http://dx.doi.org/10.5380/avs.v1i1

UFPR UNIVERSIDADE FEDERAL DO PARANÁ

Archives of Veterinary Science

https://revistas.ufpr.br/veterinary

Seroprevalence and risk factors associated with Porcine Cysticercosis and Trichinella spiralis in backyard pigs in Bucaramanga province, Colombia.

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ARTICLE INFO

Keywords: Cysticercosis., parasite., swine., zoonotic., public health., animal welfare.

PROVA AVS

Received: 29/07/22
Accepted: 19/02/23
Published: 31/03/23

ABSTRACT

A large number of the parasitic agents that alter the health of swine could be spread to humans, especially in backyard conditions, and, many times, cause difficulties in public health and food security. This investigation was conducted to determine the seroprevalence and risk factors associated with swine cysticercosis and Trichinella spiralis in backyard pigs in the Bucaramanga province of Colombia. A total of 380 serum samples were used for the search for Tr. spiralis and Tenia solium antibodies using the ELISA technique. The seroprevalence of T. solium cysticercosis infection was 40.5%, whilst anti-Tr. spiralis antibodies were not observed in the processed samples. Regarding risk factors, free-ranging pigs and non-dewormed pigs showed almost 3 (OR=2.9; $P \leq 0.05$) and 2.7 (OR=2.7; $P \leq 0.05$) times more risk of presenting antibodies against T. solium cysticercosis, respectively. The seroprevalence of swine cysticercosis found in this investigation can be caused by low-quality housing and poor hygiene, increasing the spread of this zoonotic parasite infection among swine and humans. No positive samples for Tr. spiralis were observed. The variables access to latrines and deworming of pigs were presented as the risk of infection for cysticercosis by T. solium, this could increase the probability of infection risk of parasites with zoonotic potential between pigs and humans.

1. Introduction

Backyard swine farming is a kind of production system related to scarce socio-cultural levels, inadequate facilities, poor sanitary conditions, and the increase of parasitic infections, producing alterations in public health and food security, in humans (OWEN, 2005). Some parasites can harm the health of pigs and pass to humans. In this sense, Taenia solium and Trichinella spiralis, represent a great impact on food safety and public health worldwide (WHO, 2017).

The disease caused by T. solium is endemic in the world. The serological prevalence of T. solium cysticercosis ranges from 1.8 to 31.2% in Latin America, from 12.6 to 19.2% in Asia, and from 7.7 to 34.5% in Africa using the ELISA test (CORAL-ALMEIDA et al., 2015). The disease caused by T. solium in humans occurs when cysts are ingested in undercooked pork. The larvae attach to the human intestine and develop into adult tapeworms, which release eggs into human feces that can contaminate pigs' food or the environment. These eggs ingested by pigs pass through the intestinal wall and into the bloodstream and settle in different tissues in the form of cysts (GARCIA HH & DEL BRUTTO OH 2000; GARCIA et al., 2003).

Some of the useful measures for the control of cysticercosis in humans and pigs are keeping the pigs in confinement, collective treatment of the human population against the parasite, and medical education of the community making known the characteristics of the disease and the ways of transmission, collective treatment of the pig population with oxfendazole (30 mg/kg single dose), detection and treatment of tapeworm carriers (ARTEAGA & ARTEAGA 2003).

Regarding the disease in humans caused by Trichinella spp., it is considered that the main source of transmission for humans is the ingestion of raw or undercooked meat from domestic and wild pigs (MURRELL & POZIO 2011). The bases for the control of trichinosis in pigs, main key points are architectural and environmental barriers, adequate storage of food, rodent control, adequate hygiene of production systems, and disposal of dead pigs (GOTTSTEIN et al 2009). Medications against helminths such as albendazole and mebendazole are the main drugs for the treatment of trichinosis (HEMPHILL et al., 2007).

Several authors have reported a high frequency of T. solium eggs in stool samples from backyard pigs in several farms located in the Department of Cundinamarca, Colombia (MENDOZA-GÓMEZ et al., 2015). AGUDELO-FLOREZ & PALACIO (2003) observed a serological prevalence of porcine cysticercosis between 2.33 and 6.84% in endemic areas of Colombia. In the municipality of Andagoya, Colombia it was found a seroprevalence of 8.7% of T. solium in pig breeders and 20.9% in the pigs (AGUDELO-FLOREZ et al., 2009). An investigation carried out in different areas of the department of Tolima with the ELISA method showed the prevalence of porcine cysticercosis from 15.63 to 37.5% (SERRANO et al., 1993). Also, in the municipality of Coyaima Tolima of the 102 pigs, 17% (17/102) presented anticysticercus antibodies. Regarding the sociodemographic variables of the study, a greater association was observed with water sources, taeniasis patients, environmental conditions, and type of diet (GIRALDO et al 2017). In the municipality of Tuchín, Córdoba, it was observed a seroprevalence of 10% of cysticercosis in porcine (ARANGO LONDOÑO 2022). In the department of Boyacá, a seroprevalence of cysticercosis of 4.0% was observed. Not washing hands after going to the bathroom, and latrines were identified as risk factors (FLOREZ et al 2011). Up until now, Tr. spiralis has not been reported in Colombia (MORENO & LEÓN 2015; CHAPARRO-GUTIÉRREZ et al., 2018).

Other studies have observed low-to-high serological prevalences of T. solium-cysticercus in humans in Colombia. The mean serological prevalence of antibodies against T. solium cysticercus in humans was 9.6% in the Department of Caldas to 38.7% in the Department of Vaupés. The risk factors with statistical significance associated with seroprevalence to cysticercus were the use of rainwater, the consumption of partially cooked and raw pork, and the ownership of dogs (GALIPÓ et al., 2021). FLOREZ et al. (2013) reported a national serological prevalence of 8.5% of human cysticercosis with the highest percentage in the department of Vaupés (40.2%), and the lowest in Caldas (0.5%). The consumption of unwashed vegetables was shown to be a risk factor for the presentation of IgG antibodies anticysticercus. In the municipality of Mitú, of 1,141 humans who completed the survey, 441 were found to have IgG antibodies to cysticercus, 56.0% were female, especially from 19 to 40 years old. Not washing hands after leaving the bathroom presented a higher risk of cysticercosis infection compared to those who did wash (RINCÓN VALENZUELA, C., & FLÓREZ SÁNCHEZ, A. 2009). Different studies have reported cases of cysticercosis in humans in some other regions of Colombia (PALACIO et al., 1998; SANZÓN et al., 2002; VÁSQUEZ et al 2016; ZAPATA et al., 2017).

According to the agricultural census carried out in 2017 by the Colombian Agricultural Institute (ICA), the pig population for the department of Santander was 93,000 pigs with 85% being raised in backyards (ICA, 2017). Most of these backyard farms are related to a low sociocultural and human health level, inadequate sanitary facilities and conditions, and without wastewater treatment, professional or technical assistance (PINILLA et al., 2020). The objective of this study was to determine the seroprevalence and risk factors associated with Tr. spiralis and T. solium in backyard swine in the municipality of Bucaramanga, Colombia.

2. Material e Methods

2.1. Study area

The municipality of Bucaramanga is located in the department of Santander, Colombia. The Agricultural Colombian Institute reported a swine population in the Bucaramanga province of 40,000 animals (ICA, 2017). The municipality of Bucaramanga has a geographical area of 1,479 km2 with altitudes between 600 and 1,700 meters above the sea level (m.a.s.l.) and 78% relative humidity (GOBERNACIÓN DE SANTANDER, 2017). The climate of the region is tropical with variations in temperature and humidity throughout the year. In the region, pigs are raised in the backyard, and the owners have a poor educational and social level.

2.2. Sampling design

A descriptive and transversal study was applied to 64 backyard pigs. The sampled pigs were crossbreeds between the Yorkshire, Landrace, and Pietran breeds. The backyard pig population record for the region under study was 40,000 heads (ICA 2017) and using the formula for known populations (THRUSFIELD, 2007), and an expected prevalence of 8.5% (FLOREZ et al., 2013) and a confidence level of 95% with a 5% maximum associated error, resulting in an "n" of 380 blood samples. This number was distributed proportionally according to the number of pigs in each farm visited. No clinical manifestations consistent with parasitic diseases were found in the pigs under study. Four age categories were evenly formed according to DE ARAUJO et al. (2019): ≤2 months, 3-6 months, 7-12 months, and ≥13 months.

2.3. Risk factors

Epidemiological data about potential risk factors were obtained using a questionnaire administered to the owner of each herd at the time blood samples were collected. This information included: the municipality where the farm was located, the age group (≤2 months, 3-6 months, 7-12 months, and ≥13 months), the sex (male or female), if using the free-ranging system (yes or no), access to latrines (yes or no), deworming (yes or no), the type of feed (restaurant residues, concentrate and mixed) and the water source for the farm (spring water or deep well water).

2.4. Sample collection and examination

Blood (5 ml) was taken by puncture of the jugular vein in a sterile vacutainer tube without EDTA. The samples were transported refrigerated to the Research Laboratory of the Veterinary Clinic of the University of Santander, for processing. The samples were centrifuged at 2000 rpm for 10 min and subsequently stored at -20 °C. The sera were analyzed by indirect ELISA for the detection of anti-Trichinella spiralis antibodies using the ID Screen (Grabels, France), and an ELISA Monoscreen kit was used for the antigenic diagnosis of cysticercosis (T. solium) from Bio-X Diagnostics (Rochefort, Belgium), according to the manufacturer's instructions.

2.5. Statistical analysis

The information obtained was analyzed through the Chi-square test (X2) to determine the association between the variables under study and the prevalence obtained by applying the diagnostic tests. The odds ratio (OR) and its confidence intervals (CI) for the risk factors were found by univariate logistic regression analysis, taking into account the reference category those with the lowest probability of risk, and leaving as study categories the others (AGUAYO and LORA, 2007). The level of significance for the analysis was 5%. The calculations were made using IBM SPSS version 21 (IBM, 2012).

2.6. Ethical statement

The present investigation was approved by the Ethics Committee of UDES, under initiation act number CIF0311-19.

3. Results

No positive samples for Tr. spiralis were observed. On the other hand, the observed seroprevalence of porcine cysticercosis was 40.5% (154/380). According to the univariate logistic regression analyses, a statistical association ($P \leq 0.05$) was found between the seropositive values for swine cysticercosis and the variables altitude, free-range pigs, access to latrines, and deworming.

Likewise, free-range pigs raised above 1000 m.a.s.l. had an OR of 2.0 ($P \leq 0.05$), and 2.9 ($P \leq 0.05$) times higher the risk of infection, respectively, than free-range pigs below 1000 m.a.s.l. The variables access to no latrines and not dewormed pigs showed an OR of cysticercosis infection by T. solium of 2.0, ($P \leq 0.05$) and 2.7 ($P \leq 0.05$) times higher. No other variables were observed with statistical significance for cysticercosis (Table 1).

Variable	Categories	N	Positive	%	P-value	OR	CI (9
	Bucaramanga	173	57	33		1	-
Municipality	Floridablanca	54	28	51.7		1.4	0.9-5.
	Piedecuesta	85	33	38.8		0.6	0.5-2.
	Giron	68	36	52.9	0.087	2.04	1.1-5.
Age group							
	≤2 months	88	36	40.9		1	-
	3-6 months	116	38	32.7		0.6	0.3-1.
	7-12 months	95	46	48.4		1.4	0.6-3.
	≥13 months	81	34	41.9	0.43	0.9	0.5-3.
Sex							
	Male	139	69	49.6		1	-
	Female	241	85	35.2	0.054	0.56	0.28-
Altitude	< 1000 m.a.s.l.	230	78	33.9		1	-
	> 1000 m.a.s.l.	150	76	50.6	0.02*	2	0.5-2.
Free-range pigs	No	78	17	21.7		1	-
	Yes	302	137	45.3	0.007*	2.9	0.8-4.
Access to latrines	No	131	36	27.5		1	-
	Yes	249	118	47.3	0.03*	2	0.5-2.
Deworming	Yes	15	0	0		1	-
	No	365	154	40.5	0.02*	2.7	1.1-4.
	Restaurant residues	61	29	47.5		1	-
Type of food	Concentrate	91	46	50.5		1.9	1.2-3
	Mixed	228	79	34.6	0.14	0.6	0.2-3.
Water source	Spring wáter	57	21	36.8		1	-
	Deep well wáter	323	133	41.2	0.64	1.2	0.3-3.
Total		380	154	40.5			

Table 1 *– Risk factors associated with porcine cysticercosis in backyard pigs in Bucaramanga, Colombia.*

4. Discussion

Studies on swine zoonotic diseases in Colombia are scarce. Many of the parasites that affect the health of swine can be transmitted to humans, which is why are recognized as zoonotic agents. Among these porcine parasites Toxoplasma gondii, Cryptosporidium sp., T. solium, and Tr. spiralis can be mentioned. In this way, the interest in these zoonotic diseases in the world and in the country is directly related to human and animal health and also to the socio-economic progress of the communities (PULIDO-VILLAMARÍN et al., 2019).

In this investigation, no positive diagnostic was observed against Tr. spiralis. It may be suggested that Tr. spiralis was not present in the pigs of the sampled regions. These results are similar to other studies (CHAPARRO-GUTIÉRREZ et al., 2018; PULIDO-VILLAMARÍN et al., 2019), which also did not report infection by this parasite in pigs from other regions of Colombia. On the other hand, ORTEGA-PIERRES et al. (2000) and POZIO (2014) found this zoonotic parasite in pigs from Argentina and Chile. Our data is also contrary to those observed by POZIO (2007), who observed serum samples positive for Tr. spiralis in domestic pigs in Bolivia. Serological tests can sometimes result in false positives therefore a seropositive result must be confirmed by the artificial digestion test (CHAPARRO-GUTIÉRREZ et al., 2018). However, constant surveillance of Tr. spiralis in Colombia must be maintained, taking into account the endemic situations in Argentina, Chile, and Bolivia, and the possible spread of this parasite by unofficial meat commerce.

The serological prevalence for T. solium was 40.5% in our study. Similar epidemiological outcomes have been reported by other authors in hyperendemic areas of Peru (JAYASHI et al., 2012) in pigs from semi-technical and backyard farms and also in the department of Boyacá, Colombia (MOLANO et al., 2009). Another study showed much lower serological prevalence of T. solium in Antioquia, Colombia (AGUDELO-FLOREZ and PALACIO, 2003).

The present study showed that altitude, lack of deworming, and free-range pigs increased the risk of an animal being seropositive for T. solium. Therefore, the coexistence of precarious sanitary conditions and free-range pigs could effectively play an important role in the circulation of T. solium infection in the study area. Free-range pig farming is known to be an important risk factor for T. solium infection in pigs (ASSANA et al., 2010). Pigs raised in outside systems have more access to latrines having greater contact with the eggs of T. solium, increasing the possibility of transmitting the parasite to other pigs, and even to humans (TOMAS et al., 2013). On the contrary, other investigations considered that the presence of latrines is a condition that decreases the presentation of the serological prevalence of porcine cysticercosis (ASSANA et al., 2010).

In a systematic review, Jansen et al. (2021) identified that the eggs of Taenia spp. can remain viable in the environment for up to 12 months, under favorable conditions of higher humidity and temperature (25°C). Like this, and with the elimination of eggs by the final host, the pigs could be a key factor in the development of taeniasis by T. solium, due to its coprophagous habits. Pigs that have access to latrines and feed on the excrement of a definitive host (man), ingest eggs of the parasite and develop cysticercosis. So, the meat from backyard pigs is considered high risk, especially if they are not maintained in adequate hygiene and feeding conditions and if the meat is consumed without proper cooking (FLÓREZ et al., 2011). Therefore, the observed results allow us to suggest that porcine cysticercosis could represent a risk to public health in the study area. Due to the scarce epidemiological information in previous years, cysticercosis had been undiagnosed and unreported (BRAAE et al., 2017).

Considering this situation, it is important to highlight other studies carried out on cysticercosis in humans from different regions of Colombia (PALACIO et al., 1998; SANZÓN et al., 2002; RINCÓN VALENZUELA, C., & FLÓREZ SÁNCHEZ, A. 2009; FLÓREZ et al., 2013; VÁSQUEZ et al., 2016; ZAPATA et al 2017; GALIPÓ et al., 2021). However, studies in the different departments of Colombia are still necessary to make an approximation of the epidemiological condition of the disease in the swine population (ARANGO LONDOÑO M. 2022).

Zoonoses are a constant threat to public health worldwide. Many diseases are related to poverty and without being considered health needs they remain unattended and unreported becoming obstacles to the social, economic, and cultural progress of low and middle-income countries (BUENO et., al 2015). In the present investigation, it should be noted that in the backyard pig farms, different conditions were observed that could favor the presence of the cysticercosis-taeniasis complex. Unfortunately, the owners of these farms are mostly people with limited economic resources and without technical or professional support to improve the facilities and the health of the animals or control free-living stages in the environment. Therefore, improving these farms is a task that must be led by the government health entities of the department of Santander and other national authorities.

5. Conclusion

The variables (no) latrines and (no) deworming of pigs presented to be the most important risk factors of cysticercosis. This fact could increase the probability of spreading cysticercosis and T. solium to vulnerable communities. No positive samples for Tr. spiralis were observed.

Acknowledgment: The authors wish to thank the Veterinary Program of the University of Santander, Colombia, for the financial support of this project.

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