



Original article

Awareness and knowledge of human cystic echinococcosis among at-risk individuals in Ibadan, Oyo state, Nigeria

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ABSTRACT

Introduction: Human cystic echinococcosis (CE) is a neglected zoonotic disease caused by *Echinococcus granulosus*. Its prevalence has been established in dogs and environmental samples in Ibadan. However, its level of public awareness and knowledge is unknown. We determined the awareness and knowledge level of human CE and associated factors among the at-risk population in Ibadan, Oyo State, Nigeria.

Methods: A pretested interviewer-administered structured questionnaire was used to obtain data on demography, sanitary practice, awareness and knowledge levels of human CE, attitudes, and practices from 453 at-risk individuals. Descriptive statistics, chi-square test, and logistic regression were done at $\alpha_{0.05}$.

Results: The mean \pm standard deviation age of the respondents was 29.1 ± 10.3 years. Only 62 (13.7%) respondents were aware of the disease. Being less than 36 years old (Adjusted OR (AOR): 3.0; 95% CI: 1.2 – 7.2), having a garden (AOR: 2.8; 95% CI: 1.5 – 5.2), and having at least a dog (AOR: 1.9; 95% CI: 1.0 – 3.6) were predictors of human CE awareness. Of those aware, 45 (72.6%) had good knowledge of the disease. Having at least a dog was associated with good knowledge of human CE (OR: 4.9; 95% CI: 1.3 – 20.1). Most 295 (65.1%) believe that washing vegetables with water only is sufficient to cleanse them, and in practice, only 105 (23.2%) have never eaten unwashed vegetables or fruits.

Significance: The awareness of human CE among potentially at-risk individuals in Ibadan is low. There is a need to increase public awareness of human CE.

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Introduction

Human echinococcosis is a zoonotic disease caused by tapeworm of the genus *Echinococcus*. Four forms of the disease have been identified which are the cystic form or hydatidosis caused by *E. granulosus*; alveolar form caused by *E. multicaulis*; polycystic form caused by *E. vogeli*; and unicystic form caused by *E. oligarthrus*. The cystic and alveolar forms of echinococcosis are of medical and public health importance. Currently, more than a million people are affected globally with echinococcosis with an estimated death of 19300 annually (WHO, 2021).

Dogs and other carnivores are the definitive hosts for *Echinococcus* where the adult tapeworm can be found in the intestines and they shed the eggs in their faeces. The intermediate hosts in cystic echinococcosis are the herbivores including sheep, goats, cattle, donkeys, camels, and omnivores such as pigs; while rodents play a major role in alveolar echinococcosis (CDC, 2012). The intermediate hosts, which harbor the larval stage of the tapeworm in the visceral organs, are exposed to the

the infection through ingestion of the tapeworm eggs in food, water and soil contaminated by the definitive hosts (CDC, 2012). The definitive hosts, on the other hand, are exposed by consumption of the encysted larva in the visceral organs of the intermediate hosts (WHO, 2021). Humans are exposed in a similar pattern to the intermediate host but are regarded as accidental hosts since the transmission life cycle of the tapeworm can be maintained in nature between the definitive and intermediate hosts (Possenti, *et al.*, 2016). Humans can also be inadvertently exposed through direct ingestion of the tapeworm eggs from contact with infected dogs in poor hygienic conditions. Studies have shown an association between dog ownership and human cystic echinococcosis (Possenti, *et al.*, 2016; Othieno *et al.*, 2017).

The cystic form of human echinococcosis is more globally spread than the alveolar form. The signs and symptoms of human cystic echinococcosis (CE) usually take long even years to manifest and often depend on the location of the cysts. The frequent predilection sites for tapeworm cysts are the liver and lungs, however, cysts can also be found in the spleen, kidneys, muscles, central nervous system and bones. Common signs and

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and symptoms included abdominal pain, nausea and vomiting when cysts are located in the liver, and chronic cough, chest pain and shortness of breath if in the lungs. Other signs and symptoms are anorexia, weight loss and weakness. Cases and serological evidence of human CE have also been reported in human immunodeficiency virus (HIV) infected individuals (Javed *et al.*, 2012; Ran *et al.*, 2016; Sharifi *et al.*, 2021) and slaughterhouse workers (Youssefi *et al.*, 2018; Alvi *et al.*, 2021). In Nigeria, reports on and prevalence of human CE are scarce or under-reported despite moderate to high prevalence in animals (Ohiolei *et al.*, 2020). However, recently, a case of human CE in the eye was reported in a female patient in Oyo State, Nigeria (Fasina and Ojo, 2017). Appropriate and regular deworming of dogs with praziquantel, control of stray dogs, improved abattoir hygiene and waste disposal methods, proper washing of hands with soap and water after touching dogs and before eating or cooking, and public education campaigns have been found to reduce risk of exposure and prevent transmission of echinococcosis (CDC, 2012; WHO 2021). However, the level of public awareness of the disease in Nigeria is unknown. Therefore, the study aimed to inform control and prevention by assessing the level of awareness and knowledge of at-risk populations on human CE in Ibadan, Oyo State, Nigeria.

Materials and methods

Study Area

The study area was Ibadan, Oyo State with an estimated total area of 3,080 square kilometres (Figure 1). Ibadan has eleven (11) Local Government Areas: Ibadan North, Ibadan North-East, Ibadan North-West, Ibadan South-East, Ibadan South-West, Akinyele, Egbede, Ido, Lagelu, Ona Ara, and Oluyole (Oluwaseyi, 2014). The human population of Ibadan was estimated to be 3,649,000 in 2021 (PS, 2021). Five of the 11 LGAs were purposively selected for this study and these include: Ibadan North, Ibadan South-East, Oluyole, Ido and Akinyele (Figure 1). The selection of the LGAs was based on the location of a Veterinary Teaching Hospital, a central abattoir, the presence of stray dogs, dense market activities and presence of taeniid eggs and CE in dogs, environmental samples (Awosanya and Ndiaye, 2020; Awosanya *et al.*, 2022) and a case report of human CE in the state (Fasina and Ojo, 2017). The study locations were the Veterinary Teaching Hospital, University of Ibadan; Ibadan Central Abattoir, Amosun; Mobile HIV/AIDS screening units at Beere, Molete, Challenge, Orita, New garage, Apata and Ajibode.

Study design and period

The study design was a cross-sectional survey from March through to October 2022.

Study population

The study populations were individuals who were at potential risk of human CE. These included owners or breeders of dogs; abattoir workers and individuals who presented themselves for

HIV/AIDS screening including drivers, market men and women, Point-of-Sale agents, students, hawkers, hairdressers, tailors and other walks of life.

Sample size calculation and sampling

The sample size calculation for a single proportion was done using the Thrusfield formula (Thrusfield 2007):

$$n = [(Z^2 * p * (1 - p)) / d^2].$$

Where Z is the reliability coefficient at 95% confidence level with a value of 1.96; p is the proportion of those who were aware and have adequate knowledge of human CE estimated at 0.5. The margin of error (d) was 5%. This gave a minimum sample size of 385. However, after adjusting for 15% non-response: $n' = n / 1 - f$ (Thrusfield 2007), where n' is the adjusted sample size, n is the unadjusted sample size, and f is the correction factor (0.15), a total of 453 respondents were engaged in the study. These included the following at-risk populations: 100 clients who presented their dogs at the Veterinary Teaching Hospital, University of Ibadan; 100 abattoir workers at the Ibadan Central Abattoir, Amosun; and 253 individuals who presented themselves for HIV/AIDS screening at the various mobile screening units. The sub-category ratio 1:1:2.53 was based on the infinite population of the general population screened for HIV/AIDS compared to finite populations of dog owners and abattoir workers. Total sampling was adopted until the sample size was attained. Individuals who were less than 17 years and those who refused to give consent were excluded from the study.

Data collection

A pretested interviewer-administered structured questionnaire was used to obtain data on demography, sanitary practices, awareness and knowledge of human CE, attitude towards prevention and control, and practices that could protect from or predispose to human CE. The knowledge level was assessed using a 10-item questionnaire. The Cronbach's Alpha coefficient for assessing the internal consistency of the questionnaire was 0.82 for the knowledge section. Other sections of the questionnaire had 10 items on attitude and 3 items on practices. The questionnaire was pre-tested among individuals similar to the study participants ($n = 10$) in a LGA not included in the study, and content validation was done by an expert. Feedbacks from the pretest were used to improve the questionnaire.

Ethical considerations: The study was not invasive, however informed consent was obtained from study participants. Confidentiality of the data and identity protection were maintained. This was achieved by removing any personal identifying information from the data collected, such as names or addresses. All participants were treated with respect and dignity throughout the study. This included ensuring that no participant was coerced or pressured into participating in the study.

Data analysis

The statistical analyses were conducted using Microsoft Excel 2016 (Microsoft Corp., Redmond, USA) and Epi Info version 7.2.5.0. QGIS version 2.18 was used to design the map of the study area. In assessing the knowledge level, each item had a

score of one resulting in a maximum obtainable score of 10. Items with multiple answers were prorated to a score of one. A score of five (5) and above was adjudged as good, while a score less than five was adjudged fair. The outcome variables were the awareness (have heard of human CE) level and knowledge (depth of information) of human CE. Descriptive statistics such as frequencies, mean and standard deviation were used in summarizing the data on demography, awareness, knowledge, attitudes and practice. Odds ratios were calculated to assess association between the outcome variables and demographic variables and other sanitary practices. Chi-square test was conducted to determine statistical significance in the level of associations. Logistic regression was done to determine factors that were predictors of awareness of human CE at 5% level of significance.

Results

Socio-Demographic Characteristics of Respondents

The mean age of the respondents was 29.1 ± 10.3 years. Of the 453 respondents, 283 (62.5%) were male and 309 (68.2%) were never married. Less than half 207 (45.7%) have gone for medical checkups in the last year. Only 139 (30.7%) had a garden, of which more than half 82 (59.0%) used gloves during gardening. Slightly above a third 179 (39.5%) had at least a dog, of these, 118 (65.9%) presented their dogs for deworming at veterinary clinics, and the majority 135 (75.4%) washed their hands after touching their dogs (Table 1).

Respondents' Awareness level of human cystic echinococcosis and associated factors

Only 62 (13.7%) respondents have heard of human cystic echinococcosis. Individuals presenting their dogs at the Veterinary Teaching Hospitals were twice (OR: 2.1; 95% CI: 1.1 – 3.7) more likely to have heard of human CE than those individuals presenting for HIV/AIDS screening. Respondents who are less than 36 years old were three times (OR: 3.3; 95% CI: 1.4 – 7.9) more likely to have heard of human CE than older individuals. Other factors associated with human CE awareness included having gone for a medical checkup in the last one year (OR: 2.9; 95% CI: 1.6 – 5.1); having a garden (OR: 3.9; 95% CI: 2.2 – 6.7) and having at least a dog (OR: 3.0; 95% CI: 1.7 – 5.3) (Table 2). However, being less than 36 years old (Adjusted OR (AOR): 3.0; 95% CI: 1.2 – 7.2), having a garden (AOR: 2.8; 95% CI: 1.5 – 5.2), and having at least a dog (AOR: 1.9; 95% CI: 1.0 – 3.6) remained predictors of human CE awareness adjusting for other variables (Table 3).

Respondents' knowledge level of human cystic echinococcosis and associated factors

Of the 62 respondents who had heard about human CE, the majority 46 (74.2%) knew that it is caused by a parasite. Only 6 (9.7%) did not know about any of the symptoms, and most 41 (66.1%) knew it could take months and sometimes even years

before clinical manifestation of the signs and symptoms. In addition, the majority 45 (72.6%) knew that humans could be exposed to the infection through ingestion of contaminated food and water; and that playing with an infected dog could predispose humans to the infection (67.7%). However, the majority 50 (80.6%) erroneously indicated that dogs could have the hydatid form of the disease; and few 28 (45.2%) that it could spread from human to humans. The majority knew that regular deworming of dogs (75.8%), and the practice of hand washing (79.0%) can reduce the risk of exposure to echinococcosis in humans (Table 4). Overall, 45 (72.6%) respondents among those who were aware of human CE had good knowledge of the disease. Those respondents who had at least a dog were five times (OR: 4.9; 95% CI: 1.3 – 20.1) more likely to have good knowledge of human CE compared to those who do not have. Other socio-demographic factors were not significantly associated with good knowledge of human CE among those respondents who were aware of the disease (Table 5).

Respondents' attitude towards prevention and control, and practices that could predispose to human cystic echinococcosis

Of the 453 respondents, 387 (85.4%) would like to get screened for antibodies to *Echinococcus granulosus*, and 370 (81.7%) for hydatid cysts. The majority 396 (87.4%) reported that they will go for treatment if infected and about half 224 (49.5%) believe that traditional healers and local remedies can help out in the treatment of human CE (Table 6). Most 296 (65.4%) also agree that washing vegetables with vinegar is a good preventive measure against human CE. However, 295 (65.1%) believe that washing vegetables with water only is sufficient to cleanse it. In practice, only 105 (23.2%) respondents have never eaten unwashed vegetables or fruits (Table 7). Generally, the majority believe that drinking water from open sources such as streams, rivers, and ponds can predispose to diseases 375 (82.8%), and that regular washing of hands with soap and water before eating helps prevent some diseases 415 (91.6%) (Table 6). In practice, less than half (47.2%) have never taken water from open sources, and just above half (55.0%) always wash their hands with soap and water before eating (Table 7). However, slightly more than half, 236 (52.1%) respondents, do not mind feeding their dogs with raw offal should they have one; and about one in every four, 131 (28.9%) respondents, consider deworming dogs a waste of money (Table 6). In practice, only 31 (6.8%) respondents have never dewormed themselves (Table 7).

Discussion

In the goats, intrinsic factors such as sex and age are not significantly associated with the presence of hydatid cysts. Goats with BCS of 1, 2, and 3 had hydatid cysts prevalence of 3.85%. In this study, we determined the awareness and knowledge level, as well as attitude towards prevention and control, and practices that could protect or predispose to human CE among 453 potentially at-risk-population including individuals presenting themselves for HIV/AIDS screening, clients at the small animal

unit of the Veterinary Teaching Hospital, University of Ibadan and

Table 1: Socio-demographic variables and sanitary practices of respondents

Variable	Categories	Frequency (n = 453)	Percentage (%)
Sex	Male	283	62.5
	Female	170	37.5
Age (years)	≤ 35	345	76.2
	> 35	108	23.8
Marital status	Single	309	68.2
	Married	21	4.6
	Divorced	11	2.4
	Co-habiting	4	0.9
Sub-population	Individuals for HIV/AIDS screening	253	55.8
	VTH dog clients	100	22.1
	Abattoir workers	100	22.1
Medical checkups in the past 1 year	Yes	207	45.7
	No	246	54.3
Have a garden	Yes	139	30.7
	No	314	69.3
^Wear gloves during gardening (n = 139)	Yes	82	59.0
	No		
Possess at least a dog	Yes	179	39.5
	No		
#Deworm dogs at a veterinary clinic (n = 179)	Yes	118	65.9
	No		
#Disposal of dog faeces (n = 179)	Waste bin	89	49.7
	Leave on the field	22	12.3
	Throw into the gutter	63	35.2
	Others (unspecified)	5	2.8
#Allow dog to roam outside the compound (n = 179)	Yes	121	67.6
	No		
#Wash hands after touching dog (n = 179)	Yes	135	75.4
	No		
Heard of Echinococcosis	Yes	62	13.7
	No	391	86.3

^Subset of respondents who had garden. #Subset of respondents who had dog(s).

Table 2: Socio-demographic factors associated with human cystic echinococcosis awareness in Ibadan, Oyo State

Variables	Categories	Aware (n = 62)	Not Aware (n = 391)	Odds Ratio (95% CI)	P Value
Sub-population	HIV/AIDS screened persons	32 (12.6)	221	Ref	
	VTH dog clients	23 (23.0)	77	2.1 (1.1 – 3.7)	0.02*
	Abattoir Workers	7 (7.0)	93	0.5 (0.2 – 1.2)	0.18
Sex	Male	37 (13.1)	246	0.9 (0.5 – 1.5)	0.73
	Female	25 (14.7)	145		
Age (years)	≤ 35	56 (16.2)	289	3.3 (1.4 – 7.9)	< 0.01*
	> 35	6 (5.6)	102		
Marital Status	Singles	47 (15.2)	262	1.5 (0.8 – 2.9)	0.22
	Others	15 (10.4)	129		
	Yes	42 (20.3)	165	2.9 (1.6 – 5.1)	< 0.01*

Medical checkup in the past 1 year	No	20 (8.1)	226		
Have a garden	Yes	36 (25.9)	103	3.9 (2.2 – 6.7)	< 0.01*
	No	26 (8.3)	288		
Have at least a dog	Yes	39 (21.8)	140	3.0 (1.7 – 5.3)	< 0.01*
	No	23 (8.4)	251		

Others include married, divorced and co-habiting. *Significant at $p < 0.05$

Table 3: Socio-demographic predictors of human cystic echinococcosis awareness in Ibadan, Oyo State

Variables	Categories	Aware (n = 62)	Not Aware (n = 391)	Adjusted Odds Ratio (95% CI)	P Value
Age (years)	≤ 35	56 (16.2)	289	3.0 (1.2 – 7.2)	0.02*
	> 35	6 (5.6)	102		
Have a garden	Yes	36 (25.9)	103	2.8 (1.5 – 5.2)	< 0.01*
	No	26 (8.3)	288		
Have at least a dog	Yes	39 (21.8)	140	1.9 (1.0 – 3.6)	0.03*
	No	23 (8.4)	251		

*Significant at $p < 0.05$

Table 4: Knowledge of human cystic echinococcosis among at-risk population who were aware (n = 62)

Variable	Categories	Frequency (n = 62)	Percentage (%)
Symptoms	Asymptomatic	27	43.6
	Pulmonary symptoms	16	25.8
	Gastrointestinal symptoms	32	51.6
	Cerebral symptoms	3	4.8
	Do not know	6	9.7
Mode of Transmission	Through the air	3	4.8
	Sexual contact	6	9.7
	Through contaminated food and water	45	72.6
	Through blood transfusion	5	8.1
	Through eating rodents	12	19.4
Dirt/ fomites can also be a means through which humans can get infected	Yes	39	62.9
	No	18	29.0
	Do not know	5	8.1
Animals that are predisposed to hydatid disease	Sheep	24	38.7
	Dogs	50	80.6
	Cattle	19	30.6
	Rodents	10	16.1
	Horses	13	21.0
	Donkeys	15	24.2
	Others (unspecified)	5	8.1

Playing with infected dogs could predispose to echinococcosis	Yes	42	67.7
	No	18	29.0
	Do not know	2	3.2
Cause of Echinococcosis	Parasite	46	74.2
	Virus	3	4.8
	Bacterium	4	6.5
	Do not know	3	4.8
Regular deworming of dogs will reduce the chances of contracting echinococcosis	Yes	47	75.8
	No	12	19.4
	Do not know	3	4.8
Could take months and sometimes even years before clinical manifestation of Echinococcosis	Yes	41	66.1
	No	12	19.4
	Do not know	9	14.5
Echinococcosis can spread from humans to humans	Yes	28	45.2
	No	16	25.8
	Do not know	18	29.0
Hand washing can reduce risk of exposure to echinococcosis	Yes	49	79.0
	No	10	16.1
	Do not know	3	4.8

Table 5: Socio-demographic factors associated with good knowledge of human cystic echinococcosis in Ibadan, Oyo State

		Good knowledge (n = 45)	Fair knowledge (n = 17)	OR (95% CI)	P Value
Categories	HIV/AIDS	21 (65.6)	11	Ref	
	VTH dog clients	17 (73.9)	6	1.5 (0.4 – 5.9)	0.57
	Abattoir Workers	7 (100)	0	$\infty(\infty - \infty)$	0.16
Sex	Male	27 (73.0)	10	1.1 (0.3 – 3.7)	1.00
	Female	18 (72.0)	7		
Age (years)	≤ 35	42 (72.4)	16	0.9 (0.02 – 11.9)	1.00
	> 35	3 (75.0)	1		
Marital Status	Singles	32 (68.1)	15	0.3 (0.03 – 1.8)	0.20
	Others	13 (86.7)	2		
Medical checkup in the past 1 year	Yes	34 (81.0)	8	3.4 (0.9 – 13.1)	0.07
	No	11 (55.0)	9		
Have a garden	Yes	28 (77.8)	8	1.8 (0.5 – 6.7)	0.39
	No	17 (65.4)	9		
Have at least a dog	Yes	33 (84.6)	6	4.9 (1.3 – 20.1)	0.01*
	No	12 (52.2)	11		

∞ : Undefined; Others include married, divorced and co-habiting. *Significant at $p < 0.05$

Table 6: Attitude towards prevention and control of human cystic echinococcosis among respondents (n = 453)

Variables	SA n (%)	A n (%)	U n (%)	D n (%)	SD n (%)
Like to get screened for antibodies to <i>Echinococcus granulosus</i>	166 (36.6)	221 (48.8)	9 (2.0)	40 (8.8)	17 (3.8)
Like to get screened for hydatid cyst	142 (31.3)	228 (50.3)	9 (2.0)	49 (10.8)	25 (5.5)
Will get treated if found infected	200 (44.2)	196 (43.3)	11 (2.4)	26 (5.7)	20 (4.4)
Traditional healers and local remedies can help out in treatment	37 (8.2)	187 (41.3)	10 (2.2)	147 (32.5)	72 (15.9)
Washing vegetables with vinegar is a good preventive measure	94 (20.8)	202 (44.6)	16 (3.5)	125 (27.6)	16 (3.5)
Washing vegetables with only water is okay to cleanse it	73 (16.1)	222 (49.0)	15 (3.3)	124 (27.4)	19 (4.2)
Drinking water from open sources such as streams, rivers, ponds can predispose to diseases	156 (34.4)	219 (48.3)	9 (2.0)	49 (10.8)	20 (4.4)
Washing hands always with soap and water before eating prevents against some diseases	189 (41.7)	226 (49.9)	14 (3.1)	18 (4.0)	6 (1.3)
Do not mind feeding dogs with raw offal should I have one	63 (13.9)	173 (38.2)	13 (2.9)	150 (33.1)	54 (11.9)
It is a waste of money deworming dogs	42 (9.3)	89 (19.6)	9 (2.0)	153 (33.8)	160 (35.3)

Table 7: Practices that could protect or predispose to human cystic echinococcosis among respondents (n = 453)

Variables	Always (4/4)	Sometimes (2/4)	Rarely (1/4)	Never (0/4)
How often do you wash your hands with soap and water before eating?	249 (55.0)	139 (30.7)	58 (12.8)	7 (1.5)
How often do you eat unwashed vegetables or fruits?	45 (9.9)	196 (43.3)	107 (23.6)	105 (23.2)
How often do you drink water from open sources such as stream, rivers, and ponds?	17 (3.8)	87 (19.2)	135 (29.8)	214 (47.2)

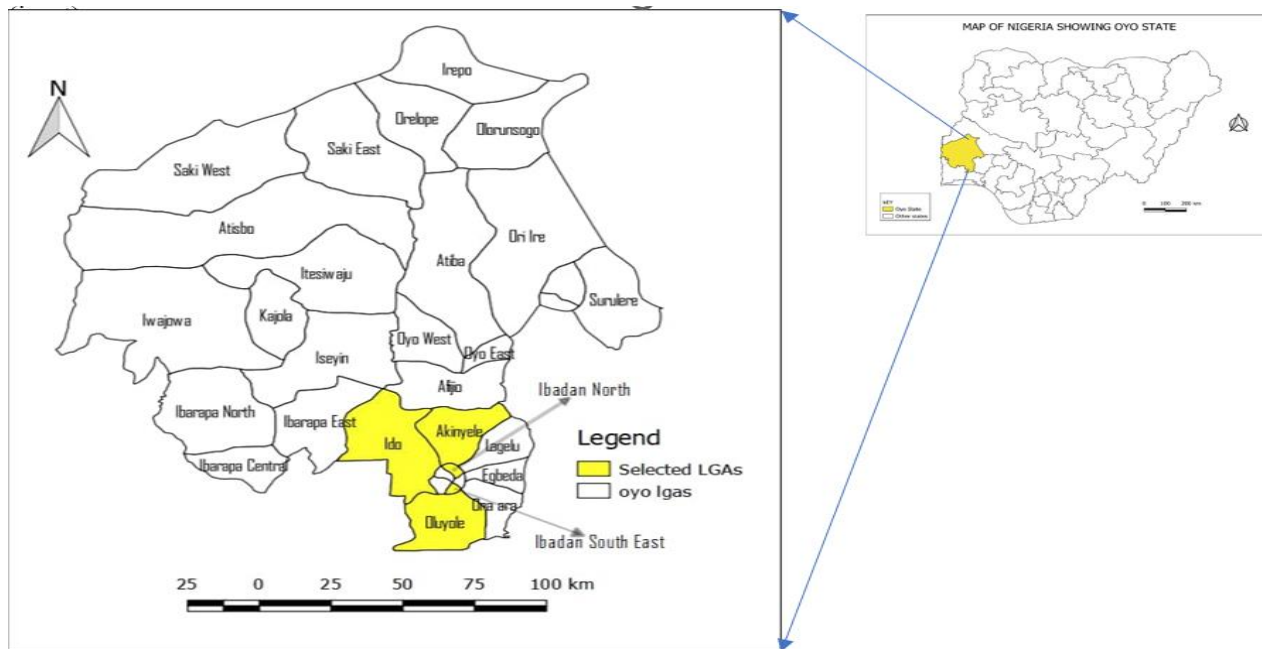


Figure 1: Map of Oyo State showing the selected Local Government Areas: map of Nigeria highlighting Oyo State (inset)

Discussion cont'd

abattoir workers in Ibadan, Oyo State.

The proportion of respondents who have heard of human CE in this study was low (13.7%). Khan *et al* (2018) also reported a very low awareness level of 4.1% among community members, dog owners and butchers in Pakistan. However, studies among students, livestock farmers, and the general population reported a higher awareness level than obtained in this study of between 21.3% and 87.7% in Algeria, Uganda and Sudan (Othieno *et al.*, 2018; Ahmed *et al.*, 2018; Lounis *et al.*, 2023; Lounis *et al.*, 2024). Level of awareness appears to be more in endemic countries than in non-endemic ones (Thys *et al.*, 2019; Qucuo *et al.*, 2020). It is however, important to increase public health awareness and sensitization in the general population and especially among potentially at-risk populations.

In this study, being less than 36 years old, possession of a garden and having at least a dog were predictors of human CE awareness level. In another recent study among the general population in Algeria, factors such as livestock rearing connection and educational level were found to be associated with the level of awareness (Lounis *et al.*, 2024). The higher level of awareness among younger respondents could be attributed to intellectual curiosity. Intellectual curiosity has been reported to be negatively associated with age after adjusting for educational level, sex and culture (Chu *et al.*, 2021). The role of dogs as definite hosts for *E. granulosus* and being a potential source of contamination to gardens and exposure to humans who are the

aberrant hosts (CDC, 2012) could have contributed to the raised awareness among owners of dogs and gardens in this study.

We also reported a high (72.6%) proportion of those who were aware of human CE had good knowledge of the subject matter with respect to the cause, incubation period, symptoms, source of exposure to humans, and preventive measures. Ahmed *et al.*, (2018) also observed a similar pattern among respondents who were aware of the disease in Sudan. About 75th percentile of the respondents in this study knew that human CE is a parasitic disease compared to less than the 50th percentile reported by Lounis *et al.* (2024) among the general population in Algeria. About two in every three respondents in our study knew the important role dogs play in the transmission of the disease to humans, similar to the report of Lounis *et al.* (2024). However, lower proportions were reported in previous studies among livestock farmers and university students (Abdulhameed, *et al.*, 2018; Lounis *et al.*, 2023). In addition, the majority (72.6%) of the respondents in our study knew that humans could also be exposed to CE through ingestion of contaminated food and water; however, Lounis *et al.* (2023) reported a lower proportion among university students in Algeria. We found a significant association between good knowledge of human CE among our respondents and owning at least a dog. Pet ownership has been reported to enhance physical and mental health in humans (Hussein *et al.*, 2021). However, knowledge gaps still exist about the spread of the disease and its symptoms.

Generally, the majority of our respondents were favourably disposed towards getting screened for either the antibodies to *E. granulosus* or the presence of the hydatid cysts. This is similar to the report of Othieno *et al.* (2018) among pastoral and

ago-pastoral communities in Uganda. Early detection of diseases through screening and early treatment has been reported to aid treatment outcome, control and prevention of diseases (Dillner 2019; Setyawati *et al.*, 2024). The majority of the respondents also had a positive attitude towards receiving hospital treatment if infected; this however, is in contrast to the report of Othieno *et al.* (2018) in two regions of Uganda where unorthodox treatment was preferred. More than half of the respondents believe that washing of vegetables before consumption will help reduce the risk of exposure to *E. granulosus* infection. Our findings are similar to the reports of Lounis *et al.* (2024) though with a higher proportion. Over 90th percentile of our respondents believes that regular washing of hands with soap and water before eating helps prevent some diseases; a view also shared by a previous study (Lounis *et al.*, 2023). In addition, slightly above a quarter of our respondents consider deworming dogs a waste of money. This finding is also similar to that reported by Abdulhameed, *et al.* (2018). Periodic deworming of dogs by qualified personnel has been reported to be effective in reducing *E. granulosus* infection in dogs and potential exposure to humans (Eckert *et al.*, 2001; Adebudo *et al.*, 2023).

In practice, from our study, slightly above half of the respondents indicated eating vegetables or fruits without washing. In contrast, previous studies reported higher proportion of individuals wash their vegetables and fruits before eating (Abdulhameed, *et al.*, 2018; Lounis *et al.*, 2023). Eating unwashed vegetables or fruits has been associated with risk of exposure to human CE (Tamarozzi *et al.*, 2019; Zhang *et al.*, 2022). We also reported that about 23% of the respondents have taken water from open sources, similar to the report of Abdulhameed, *et al.*, (2018). Open source of water for domestic purposes or consumption of non-potable water has also been associated with human CE (Othieno, *et al.*, 2017; Acosta-Jamett *et al.*, 2022). In our study, only about half (55.0%) of the respondents always wash their hands with soap and water before eating. Khan *et al.* (2018) reported a higher proportion of individuals in a similar study. Washing of hands after handling dogs and before handling foods have been reported to be associated with human CE (CDC, 2012; Zhang *et al.*, 2022).

This study may be limited by response bias as participants may provide answers that they think are socially acceptable and may not reflect their actual practices or may not accurately recall certain information. We mitigated this bias through triangulation, and ensuring adequate sample size. More so, because the questionnaire was designed in English, and some of the participants may find it difficult to understand, we engaged an interpreter who was trained on the questionnaire. In addition, to mitigate interviewer bias, we ensured that the interviewer engaged in the study was duly trained on the questionnaire administration.

CONCLUSIONS

The awareness of human cystic echinococcosis among abattoir workers, individuals presenting for HIV/ AIDs screening and dog owners in Ibadan is low. Being less than 36 years old, having a garden, and at least a dog were predictors of human cystic

echinococcosis awareness among at-risk population in Ibadan. Having a dog was also associated with good knowledge of human cystic echinococcosis among subpopulation of those aware of the disease. There is need to increase awareness and public health education campaigns on human cystic echinococcosis among at-risk population in Ibadan. Practices that could predispose to human cystic echinococcosis such as eating unwashed vegetables and fruits and drinking untreated water.

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Conflicts of interest

The authors declare no conflicts of interest.

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