-sectional prospective study using a convenience sampling technique. Ethical approval for the research was obtained from the Health research ethics committee of Zamfara State Ministry of Health with reference number ZSHREC23012025/274 (Appendix III) before the commencement of the study.The study was carried out at King Fahad Women and Children Hospital Gusau and General Hospital Gusau, Zamfara State. Patients presented with cough, fever and consented to participate in the study.The sample size of this study was determined using the formula (Nainget al., 2006) approximately 168. A well-structured questionnaire was administered to the consented participants and the data was collected using structured questionnaire, 3ml of whole blood was collected using Monovette® blood collection bottles. The blood collected was labelled and then allowed to clot. The clotted blood was centrifuged at 3000 rpm for 10 minutes using centrifuge. The serum obtained was transferred into sterile serum separation tubes and stored immediately at -20 until used. The Echinococcus IgG antibody test kit is based on the principle of the enzyme immunoassay (EIA). The GeneXpert MTB/RIF automated in vitro diagnostic test using nested real-time PCR for the qualitative detection of MTB-complex and RIF resistance a used.Each Genexpert cartridge was labeled with sample serial number. Sputum container lid was unscrewed and prepared 2 volumes of sample reagents to 1 volume of sample (ratio of 2:1) and lid was closed. It was shaked vigorously for 20 times. It was incubated for 5 minutes at room

temperature. It was shaked again for 20 times. It was incubated for another 10 minutes.The sample was observed completely and no clumps of sputum are visible. It was shaked again and incubated for another 5 minutes (Cepheid, 2019).The data collected and result obtained was analyzed using statistical package for the social sciences (SPSS) version 20.0. The result was presented in form of tables and chart using statistical tests. Test for normality was performed to ascertain normal distribution of the variables. Chi-square test was used to analysed frequency distribution and association between variables. The Echinococcus IgG antibody test kit is based on the principle of the enzyme immunoassay (EIA). Echinococcus antigen is bound on the surface of the microtiter strips. Diluted patient serum or ready-to-use standards are pipetted into the wells of the microtiter plate. A binding between the IgG antibodies of the serum and the immobilized Echinococcus antigen takes place. After one hour incubation at room temperature, the plate is rinsed with diluted wash solution, in order to remove unbound material. Then ready-to-use anti-human-IgG peroxidase conjugate is added and incubated for 30 minutes. After a further washing step, the substrate (TMB) solution is pipetted and incubated for 20 minutes, inducing the development of a blue dye in the wells. The color development is terminated by the addition of a stop solution, which changes the color from blue to yellow. The resulting dye is measured spectrophotometrically at the wavelength of 450 nm. The concentration of the IgG antibodies is directly proportional to the intensity of the color. All standards and samples were added in duplicate to the microelisastripplate. Separately, fifty microliter (50µL) of sample, positive and negative control was added in to sample, positive and negative well respectively. One hundred microliter (100µL) of HRP-conjugate reagent were added in to each well. Plate was covered with the enclosed foil and incubated at 37°C for 60 minutes. The wells of the plate were aspirated and washed four times for a total of five times by adding 400µL of diluted washing solution. Rests of the washing buffer was afterwards removed by gentle tapping of the microtiter plate on a tissue cloth. Fifty microliter (50µL) each of chromogen solution A and B were added in to each well. It was gently mixed for 15 minutes at 37°C and protected from light. Fifty microliter (50µL) of stop solution was added in to each well. The optical density was read at 450 nm within 15 minutes. (Ahmad et al., 2017).The results were considered statistically not significant when the p-value is ≥ 0.05

3. Results

Out of one hundred and eighty five (185) participants recruited for this study, twenty four (24) tested positive for EC IgG antibodies thus accounting for overall prevalence of 12.97%. Out of the 185 recruited for the study, 1 (0.54%) was positive within age range of 10-19 years, 8 (4.34%) were positive among 20-29 age group, 3 (1.62%) were positive among 30-39 age group, 5 (2.70) were positive among 40-49 age group, 3 (1.62%) were positive among 50-59 age group, 2 (1.08) were positive among 60-69 age group, 1 (0.54%) was positive for age bracket 70-79 and 80-89 age groups each (Table 1).

Table 4.1 Seroprevalence of Echinococcus granulosus among the study participants

Age group	Frequency (n)	Positive (%)	χ^2	p-value
10-19	7	1 (0.54)	3.58	0.83
20-29	56	8 (4.32)		
30-39	38	3 (1.62)		
40-49	36	5 (2.70)		
50-59	20	3 (1.62)		

60-69	14	2 (1.08)
70-79	12	1 (0.54)
80-89	2	1 (0.54)
Total	**185**	**24 (12.97)**

n = Frequency, % = percentage, χ^2 = Chi-square, p-value = Probability value ≥ 0.05 is considered statistically not significant.

Out of the 185 participants recruited for this study, 10 (5.4%) tested positive out of the 80 male participants and 14 (7.57%) tested positive out of the 105 female participants recruited (Fig 1).

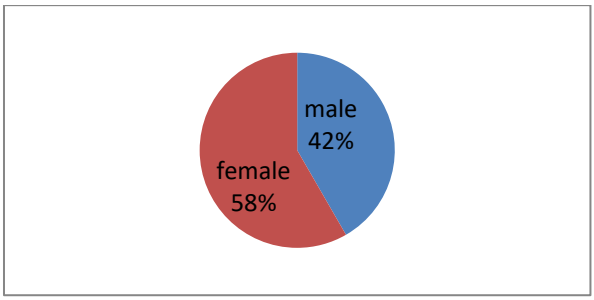

Figure 4.1: Gender distribution of Echinococcus granulosus among the study participants.

Out of the one hundred and eighty five (185) participants recruited for this study, 26 tested positive for MTB using GeneXpert thus accounting for overall prevalence of 14.05%. Out of the 185 recruited for the study, none tested positive within age range of 10-19 years, 9 (4.86%) were positive among 20-29 age group, 6 (3.24%) were positive among 30-39 age group, 4 (2.16%) were positive among age bracket 40-49 and 50-59 age bracket each and (0.54) were positive among age bracket 60-69, 70-79 and 80-89 each (Table 4.2).

Table 4.2 GeneXpert detection of Mycobacterium tuberculosis among the study participants

Age group	Frequency (n)	Positive (%)	χ^2	p-value
10-19	7	0 (0.00)	4.50	0.72
20-29	56	9 (4.86)		
30-39	38	6 (3.24)		
40-49	36	4 (2.16)		
50-59	20	4 (2.16)		
60-69	14	1 (0.54)		
70-79	12	1 (0.54)		
80-89	2	1 (0.54)		
Total	**185**	**26 (14.05)**		

n = Frequency, % = percentage, χ^2 = Chi-square, p-value = Probability value ≥ 0.05 is considered statistically not significant.

Out of the 185 participants recruited for this study, 18 (9.72%) tested positive out of the 80 male participants and 8 (4.32%) tested positive out of the 105 female participants recruited (Fig 4.2)

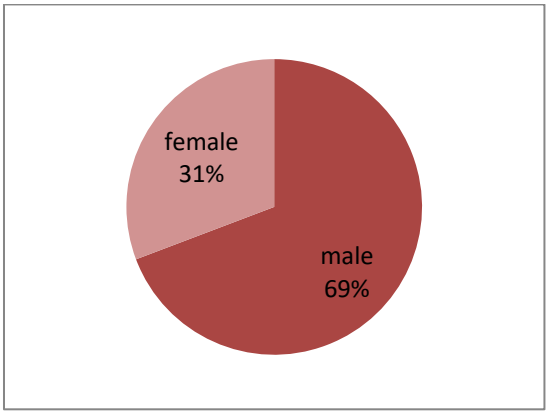

Figure 4.2: Gender distribution of MTB among the study participants

Out of the one hundred and eighty five (185) participants tested for both Echinococcus granulosus and Mycobacterium tuberculosis recruited for this study, 4 tested positive for EG IgG antibodies and MTB using GeneXpert thus accounting for overall prevalence of 2.16%. Out of the 185 recruited for the study, none tested positive within age bracket of 10-19, 20-29, 50-59 and 70-79 years each. 1 (0.54%) were positive among age bracket 30-39, 40-49, 60-69 and 80-89 each (Table 4.3).

Table 3 Co-infection of Echinococcus granulosus and Mycobacterium tuberculosis among study participants

Age group	Frequency (n)	Positive (%)	χ^2	p-value
10-19	7	0 (0.00)	25.56	0.02
20-29	56	0 (0.00)		
30-39	38	1 (0.54)		
40-49	36	1 (0.54)		
50-59	20	0 (0.00)		
60-69	14	1 (0.54)		
70-79	12	0 (0.54)		
80-89	2	1 (0.54)		
Total	**185**	**4 (2.16)**		

n= Frequency, % = percentage, χ^2 = Chi-square, p-value = Probability value ≥ 0.05 is considered statistically not significant.

Out of the 185 participants recruited for this study, 3 (1.62%) tested positive out of the 80 male participants and 1 (0.54) tested positive out of the 105 female participants recruited (Fig 4.3).

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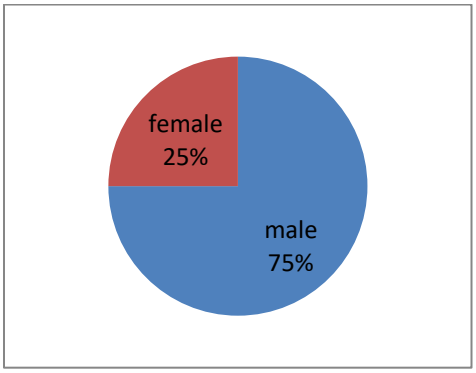

Figure 3 Gender distribution of Echinococcus granulosus and Mycobacterium tuberculosis co-infection

Out of the 185 participants recruited, 127 were from rural setting with 17 (9.18%) tested positive. 58 were from urban settings with 7 (3.78%). There was a statistically observed significance with the distribution based on lives stock farming where 11 (5.94) livestock farmers tested positive out of the 37 recruited, while 13 (7.03) out of the 148 non-livestock farmers recruited (p=0.01). There was no statistically observed relationship between EG infection among 57 dog owners where 8 (4.32) were positive and 16 of 128 non-dog owners tested negative (p=0.77) (Table 4).

Table4 Distribution of Demographic characteristic factors associated with Echinococcus granulosus and Mycobacterium tuberculosis co-infection

Demographic Factors	Positive	Negative	Total	χ^2	p-Value
Urban/Rural					
Rural	17	110	127	0.06	0.81
Urban	7	51	58		
Livestock Farmer					
Yes	11	26	37	11.50	0.01
No	13	135	148		
Dog Owner					
Yes	8	49	57	0.08	0.77
No	16	112	128		
Liver/Lung Diseases					
Yes	0	12	12	0.25	0.59
No	4	169	173		
Asthma					
Yes	0	4	4	0.09	0.76
No	4	177	181		

n = Frequency, % = percentage, χ^2 = Chi-square, p-value = Probability value ≥ 0.05 is considered statistically not significant.

4. Discussion

This recorded an overall seroprevalence of 12.97% of Echinococcus granulosus which reflects the findings of Galehet al. (2018) in the eastern part of Iran that reported a prevalence of 10.7%. The result of our findings is comparatively lower than in Pakistan by Khan et al. (2022) that reported 21.0%. This high prevalence could be alluded to unregulated slaughtering (home or bush slaughter) and lack of veterinary supervision that increase the risk of infected animal organs being consumed by dogs and aid in the transmission of diseases.Andrabiet al. (2020) recorded seroprevalence rate of 4.4% lower than south Kashmir, India, which is lower than our findings. Moreover, Bitruset al. (2020) reported 3.3% prevalence in Jos.This study recorded the highest positivity rate of Echinococcus granulosus in participants aged 20–29 years (4.32%), followed by the age group 40–49 years (1.62%). Young adults of this age groups may be more likely to engage in agricultural or live-stock related activities, increasing their exposure to the infected animals, such as dogs or contaminated environment. Another reason might be due to lower education levels have been linked to a higher incidence of Echinococcus granulosus, potentially due to limited knowledge about the risk of the disease and poor hygiene practice. Our finding is similar to the findings of Salamaet al. (2014) that reported prevalence of 47.8% and 46.7% in the age group. In contrast, Andrabiet al. (2020) reported lower positivity rate among 1-17-years age group, this could be due to proper parental supervision given to the younger individuals of this age group which may reduce their likelihood of engaging in high-risk behaviours and they are less likely to be involved in agricultural or livestock related activities that increase the exposure to infected animals.
This study shows higher prevalence of Echinococcus granulosus in females 7.57% than males 5.4%,which is similar to the findings of Khaliliet al. (1990) and Craig et al. (2007).This could be attributed to the active involvement of most women in domestic and agricultural activities that brings them into direct contact with livestock and dogs on regular basis. Moreover, most of the women interviewed in our study demonstrated low level of understanding about the epidemiology of E. granulosus, and are therefore prone to unhygienic habits (not washing of hands properly before eating, drinking contaminated water without boiling, preparation of locally made salad with vegetables from the back yard farms without proper washing with brine) that exposes them to the risk of contracting the infection.

The overall prevalence of Mycobacterium tuberculosis using Cepheid GeneXpert technique was 14.05%, which is comparatively similar to the findings of Olalubiet al. (2020) who reported 13.4% in Ilorin, Nigeria.10.8% was reported in southeastern Nigeria by Ahiarakwem et al. (2020). Also 10.0% were reported in Adamawa, North-East Nigeria by Omisore et al. (2019), In contrast, Semuniguset al. (2016) reported 2.6% and Elisoet al. (2015) also reported 4.6%. This lower prevalence might be due access to health care, which include timely diagnosis and treatment that reduce the duration of the disease and transmission. Prevalence of Mycobacterium tuberculosis recorded in this study is greater than 3.3% reported by Otokunefor et al. (2018), in Port Harcourt, south-southern Nigeria. Also 7.3% reported by Ukwamedua et al. (2019), in South-South Nigeria; 7.4% reported in South-western Nigeria by Kuyinu et al. (2018). This could be due to differences in methodology. The findings revealed higher prevalence of Mycobacterium tuberculosis in males than in females with 9.7% and 4.32%, this is similar to the findings of Neyrolles and Quintana (2009) who reported (10.6%) for males and (6.1%) for female. This is consistent agrees with WHO report in 2012 that the prevalence of TB is more common among men

than women. This is substantiated by Kaulagekaret al. (2007) that the inability of women in reaching health facilities.

The higher prevalence of M. tuberculosis cases were found in age group of 20–29 years which is consistent with previous findings of Abdellaet al. (2015) in Ethiopia. This might be due to outdoor activities that expose them to the tuberculosis infected individuals.

This study recorded 2.16% co-infectionamong the study participants which is similar to 2.5% reported in northern China by Yang et al. (2009). This could be due to close contact of livestock such as sheep, goats or cattle which may increase risk factors for CE, while also being vulnerable to TB due to socioeconomic factors. Individuals living in poverty and poor living may be more susceptible to both CE and TB, due to limited access to health care, poor sanitation and increase exposure to infected animals.

In this study, the prevalence of co-infection cases were found in age group of 30–39 years (0.54%), 40-49 years (0.54%), 60-69 years (0.54%), and 80-89 years (0.54%), which was statistically significant. also it was higher in males 1.62% than females 0.54%. which was found to be not significant.

This is in accordance with previous cases report of CE/TB co-infection by Jalayeriet al. (2024), who reported 58-year old female patient at SayyadShirazi Hospital, Gorgan, Iranin Iran. A 62-year-old male healthcare worker in Austria was reported having co-infection by Dalleret al. (2025). Also, another case report of a 45 year old woman in Sinnar, Sudan by Mohamed et al. (2025), who's reported the occurrence of co-infection. Similarly, there is another case report by Saeedet al. (2009) reported the co-infection in a 60-year-old female in India where by the Histology showed concomitant hydatid disease and tuberculosis.

Our study revealed that dog ownership was not a risk factor for E. granulosus seropositivity, which implies that infection in human with E. granulosus is not restricted to those who own dogs. This could be explained by the fact that the common practice in most of the study area is to allow dogs to roam freely and scavenge on improperly disposed offal and diseased organs, and defecating in the open thereby contaminating the environment and consequently exposing humans especially children to the risk of E. granulosus infection. This is further compounded by ignorance about E. granulosus transmission cycle, lack of veterinary care for dogs, multi-species animal rearing without herd health program, unauthorized slaughter of animals without proper meat inspection and other unhygienic behaviours by most of the rural dwellers.

A significant association was found between being a livestock farmer and E. granulosusseropositivity with prevalence of 5.94%. This reinforces existing literature showing that people in regular contact with livestock have a higher risk of exposure due to the parasite's life cycle. However, dog ownership and rural/urban residence did not show significant associations.

5. Conclusion

E. granulosusinfection that is presumed to be neglected is still prevalent in the population. Insufficiency of testing could be what masks the reality of transmission of the parasitic infection. Coexisting Echinococcus granulosus and Mycobacterium tuberculosis in individual is an extremely rare occurrence. Given the similarities in the clinical manifestations and morbidities of both, specific diagnosis in individuals co-infected with these is difficult.

This pioneering cross-sectional study represents the first investigation of Echinococcus granulosus and Mycobacterium tuberculosis co-infection in Nigeria, analyzing a cohort of 185 participants.

The observed prevalence rates of 12.97% for Echinococcus granulosus, 14.05% for Mycobacterium tuberculosis, and 2.16% for co-infection highlight a notable public health burden in rural Nigerian communities. The convergence of risk factors underscores the need for integrated surveillance, improved diagnostic access, enhanced veterinary and hygiene interventions, and context-tailored health education. Coexistence of TB and CE disease is rare, but not unknown. The diversity of the clinical presentations warrants the need for diagnosis by a multimodality approach with clinicoradiological, serological, and microbiological correlation.

6. Recommendation

Based on the findings in this study, the following recommendations were made;

1. Enhance Active Case Detection of Echinococcus granulosus and Mycobacterium tuberculosis: Investigate the impact of deploying advanced diagnostics (e.g., GeneXpert for TB, ultrasound/ELISA for CE) alongside active case-finding in high-burden zones and high-risk demographics, including livestock farmers and strengthen surveillance at all healthcare patient interaction points.
2. Strengthen NTBLCP Resources and Accessibility: Secure sustainable funding and logistical support for the National Tuberculosis and Leprosy Control Programme to effectively reach rural and underserved women, regardless of educational level or social status.
3. Evaluate Community Engagement and Education Interventions: Assess combined public health campaigns that promote TB symptom awareness (e.g., persistent cough ≥2 weeks) and CE hygiene practices (handwashing, safe food preparation, dog deworming).
4. Assess Veterinary and Slaughterhouse Controls: Research the effectiveness of enhanced veterinary oversight including slaughter regulations, dog deworming frequency, and livestock vaccination (e.g., EG95)—in interrupting the CE transmission cycle from livestock to dogs and humans.
5. Investigate Integrated One-Health Models: Pilot multidisciplinary One-Health initiatives that combine TB and CE surveillance, diagnostics, veterinary services, and community mobilization. Evaluate outcomes related to disease prevalence, program sustainability, and cost-effectiveness in Nigeria's endemic rural settings.
6. Clinicians should be aware that cystic echinococcosis and tuberculosis may coexist and clinical presentation could be largely atypical which may lead to initial misdiagnosis.

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