Original Research Article

Seroprevalence of *Echinococcus granulosus* in dogs in Southern China

A serological survey was conducted to estimate the prevalence of *Echinococcus granulosus* infections in domestic dogs. Blood samples from 310 dogs (144 males and 66 females) in Fuzhou, Shenzhen, Chongqing, Kunming, Nanchang, Guangzhou and Nanning in Southern China were examined using an enzyme-linked immunosorbent assay (ELISA) kit. Overall seroprevalence of *E. granulosus* infection among these dogs was 2.58%. The prevalence in male dogs (five of 144, 3.47%) was higher than in female dogs (three of 166, 1.81%). The seroprevalence rate was 3.3% in dogs <1 year-old age group, 2.76% in the 1-4 year-old age group, and 1.35% in the >4 year-old age group. There was no significant difference observed in the sexes and age classes. However, this is a little surprising that *E. granulosus* seroprevalence was mainly on the coastal economy area (little herbivores) compared to the mountain cities (with sheep and cattle) in low endemic areas. To our knowledge, this is the firstly reported serological survey of anti-*E. granulosus* antibodies in Southern China to date.

**Key words:** *Echinococcus granulosus*, seroprevalence, China, dogs

INTRODUCTION

Echinococcosis is a zoonotic parasitic disease caused by the cystic stage of *E. granulosus*, which commonly exists in a cycle between cloven-hoofed livestock and domestic dogs. The adult tapeworms of *E. granulosus*, is long 3-6 mm. It lives in the small intestine of carnivorous definitive hosts, such as dogs and wolves. The larval stages (tissue-invading metacestode) occur in herbivorous intermediate hosts (Figure 1). The disease is apparent to public health importance (Torgerson and Budke, 2003), humans can act as intermediate hosts following direct contacting with infected dogs or ingestion of eggs passed in the faeces of infected dogs (Dakkak, 2010).

Human echinococcosis is distributed mainly in Western and Northwestern China. The first case of human alveolar echinococcosis was reported in China (Yao, 1965). Previous studies reported that the mean prevalences of 4-6% for both human cystic echinococcosis and alveolar echinococcosis in Tibet Autonomous Region, Sichuan, and Qinghai (Feng et al., 2015; Li et al., 2010; Schantz et al., 2003). Epidemiological studies of human echinococcosis revealed that the high prevalence areas in China, including Xinjiang, Gansu, Ningxia, Inner Mongolia, Qinghai, Tibet, and Sichuan (Tiaoying et al., 2005; Craig, 2006a; Wang et al., 2008; Yang et al., 2008). China is one of the most important endemic areas of echinococcosis in the world. Echinococcosis seems to emerge or re-emerge in recent years (Eckert et al., 2004; Jenkins et al., 2005). Human activities including the booming livestock pastoralism and changing land-use patterns are highly related to the transmission of echinococcosis in China (Wang et al., 2008).

Monitoring of canine echinococcosis is considered as the most effective method for assessment of the risk to humans (Guarnera et al., 2000; Craig and Larrieu, 2006b). Recent studies indentified 12.7% in Shiqu County of dogs with *E. granulosus* infection, 50% in Qinghai, 55.6% in Ningxia
Figure 1: Life cycle of Echinococcus granulosus (adapted from Moro and Schantz, 2009)

(Wang et al., 2006; Budke et al., 2005a). No studies have been carried out to determine risk factors for canine echinococcosis in Southern China. It has become increasingly important to evaluate the epidemiological situation of E. granulosus infection in dogs. In this study, we collected 310 dog blood samples and then detected IgG antibody against E. granulosus. A cross-sectional study is used to assess the anti-E. granulosus antibodies in dogs in Fuzhou, Shenzhen, Chongqing, Kunming, Nanchang, Guangzhou and Nanning (mainly in Southern China), and the risk factors for antibody positivity.

MATERIALS AND METHODS

Study areas

This study was conducted in Fuzhou, Shenzhen, Chongqing, Kunming, Nanchang, Guangzhou and Nanning (one shoreline area, three urban areas and three mountain areas) in Southern China local veterinary clinics (Figure 2).

Animals

During November 2010 and April 2011 the 310 dogs (144 males, 166 females; 91 dogs <1 year, 145 dogs 1-4 years, 74 dogs >4 years) had been sampled in local veterinary clinics. All procedures used in this study were approved by the Ethics Committee of Guangdong Academy of Agricultural Sciences.

Blood Sampling

Blood for serum was collected. The saphenous veins of the dogs was used to collect 5ml (or so) on plain tube then the serum separated by centrifugation stored frozen at -20 °C until needed. The sera were placed in a cool box and transported to the laboratory.

Determination of antibodies to E. granulosus

The detection of IgG antibody against E. granulosus was performed by an enzyme immunoassay using a commercial kit (specificity, 93% and sensitivity, 80%) from Shenzhen Combined Biotech Co., Ltd. (China), according to the manufacturer's instructions, positive and negative control sera were placed in the ELISA kit.

Data management

The dogs were designated as either E. granulosus positive or negative according to the cut-off value obtained by the mean value of the optical density (OD) from the negative controls multiply 2.10, while positive control at an OD identical to or higher than 0.30, and negative control at an OD identical to or lower than 0.10. The sera were considered negative for E. granulosus infection if the OD of the sample was less than the cut-off value and positive if the
OD of the sample was greater than the cut-off value according to the recommendations of the manufacturer.

**Statistical analysis**

The number and proportion of positive serum, the effects of age, sex, and region on *E. granulosus* status were calculated using an exact binomial confidence interval of 95%. Data analysis was conducted using SPSS 15.0, *p*-value ≤0.05 was considered statistically significant.

**RESULTS**

The results of the ELISA examination showed that the overall seroprevalence of canine echinococcosis was 2.58%, and the distribution of seropositivity in the seven cities is listed in Table 1. According to the districts of origin of the dogs seroprevalence ranged from 0 (Chongqing, Nanning, Kunming) to 6.67% (Guangzhou, and Shenzhen). There was no significant difference for the seroprevalence between female (three of 166, 1.81%) and male dogs (five of 144, 3.47%). The prevalence rate was 3.3% in dogs <1 year-old age group, 2.76% in the 1-4 year-old age group, and 1.35% in the >4 year-old age group.

Statistical analysis revealed no significant difference in seroprevalence was found in different age groups. No risk factor for dogs was found in age and gender groups. The prevalence in Shenzhen and Guangzhou City were significantly higher than that in the other five cities.

**DISCUSSION**

Determining the rate of infection and mean abundance in dogs is probably the best index of the degree of transmission of *E. granulosus* in a local region (Craig, 2006a; Wang et al., 2008). Recent research observed that 2.8% of tested persons (175) were positive for *E. granulosus* using the ELISA method, and all subjects had a
history of contact with dogs (Kasaei et al., 2016). In this study, we found that 2.58% of sampled dogs (310) were serologically positive for *E. granulosus*. The prevalence rate observed in this study was lower than that observed from farm dogs in South Powys (10.6%), and Wales (8.1%) (Mastin et al., 2011; Buishi et al., 2005), lower than that observed in the western and northwestern provinces and autonomous regions in China (Budke et al., 2005a), and similar to that observed in Slovakia (2.8%) (Antolová et al., 2009).

Like many other parasite infections, the course of *E. granulosus* infection is complex. The worm has a life cycle that requires definitive hosts and intermediate hosts. Definitive hosts are normally carnivores such as dogs, while intermediate hosts are usually herbivores such as sheep, cattle, goats, camel and human. Traditionally there is a high incidence of infection by *E. granulosus* often coincide with rural, grazing areas where dogs are able to ingest organs from infected herbivores, such as sheep and cattle.

In the present study, Shenzhen, Guangzhou, Fuzhou and Nanchang, especially Shenzhen and Guangzhou were the most developed economy area in China, the animal husbandry output value accounts in these areas have reduced to almost zero, especially little herbivores. In the other areas, there are more sheep and cattle. While an interesting observation in this report is that the geographical distribution of dogs infected *E. granulosus* was mainly on the coastal economy areas. However, the areas with more sheep and cattle have lower prevalence rate. Similar observations reported in the previous year that higher prevalence was found in urban compared to rural areas (Acosta-Jamett et al., 2010). Some factors may explain the infection of domestic dogs in areas with little animal husbandry. One possible explanation is related to the trade of livestock from endemic areas. In recent years, the consumption of mutton and beef in coastal economy areas are very high, and the meat of sheep and cattle were mainly transported from endemic areas: Xinjiang, Gansu, Ningxia, Inner Mongolia, and Qinghai in China. In Sousse city in Tunisia, an urban cycle of *E. granulosus* was found with high prevalence rate (~70%) of canine echinococcosis in free-roaming dogs (Bchir et al., 1987; Deplazes et al., 2011).

In this study, we found that age is not an important risk factor for dogs. Similar results have also been reported in *E. granulosus* infected dogs aged <5 years in high endemic areas of China (Budke et al., 2005b). The seroprevalence was 3.47% in males, and 1.81% in females. Gender was not significantly related to the serology positive for *E. granulosus* in dogs, similar to previous study (Benito et al., 2006).

In conclusion, the current study has identified the anti-*E. granulosus* antibodies in domestic dogs in Southern China. This finding indicated that dogs infected *E. granulosus* may be a public health threat in urban areas. It is recommended that further surveillance will be conducted, in order to better estimate the prevalence of *E. granulosus* infection in low endemic areas.

**ACKNOWLEDGEMENTS**

This research was supported by a NSFC grants (No: 31302087 and 31402186), NSF grant of Guangdong province (No: 2015A030313561), the Science and Technology Planning Project of Guangdong province (No: 2014A020208057, 2015A02010080, 2014B090901035, 2015B050501007 and 2012A020100001).

**Conflict of Interests**

The authors declare that there is no conflict of interests regarding the publication of the paper.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of dogs (%)</th>
<th>Positive dogs (%)</th>
<th>Odds ratio</th>
<th>95% Confidence interval</th>
<th>P-value</th>
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<tbody>
<tr>
<td>Total</td>
<td>310 (100)</td>
<td>8 (2.58)</td>
<td></td>
<td></td>
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<td>Sex</td>
<td></td>
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<tr>
<td>Females</td>
<td>166 (53.55)</td>
<td>3 (1.81)</td>
<td>1</td>
<td>0.459-8.325</td>
<td>0.356</td>
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<tr>
<td>Males</td>
<td>144 (46.45)</td>
<td>5 (3.47)</td>
<td>1.954</td>
<td></td>
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<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>&lt;1</td>
<td>91 (29.354)</td>
<td>3 (3.30)</td>
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<td>1-4</td>
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<td>4 (2.76)</td>
<td>0.832</td>
<td>0.182-3.806</td>
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<td>&gt;4</td>
<td>74 (23.87)</td>
<td>1 (1.35)</td>
<td>0.402</td>
<td>0.041-3.946</td>
<td>0.419</td>
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<td>Kunming</td>
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REFERENCES


