Seroprevalence and risk factors associated with Trichinellosis in swine productions of western Puerto Rico

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Abstract Trichinellosis is a parasitic disease caused by a nematode that affects principally humans and pigs, with global distribution and public health implications. In Puerto Rico, there are no previous reports on Trichinella spp. prevalence. Thus, the present investigation was conducted to assess the seroprevalence of Trichinella and risk factors associated with the disease in the western half of the island. Serum samples of 416 pigs were tested for antibodies to Trichinella spp. using ELISA. In addition a questionnaire was designed to compile information about management practices from each farm. Seven pigs tested positive for Trichinella spp. The existence of Trichinella spp. in Puerto Rico is thereby confirmed. Causative factors associated with trichinellosis were exposure of pigs to cats and dogs (p< 0.01) and feeding waste containing meat to the pigs (p<0.03).

Key words: Pigs, Risk factors, Seroprevalence, Trichinella, Zoonotic diseases

Estudio de prevalencia de Trichinella spp. en producciones porcinas de la región oeste de Puerto Rico.

Resumen La triquinelosis es una enfermedad parasítica causada por un nemático que afecta principalmente humanos y cerdos, la distribución del parásito es mundial y genera impactos en la salud pública. No se conoce ningún estudio previo en Puerto Rico sobre su prevalencia. Los objetivos de la presente investigación fueron evaluar la seroprevalencia de Trichinella y los factores de riesgo asociados con la enfermedad en la mitad oeste de la isla. Se evaluaron un total de 416 muestras de suero porcino para determinar anticuerpos presentes de Trichinella spp. usando el método ELISA. Además se realizó un cuestionario para obtener información sobre las prácticas de manejo en cada finca. Se diagnosticaron siete cerdos como positivo a Trichinella spp. Esto confirma la existencia de Trichinella spp. en Puerto Rico. Los principales factores de riesgo asociados con triquinelosis fueron exposición de los cerdos a perros y gatos (p< 0.01) y alimentación de los cerdos con desperdicio conteniendo residuos cárnicos (p<0.03).

Palabras clave: Cerdos, Enfermedades zoonóticas, Factores de Riesgo, Seroprevalencia, Trichinella

Introduction

The consumption of pork has been associated historically with several human diseases, mostly of parasitic origin. Among the parasitic diseases, trichinellosis caused by the nematode Trichinella spp., is considered a re-emerging problem due to the high number of cases worldwide during the last decade (Murrell and Pozio, 2011). Although this parasite primarily affects mammals, it has also been reported in reptiles and birds (Pozio, 2013). The human is an accidental host who acquire the infection mainly by consuming raw or undercooked pork (Bălescu et al., 2013). However, various studies demonstrate that the consumption of horse meat and game animals has become a relevant source of infection (Gajadhar and Forbes, 2010; Liciardi et al., 2009).

Trichinellosis has a high economic, social and health impact. For the pork industry the consequences include limitations in trade, penalties, and confiscation of carcasses. In the European Union around 200 million infected pigs are slaughtered...
annually, and nearly 570 million Euros are invested in campaigns to control the disease. Similarly the USA invests $200 billion annually on prevention and inspection programs (Murrell and Pozio, 2000).

Trichinellosis is usually present in swine production systems with poor sanitary conditions (e.g. lack of control of rodents, feeding waste containing meat, and use of free-range systems (Gamble et al., 1999; Ribicich et al., 2009). This disease has been reported in 198 countries; Puerto Rico is among the 40 islands with no previous epidemiological studies and has been considered a country free from Trichinella spp. (Chávez et al., 2006; Pozio, 2007). However, the pork industry in Puerto Rico is constituted mostly of backyard and free-range systems, while 94% of the pork consumed in the island is imported, which increases the risk of acquiring Trichinella spp. Therefore, the aim of the present investigation was to determine if Trichinellosis is present in swine production systems in Puerto Rico and to determine risk factors associated with the prevalence of the disease.

Material and Methods

Study area and sample selection

Pig farms from western Puerto Rico were selected using a USDA-APHIS Veterinary Services database of licensed farms (Figure 1). Trichinella spp. infection was tested in 416 pigs, older than four months, from 90 farms. Three types of production systems were included: intensive, extensive and backyard systems.

Epidemiological data collection

A questionnaire was designed in the statistical program Lexica Sphinx Survey 4.0 containing closed questions about management practices possibly associated with the presence of Trichinella spp. Questions were formulated to evaluate: animal origin, type of production system, type of feed, presence of rodents, wildlife and other domestic animals, exposure to swine and other animal carcasses.

The questionnaire was administered at the time of inspection and each farmer voluntarily accepted to participate and signed an informed consent form. The study was previously approved by the Institutional Review Board (IRB) committee of ethics for use of humans in research. This project was exempt from review of the Institutional Animal Care and Use Committee because pigs used were those sampled by the USDA APHIS Veterinary Services and only serum samples were handled by the investigators.

Trichinella spp. detection

Veterinarians of the USDA APHIS Veterinary Services obtained a blood sample (10 mL) from the jugular vein of each pig. The blood was centrifuged and resulting serum was collected and stored at -20°C. Serum samples were sent to the USDA-ARS Animal Parasitic Diseases Laboratory for detection of Trichinella spp.

Figure 1. Map of Puerto Rico (Western Puerto Rico enclosed). (1) Northwest Puerto Rico; (2) Southwest Puerto Rico. Dots represent actual sites where farms were surveyed.
Risk factors associated with *Trichinellosis* in swine production in western Puerto Rico

### Statistical Analysis

A Fisher’s exact test was performed using PROC FREQ from a SAS program, to establish the association between the categorical variables risk factors and seroprevalence. Statistical differences were considered with p<0.05. Additionally, odds ratios were calculated to determine level of association between variables.

### Results

*Trichinella* spp. infection was detected in seven of 416 pigs, which gives a general prevalence of 1.68%. Prevalence among farms was 5.6%; five of a total of 90 farms were positive to *Trichinella* spp. Of all the selected farms, 72.2% had fewer than 60 pigs (Table 1) and the five positive testing farms had a herd of less than 25 pigs.

Management practices were analyzed to determine risk factors associated with *Trichinella* spp. infection in pigs (Table 2). Pig exposure to cats and dogs, and feeding waste food containing meat were factors associated with *Trichinella* spp. infection (p<0.01 and p<0.03, respectively; Table 2). The variables cannibalism, animal origin, housing, management records, and farmer’s knowledge about *Trichinella* were not associated with *Trichinella* spp. detection in the serum of the pigs (Table 2).

### Discussion

To our knowledge this is the first study of seroprevalence for *Trichinella* spp. infection conducted in Puerto Rico. The results showed that *Trichinella* spp. is present in locally raised pigs, although at a low prevalence rate (1.68%). However, this rate is higher than in the United States (0.26 to 0.47%; Gamble *et al*., 1999). On the other hand it represents a much lower prevalence compare to other countries such as Argentina (24.5%; Costantino *et al*., 2009), China (29.95%; Cui *et al*., 2013) and Chile (5.1 to 43.6%; Ortega-Pierres *et al*., 2000). The prevalence of this parasitic disease diminishes in countries with intensive production systems, due to investment in infrastructure, and inspection at level farm and slaughterhouses. Also the risk of exposure to sources of infection is reduced by confinement and biosecurity practices (Robertson *et al*., 2014).

Seventy percent of the farms selected in this study use backyard or free-range systems, with fewer than 60 pigs. The animals were often reared in partial or total confinement, under poor hygienic conditions, sometimes exposed to animal carcasses and commonly fed with waste products containing meat. All the positive testing premises featured this type of system, which is in agreement with studies in other countries of Van der Giessen *et al*., (2007) and Theodoropoulos *et al*., (2009), who reported significant prevalence in outdoor and smallholder farming systems.

Several other studies have linked seropositivity to *Trichinella* spp. with cannibalism and scavenging behavior; lack of farmers knowledge about *Trichinella* spp; and introduction of new pigs on the farms without any sanitary information; poor housing facilities and lack of management records (Venturiello *et al*., 1998; Gottstein, *et al*., 2009; Ribicich *et al*., 2009; Torgerson, 2013; Cui *et al*., 2013). Although in the present case statistical differences

### Table 1 Production size of pig farms

<table>
<thead>
<tr>
<th>Number of pigs</th>
<th>Number of farms</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 60</td>
<td>65</td>
<td>72.2</td>
</tr>
<tr>
<td>60 -120</td>
<td>16</td>
<td>17.8</td>
</tr>
<tr>
<td>120 -180</td>
<td>6</td>
<td>6.7</td>
</tr>
<tr>
<td>180 -240</td>
<td>2</td>
<td>2.2</td>
</tr>
<tr>
<td>240 - 300</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>300 - 360</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>More than 360</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Total number of observations</td>
<td>90</td>
<td>100</td>
</tr>
</tbody>
</table>
were verified only for the risk factors exposure to cats and dogs (p< 0.01) and feeding waste containing meat to the pigs (p< 0.03), the OR results regarding these two factors suggest that they did not constitute a potential risk factor in this investigation. The positive cases confirmed could not be attributed to direct contact of the pigs with pet animals. Furthermore, in all the selected premises that were feeding waste food, the procedures complied with Code 9 of the United States Federal Regulations (9CFR), part 166, which requires cooking the waste products according to specifications.

Most of the risk factors considered in this study did not play a significant role in *Trichinella* spp. infection. However the descriptive data suggest that the farmer's lack of knowledge concerning the disease and lack of records on animal sales and purchases increases the odds of becoming seropositive compared to better managed operations. In agreement with Dupouy-Camet and Murrell (2007), improving biosecurity and employing good production practices reduces the risk of acquiring Trichinellosis.

This first epidemiological study showed that the seroprevalence of *Trichinella* spp. in western Puerto Rico is low. Nonetheless, the parasite was shown to be present locally and the infection is latent in backyard and free-range systems. The implementation of preventive and monitoring practices at slaughterhouses, combined with education of farmers and consumers about the need for inactivation of parasites present in meat, should reduce the risk of Trichinellosis. Further studies should include identifying which *Trichinella* spp. species are present in Puerto Rico.

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**Literature Cited**


