



Swine cysticercosis and associated risk factors in non-technified pig breeding in semi-arid region of Sergipe state, Brazil

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Abstract

The aim of this study was to determine the frequency of *Taenia solium* anti-metacestode antibodies in slaughtered pigs in a semi-arid region of the “Alto Sertão” of Sergipe state, Brazil, and verify the risk factors associated with swine cysticercosis. For this, 230 samples of swine blood from two slaughterhouses were collected and analyzed by indirect ELISA. The pigs came from five non-technical properties in the semi-arid region of the Alto Sertão of Sergipe state. Searches for cysts in the skeletal muscles of the pigs were performed during slaughter. In addition, an epidemiological questionnaire was applied to the pigs’ original properties to determine risk factors. Besides that, the official health services database was evaluated for confirmed cases of neurocysticercosis and taeniasis in humans in the last 5 years, living in the studied region. Seropositivity in pigs was 12.6%, with no significant difference between males and females. No cysts were found in the carcasses of the slaughtered pigs. A positive association was found for properties that discharge domestic sewage into the environment, in river or streams, increasing the risk of positivity by 5.72 times. When analyzing the database of official agencies, there were no records of cases of neurocysticercosis or taeniasis in the resident population in the last 5 years. However, there were frequent cases of idiopathic epilepsy. The results demonstrate that study area is endemic for swine cysticercosis and serves as a warning of the possibility of the occurrence of the taeniasis-cysticercosis complex.

Keywords Epidemiology · *Taenia solium* · *Cysticercus cellulosae* · ELISA

Introduction

Among the neglected tropical diseases of importance in humans and animals, the taeniasis-cysticercosis complex is endemic in developing countries, characterizing the concept

of “One health” (Satyaprakash et al. 2018). In taeniasis, humans are the definitive host due to the ingestion of the larval form of the tapeworm *Taenia solium* and *Taenia saginata* present inside cysts (cysticerci) in pork and beef, respectively. On the other hand, pigs (the intermediary host) acquire cysticerci through the ingestion of tapeworm eggs in the feces of the definitive host (Sakai et al. 2001; Mableson et al. 2014) releasing the *T. solium* cysticercus in different skeletal muscles and the nervous system of the pigs, characterizing cysticercosis. Therefore, the presence of cysticerci in the muscles of these pigs indicates their access to contaminated human feces, being an important indicator of the quality of basic sanitation and the risks to public health.

When the pig ingests water and food contaminated by *T. solium* eggs, there is a frequent development of the larval form, called *Cysticercus cellulosae*, inside a vesicle which triggers an inflammatory response; this benefits the parasite using pro-inflammatory cytokines (i.e., transforming growth factor- β) for its establishment in the host (Adalid-Peralta et al.

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2017). In pigs, the major predilection sites where frequently the cysticercus vesicles are found are the interfascicular connective tissues of the sublingual, chewing, diaphragmatic, and cardiac muscles and brain of pigs (Viana et al. 2012; Garcia et al. 2014), which can be detected by the official meat inspection service during slaughter. According to Dorny et al. (2004), in meat inspection, the sensitivity was 22.1% and the specificity was 100%. The sensitivity of the tongue inspection technique varies greatly with the degree of infection in pigs. In pigs with intense infection, the sensitivity may be approximately 70%, but in mild infections (less than 100 cysts), the sensitivity may be lower (Murrell et al. 2005).

To increase sensitivity and specificity, different studies have associated macroscopic lesions and immunoenzymatic tests for the diagnosis of swine cysticercosis. However, the enzyme-linked immunosorbent assay (ELISA) with *T. solium* antigens or those of the related parasites *T. crassiceps* and *T. saginata* have been used for the detection of *T. solium* cysticercosis (Arruda et al. 2005). The performance of the test varies according to the antigen used. When using *T. crassiceps* antigens, Nunes et al. (2000) found 100% of sensitivity and 96.4% of specificity for *T. solium* antibodies to detection.

The standardization and validation of serological techniques for swine species have limited use in commercial and rural pig farming, related to seroconversion status (Sciutto et al. 1998), but the techniques are widely used to determine the prevalence and epidemiological status of pig farms, as well as the risk factors associated with disease (Weka et al. 2013; Okello et al. 2014). Although globally distributed, the swine cysticercosis has been found to be more prevalent in developing countries. In Brazil, the current epidemiological situation and its risk factors is still poorly understood (Rossi et al. 2016). However, it is known that the regions with inspected pig slaughter have a seroprevalence of around 5.5 times minors compared with regions without official inspection (Pinto et al. 2002). Pigs in poor sanitation locations, without infrastructure, a latrine, adequate handling and poor sanitary control are considered risk factors for the occurrence of swine cysticercosis (Acevedo-Nieto et al. 2017).

In the Brazilian semi-arid region, located in the northeast of the country, the breeding of non-technified pigs predominates by family subsistence with no sanitary control in the breeding. According to Rossi et al. (2016), non-technified creations are characterized by not adopting biosafety practices, low sanitary control, and low food quality and used free-range system in animal rearing or in pigsty. In the “Alto Sertão,” a semi-arid region of the state of Sergipe, it is common to observe pig farming being developed by small producers in the countryside, constituting an important source of income through the sale of live and slaughtered animals (Silva Filha 2008), often without proper sanitary control. There are no official reports of the epidemiological situation of cysticercosis in free-ranging pigs in the semi-arid region of Sergipe, hindering the

development of official control programs of the disease and the implementation of specific measures for public health (Komba et al. 2013).

Considering the aspects of pig rearing in the Brazilian semi-arid region, the present study aimed to determine the frequency of anti-metacestode antibodies to *Taenia solium* in non-technified pig rearing and to determine the risk factors associated with cysticercosis in the semi-arid state of Sergipe, Brazil.

Material and methods

The study region

The Alto Sertão region of the state of Sergipe consists of seven municipalities: Nossa Senhora da Glória (10° 13' 06" S, 37° 25' 13" W), Porto da Folha (09° 55' 02" S, 37° 16' 42" W), Gararu (09° 58' 03" S, 37° 05' 00" W), Poço Redondo (09° 48' 18" S, 37° 41' 04" W), Canindé do São Francisco (09° 39' 36" S, 37° 47' 22" W), Monte Alegre de Sergipe (10° 01' 38" S, 37° 33' 44" W), and Nossa Senhora de Lourdes (10° 04' 46" S, 37° 03' 28" W). This region presents a territory of 4,900,686 km², representing 22.37% of the total state and a demographic density of 28 hab/km², with 53.37% of the people living in the rural area. It is verified that the Alto Sertão region has 41% of all pig breeding in the state of Sergipe, with the municipality of Nossa Senhora da Glória being the largest pig producer (Brasil 2020). Most of the pig farms are non-technified, characterized by cross breeds pigs, raised in pigsties or free range, without biosafety practices or sanitary control of water and food, with family labor and the mixed production of milk, cheese, and agriculture. The climate is semi-arid with an irregular annual average rainfall between 368 and 630 mm (Teixeira et al. 2011).

Study design

The study type was cross-sectional investigation to determine associated between the frequency of anti-metacestode antibodies to *Taenia solium* in non-technified pig rearing and risk factors (educational level, type of installation and handling of pigs, destination of manure and sewage, and sanitary issues) in the semi-arid region of the state of Sergipe, Brazil.

The size of the population sample was classified using the equation provided by Thrusfield (2007), which consists of the following: $n = [Z^2 \cdot P(1 - P)]/d^2$, where n = sample size, Z = normal distribution value for 95% significance level ($Z = 1.96$), P = expected prevalence, and $d = 5\%$ error. Since there are no studies with non-technified farms pigs in this region, the expected disease's prevalence was considered as 6.8%, as found by Rossi et al. (2016) in the same type of pig farming in Brazil. Therefore, the minimum significant number of animals

sampled for this location was 98 pigs. In the Alto Sertão region, there are officially 1900 swine matrices (Brasil 2020) and only two municipal slaughterhouses with official health inspection located in Nossa Senhora da Glória and Canindé do São Francisco cities.

During October to December 2015, 230 pigs between 6 and 8 months of age destined for slaughter in the two municipal slaughterhouses were randomly selected. The only criterion for selecting the pigs at the slaughterhouse was that they came from non-technified properties in the Alto Sertão of the state of Sergipe. Blood samples (5 mL) were collected during the bleeding phase in *vacutainer* tubes that were identified and stored in an isothermal box at 4 °C until processing in the laboratory. After being centrifuged, the serum was stored in 1.5 mL polypropylene microtubes identified and kept at a temperature of −20 °C until use. The seropositivity of pigs to anti-metacestode antibodies to *Taenia solium* was verified by applying the samples to the ELISA test.

During the slaughter of the pigs, incisions were made in the masseter and pterygoid skeletal muscles, as well as visual inspection of the rest of the carcass to identify cysts, in all the sampled pigs.

To determine the risk factors through the application of a questionnaire with the pig farmers, the traceability of the origin of the slaughtered animals was identified by crossing the data of the animal transport guides by batch and official data from the Agricultural Development Company of Sergipe (EMDAGRO).

ELISA antibody detection

The samples were subjected to the indirect ELISA test (sensitivity of 100% and specificity of 96.4%) performed according to the previous standardization by Nunes et al. (2000), at the Department of Animal Production and Health, Faculty of Veterinary Medicine, Universidade do Estado de São Paulo (UNESP), Araçatuba campus. The detection of anti-cysticercal antibodies (Ab-antiCy) was performed using *T. crassiceps* metacestode vesicular fluid, since the indirect ELISA test has been previously standardized for *T. crassiceps* cysts antigens with better sensitivity than *T. solium* cysts antigens (Nunes et al. 2000). The 96-well polystyrene plates (Maxisorp Nunc—Thermo Scientific®) were sensitized with 100 µL per well of antibodies from *T. crassiceps* metacestode vesicular fluid at 5 µg/mL with 0.05 M carbonate/bicarbonate buffer (pH 9.6) during 18 h at 4 °C. The plates were blocked with 200 µL of 0.05 M carbonate/bicarbonate buffer plus 10% skimmed milk powder (Svelty—Nestlé®), for 2 h, at 4 °C.

Then, sample serum and positive and negative controls were diluted 1/800 in 0.01 M phosphate-buffered saline (PBS, pH 7.2) plus 0.05% Tween 20 and 5% skimmed milk powder (Svelty—Nestlé®), after which 100 µL per well was placed and incubated for 1 h at 37 °C. After incubation,

100 µL/well of peroxidase-labeled anti-swine IgG conjugate (Sigma Immuno Chemicals®) was diluted to 1/4000 in 0.01 M PBS (pH 7.2) plus 0.05% Tween 20 and 5% skimmed milk powder (Svelty—Nestlé®) and incubated again for 1 h at 37 °C. As a chromogenic solution, 3,3',5,5'-tetramethylbenzidine (TMB) (Invitrogen®) pH 5.0, was used at room temperature. The reaction was stopped after 20 min, with 50 µL of 1 N HCl. The reading of microplates was performed on a Multiskan EX photometer (Labsystems®) with a length of 450 nm. Between all stages, the wells were washed 3 times with 0.01 M PBS (pH 7.2) plus 0.05% Tween 20. The samples were tested in duplicate, and, in each assay, a positive control (positive pigs at inspection) and a negative control (negative pigs at inspection) were included.

ELISA cutoff values

The optical density (O.D.) values were expressed through the arithmetic mean of two readings and transformed into the *A/P* ratio (sample in relation to the positive control) according to the following formula: $A/P = (\text{average O.D. sample} - \text{average O.D. negative control}) / (\text{average O.D. positive control} - \text{average O.D. negative control})$.

ELISA cutoff values for the ELISA antibody were calculated and samples with *A/P* values ≥ 0.076 were considered positive for Ab-antiCy-ELISA; *A/P* values < 0.076 were considered negative for the Ab-antiCy-ELISA, according to previous standardization by Nunes et al. (2000).

Epidemiological questionnaire

The traceability of animals slaughtered properties was identified through the official records of the Empresa de Desenvolvimento Agropecuário de Sergipe (EMDAGRO). The epidemiological questionnaire was applied in 187 properties (10 located in Canindé do São Francisco; 9 in Poço Redondo; 56 in Porto da Folha; 28 in Monte Alegre de Sergipe and 84 in Nossa Senhora da Glória) included in the study in order to evaluate and identify potential risk factors for the occurrence of swine cysticercosis. The pre-structured questionnaire aimed to collect information related to the health conditions of the properties, animal breeding system, personal hygiene, eating habits, and information level of the producer.

As cysticercosis can affect humans, a survey of the official records of suspected or confirmed cases of taeniasis and neurocysticercosis in humans living in the investigated municipalities was also carried out. This information was obtained from the Epidemiological Surveillance Service of each municipality and from the Endemic Nucleus of the Health Department of the State of Sergipe, in addition to consulting the Department of Informatics of the Unified Health System (DATASUS) of the Ministry of Health, Brazil.

Statistical analysis

The data were analyzed descriptively using absolute and percentage frequencies. To assess a significant association between the dependent variable (seropositivity) and the independent variables (gender of animals, socio-educational, handling of pigs, and environmental sanitation variables), Pearson's chi-square test or Fisher's Exact test was used when the condition for using the chi-square test was not obtained. The odds ratio (OR) was calculated to evaluate the association of risk factors for the presence of cysticercosis, considering the confidence interval of 95% and $P \leq 0.05$. To verify which variables influenced the highest frequency of swine cysticercosis, a logistic regression model was applied with the variables that showed a significant association up to 20% ($P \leq 0.20$) in the bivariate study. The Lemeshow test was applied to adjust the data to the logistic model with a margin of error of 5% in SPSS (Statistical Package for the Social Sciences) version 23.

Results

Seropositivity for *Taenia* spp. antibodies

In total, 230 samples of swine blood were obtained from 187 farms. A frequency of 12.6% (29/230) of positivity for anti-metacestode antibodies of *T. solium* was verified in slaughtered animals from the studied region. In addition, it was possible to determine statistical significance between the municipalities of origin of the animals, with greater seropositivity in farms from the municipalities of Poço Redondo: 31.6% (6/19) and Canindé do São Francisco: 31.3% (5/16). Of the pigs that tested positive, 65.5% (19/29) were males, with no significant association in relation to the sex variable for the frequency of seropositivity between males (15%) and females (9%). In all the carcasses sampled, the presence of cysts characteristic of cysticercosis was not verified.

Risk factors associated with seropositivity to *Taenia* spp.

Through the epidemiological questionnaire, non-technified pig breeding was characterized in the Alto Sertão region of Sergipe. The animals are raised in 64.7% (121/187) of the properties in the pigsty system, built with cement, ceramic blocks and asbestos tiles, with the pigs separated by age group. In this region, 100% of the properties use fresh bovine whey to feed the pigs, associated with feed or food scraps. In addition, 93.6% (180/187) of producers never received guidance from veterinarians. The destination of animal waste in 58.3% (109/187) of the properties is disposal in the environment, with 41.7% (78/187) using it as fertilizer in the plantations. On the other hand, in relation to the destination of

domestic sewage, 84% (157/187) of the properties use a septic tank, while 16% (30/187) discard this waste in the environment. It was shown that 86.1% (161/187) of the properties use drinking water stored in a water tank, while 13.9% (26/187) use non-potable water.

In the bivariate analysis, a significant association of swine cysticercosis was found for the following variables: source of water for human consumption ($P = 0.036$) and destination of domestic sewage ($P = 0.010$) (Table 1). However, after the application of multivariate logistic regression, only the variable destination of domestic sewage showed statistical significance ($P = 0.028$), with a 5.72 times higher chance of the disease occurring (Table 2).

Neurocysticercosis and taeniasis

In the consultation of official databases of the Epidemiological Surveillance of the Municipalities involved in the research, there were no records of the occurrence of taeniasis and neurocysticercosis in the resident population during the last 5 years. However, when evaluating data using the Ministry of Health's Information System database (DATASUS), four deaths associated with cysticercosis (ICD-10 B69) have been recorded in the state of Sergipe in the last 14 years, but none in the municipalities studied.

Discussion

Pigs are the intermediate hosts in the taeniasis cycle; identification of the frequency of positive pigs in a region is important to direct measures to control the disease. In the present work, we investigated the presence of anti-*T. solium* antibodies in non-technified pig breeding properties in the semi-arid region called Alto Sertão using the indirect ELISA technique. This region is located in Sergipe state, northeast of Brazil, in which the temperatures show little variation, with an annual average of approximately 26 °C; due to the distance to the Atlantic coast, the rainfall usually totals less than 750 mm/year and is concentrated in three consecutive months (Costa et al. 2007). In this region, there is no information regarding the seroprevalence of cysticercosis in pigs, which hinders the disease control actions. However, in the present study, it was possible to verify the frequency of positive sera for cysticercosis in 12.6% of the pigs tested. In relation to the different states of Brazil, this percentage was lower than that found by Santos (2014) in the southern coast of Bahia, with a prevalence of 22%, and by Gottschalk et al. (2006) in the region of Registro, state of São Paulo, with a prevalence of 20.5%. However, the percentage of the present study is higher than that found by Acevedo-Nieto et al. (2017), in Rio Doce Valley in the east of Minas Gerais State, with a prevalence of 5.3% (13/247), by Silva et al. (2007) in Pedra Branca, state of Ceará with 3.5%, by

Table 1 Bivariate analysis between seroprevalence for cysticercosis and associated risk factors in pigs of semi-arid region of “Alto Sertão”, state of Sergipe, Brazil

Risk factors	Swine cysticercosis (ELISA)						<i>P</i> value	OR (CI 95%)
	Positive		Negative		Total group			
	<i>N</i>	%	<i>n</i>	%	<i>n</i>	%		
Education level							0.094 ¹	
Semi-literate	6	30.0	14	70.0	20	100.0		2.68 (0.94–7.69)
Literate	23	13.8	144	86.2	167	100.0		
Pig breeding							0.673 ¹	
Confined		14.8	115	85.2	135	100.0		1.20 (0.51–2.84)
Mixed (confined/unconfined)	9	17.3	43	82.7	52	100.0		
Type of installation							0.746 ¹	
Mixed	11	16.7	55	83.3	66	100.0		1.14 (0.51–2.59)
Pigsty	18	14.9	103	85.1	121	100.0		
Installation material type							0.744 ²	
Cement	27	16.2	140	83.8	167	100.0		1.74 (0.38–7.20)
Wood/cement	2	10.0	18	90.0	20	100.0		
Type of feed							0.543 ¹	
Serum and rest of food	8	13.6	51	86.4	59	100.0		1.03 (0.39–2.74)
Serum and feed	11	13.9	68	86.1	79	100.0		
Serum, feed, and rest of food	10	20.4	39	79.6	49	100.0		1.64 (0.59–4.53)
Veterinary care							1.000 ¹	
None	28	15.6	152	84.4	180	100.0		1.11 (0.13–9.54)
More than once	1	14.3	6	85.7	7	100.0		
Destination of pig manure							0.234 ¹	
Fertilizer	15	19.2	63	80.8	78	100.0		1.62 (0.73–3.58)
Environment	14	12.8	95	87.2	109	100.0		
Source of water for human consumption							0.036 ^{*2}	
Potable water	21	13.0	140	87.0	161	100.0		2.96 (1.14–7.67)
No-potable	8	30.8	18	69.2	26	100.0		
Water storage							0.792 ¹	
Water tank	20	16.0	105	84.0	125	100.0		1.12 (0.48–2.63)
Tanker/reservoir	9	14.5	53	85.5	62	100.0		
Destination of domestic sewage							0.010 ^{*2}	
Septic tank	19	12.1	138	87.9	157	100.0		3.63 (1.48–8.91)
Environment/river/stream	10	33.3	20	66.7	30	100.0		
Distance between sewage and pig farming							**	**
More than 2 m	29	15.5	158	84.5	187	100.0		

*Significant association at 5%

**Not determined due to the occurrence of a single category or zero frequency

¹ Pearson's chi-square test² Fisher's exact test

Iasbik et al. (2010) in Viçosa, state of Minas Gerais, with a prevalence of 0.4% and by Rossi et al. (2016) in São Paulo state (6.82%). The reasons for this variation in prevalence in relation to the present study can be attributed to the type of breeding, the degree of access of pigs to domestic sewage, the contact with other species, and the pig population. In the cities evaluated in the Alto Sertão, there were variations in the

frequencies of anti-*T. solium* antibodies in non-technified pig breeding. The city of Poço Redondo had the highest seropositivity (31.6%) and the city of Nossa Senhora da Glória had the lowest (7.2%). This difference in frequencies can be justified because in the municipality of Poço Redondo, pigs are raised close to the urban perimeter and fed with food waste from local residents, increasing the risk of contact of pigs with

Table 2 Multivariate logistic regression between seroprevalence for cysticercosis and associated risk factors in pigs of semi-arid region of “Alto Sertão,” state of Sergipe, Brazil

Risk factors	Bivariate		Multivariate	
	OR (CI 95%)	P value	OR (CI 95%)	P value
Source of water for human consumption		0.036*		0.335
Potable water	2.96 (1.14–7.67)		2.46 (0.40–15.24)	
No-potable				
Destination of domestic sewage		0.010*		0.028*
Septic tank	3.63 (1.48–8.91)		5.72 (1.21–27.14)	
Environment/river/stream				

*Significant at 5.0%

human feces. On the contrary, in Nossa Senhora da Glória, pigs are raised far from the urban center and better quality feed is provided. Variations between locations was also reported in the state of Bahia by Sakai et al. (2001), where they verified 4.4% in Salvador, 3.2% in Santo Amaro, and 23.5% in Jequié. This behavior indicates that swine cysticercosis has a strong relationship with the locality through its socio-cultural determinants, breeding, and hygiene aspects.

Cysticercus cellulosae cysts (larval form) were not observed in the skeletal muscles of slaughtered pigs. This may have occurred due to the age of the slaughtered animals (between 6 and 8 months of age), since it has been reported that young pigs have fewer evident cysts and a lower capacity to form an efficient immune response to the larval form when compared with older pigs, which would impair the inflammatory reaction around the cysts and the production of antibodies (Sciutto et al. 1998). According to Gemmel (1999), maternal antibodies protect piglets at the initial exposure to swine cysticercosis, although these animals later become susceptible. In this way, older animals would be more prone to infection due to the decrease in antibody titers and their exposure time. In Africa and Latin America, numerous studies have shown similar evidence of this immune response behavior to swine cysticercosis (Sarti et al. 1992; Garcia et al. 2003; Gottschalk et al. 2006; Aragão et al. 2010; Pondja et al. 2010). Although the focus of our study was to determine the frequency of antibodies for cysticercosis in pigs slaughtered for local consumption, it must be inferred that the frequency found in the region of the Alto Sertão could be higher if the age of the slaughtered animals was above 12 months.

In the present study, indirect ELISA was used with plaques sensitized with *T. crassiceps* metacestode antigens. For the serological tests, several studies have used the heterologous total antigen of *Taenia crassiceps*, showing high rates of sensitivity and specificity (Pinto et al. 2000; Acevedo-Nieto et al. 2017) and demonstrating its potential as an efficient antigen for diagnosis. There was no significant variation in positivity between male and female pigs, corroborating the results of Acevedo-Nieto et al. (2017). On the other hand, Weka et al. (2013) found that females were twice as likely to be positive.

In the univariate evaluation, a higher percentage of positives was observed for the following variables: destination of domestic sewage in the environment/rivers/streams (33.3%), consumption of non-potable water for humans (30.8%), and semi-literacy (30%), respectively. In the bivariate evaluation, a positive association was found for the source of water for human consumption and the destination of domestic sewage, exclusively. Although the semi-literacy variable is directly related to the ability to self-instruct about health measures, a similar result was found by Komba et al. (2013) in Tanzania, with 72% of respondents having only primary education. In endemic areas, socio-economic condition, education, and superstitious beliefs about *T. solium* are associated with an increased risk of disease transmission (Weka et al. 2019), but the factors most strongly associated with risk factors appear to be “environmental health.” This relationship is confirmed by the presence of a positive association by multivariate analysis of the variable: destination of sewage, exclusively (Table 2). It was possible to verify that in the Alto Sertão region of the state of Sergipe, dumping sewage in the environment, in rivers, or streams was an important risk factor. Similarly, in Agrarian Reform settlements, located in the state of Minas Gerais, Brazil, there was a 7.6 times higher chance of swine cysticercosis occurring when sewage was discharged into the environment (Acevedo-Nieto et al. 2017). In the same state, Pinto et al. (2019) also found that properties that discharged sewage into the environment were 12 times more likely to experience swine cysticercosis. This reinforces the importance of man in the biological cycle of *T. solium*, where humans are responsible for the dissemination of eggs in the environment, especially in rural environments where there is a lack of basic sanitation (Gottschalk et al. 2006). Thus, it can be inferred that the degree of cysticercosis in pigs and humans is an important marker of the quality of “environmental health” in which the population is raising their animals. In addition, the access of domestic sewage by animals intended for human consumption increases the maintenance of the parasite cycle and the occurrence of other diseases with potential epidemics.

According to Savioli (2010), neurocysticercosis is the most common late-onset epilepsy form in humans and often being

asymptomatic for many years. Although cases of idiopathic epilepsy have been reported in the studied region, cases of neurocysticercosis in the last 5 years were not officially reported. This points to possible underreporting of cases, since taeniasis/cysticercosis is not notifiable.

In conclusion, cysticercosis in pigs slaughtered in the semi-arid region of the state of Sergipe, from non-technified pig breeding properties, is endemic. It is directly associated with properties that throw domestic sewage into the environment, rivers, or streams. This evidence of the occurrence of cysticercosis in pigs destined for consumption, the absence of reports of cases of taeniasis/cysticercosis in the resident population, as well as the existence of patients with idiopathic epilepsy point to an evident risk to the population of this region and the probable underreporting of cases.

Compliance with ethical standards

Statement of animal rights All experiments were carried out in accordance with the Ethics Committee on Animal Use (CEUA) at the Universidade Federal Rural de Pernambuco, Brazil, under approval protocol 072/2014.

Conflict of interest The authors declare that they have no conflict of interest.

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