Seroprevalence of *Toxoplasma gondii* infection in dairy cattle in southern China

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**Abstract**

**Background:** As an obligate intracellular parasite, *Toxoplasma gondii* can infect humans and almost all warm-blooded animals. The consumption of raw or undercooked beef and milk is considered a risk for *T. gondii* infection in humans. However, little is known of *T. gondii* infection in dairy cattle in metropolitan Guangzhou, southern China. This study was performed to determine the seroprevalence of *T. gondii* in dairy cattle in Guangzhou, southern China.

**Findings:** Serum samples were collected from 350 dairy cattle on five farms in Guangzhou, China from 2009 to 2010, and all of the 350 serum samples were examined for specific antibodies to *T. gondii* by indirect hemagglutination antibody test (IHA). The overall seroprevalence of *T. gondii* in dairy cattle was 5.7% (20/350). Among these examined dairy cattle, dairy cattle which were < 6 year old or ≥ 5 year old had the highest seroprevalence of 12.5% followed by those dairy cattle which were < 5 year old or ≥ 4 year old (8%); dairy cattle with 3 pregnancies had the highest seroprevalence (11.5%), among the examined dairy cattle, although these differences were not statistically significant.

**Conclusions:** The results of the present survey indicate that *T. gondii* infection is prevalent in dairy cattle of all age ranges in Guangzhou, southern China, which may be a risk factor for human infection with *T. gondii* in this region. Dong-Hui Zhou and Fu-Rong Zhao contributed equally.

**Background**

*Toxoplasma gondii* is an obligate intracellular protozoan parasite, infecting humans and almost all warm-blooded animals and causing serious zoonotic toxoplasmosis, with a worldwide distribution [1-5]. Toxoplasmosis is an important food-borne parasitic disease, which is usually asymptomatic in immunocompetent individuals but can cause toxoplasmic encephalitis in immuno-compromised patients, blindness, abortion, fetal abnormalities or even prenatal death in congenital cases [1-3]. Humans and animals acquire infection mainly by the consumption of raw and undercooked meat, and also by the ingestion of *T. gondii* oocysts present in the environment (water, soil, fruits and vegetables) contaminated with the faeces of infected cats [1-3].

Although being considered a poor host for *T. gondii*, both natural and experimental infections of *T. gondii* in cattle have been reported [1,6]. Infection with the parasite may cause abortion, resulting in substantial economic loss and also the potential to transmit to other animals and humans [7]. Studies have indicated that the consumption of raw or undercooked beef and milk may be a risk for *T. gondii* infection in humans [8].

*T. gondii* seroprevalence has been documented in humans, cats, dogs, rats, ducks and chickens in Guangzhou, southern China [9-13]. However, little is known of the infection of *T. gondii* in dairy cattle in this city. The objective of the present investigation was to determine *T. gondii* seroprevalence in dairy cattle from dairy farms in Guangzhou, southern China by using an indirect hemagglutination antibody test (IHA). The results of the survey will provide base-line data for the implementation of effective strategies and measures for the control
and prevention of T. gondii infection in dairy cattle in this southern city.

**Methods**

**Serum preparation**

Blood samples were collected from 350 dairy cattle on 5 farms in Guangzhou City, southern China between July 2009 and January 2010. The dairy cattle populations represented a local breed (Chinese Holstein) and an introduced breed (American/Australian Holstein-Friesian and British Jersey). All the blood samples were immediately transported to the laboratory at The College of Veterinary Medicine, South China Agricultural University. Serum was separated by centrifugation at 3,000 rpm for 10 min. The serum samples were stored at -20°C until tested for antibodies against T. gondii.

Biometric data for dairy cattle, including age, breed and numbers of past pregnancies were obtained from the farmers.

**Serological examination**

Antibodies against T. gondii were determined by IHA using a commercially-marketed kit (Veterinary Research Institute, Jiangsu Academy of Agricultural Sciences, Jiang Province, China) according to the manufacturer’s protocol as described previously [14,15]. The test was considered positive if a layer of agglutinated erythrocytes was formed in wells at serum dilutions of 1:64 or higher. Positive and negative control sera were provided in the kit and were included in each test. The positive control sera were collected from pigs experimentally infected with T. gondii. The negative control sera were collected from pigs without T. gondii infection (collected before experimental infection).

**Statistical analysis**

Differences in T. gondii seroprevalence among dairy cattle of different age groups and different numbers of pregnancies were analyzed by a Chi square test using the SPSS for Windows (Release 18.0 standard version, SPSS Inc., Chicago, Illinois). The differences were considered statistically significant when \( P < 0.05 \).

**Results**

A total of 350 dairy cattle from 5 farms in Guangzhou, Southern China were examined by IHA for T. gondii antibodies. 20 of the 350 (5.7%) examined dairy cattle were seropositive for T. gondii infection by IHA at the cut-off of 1:64 (Table 1). Different levels of T. gondii seropositivity were detected in 5 different farms (Table 1). Seroprevalence varied in different age groups, ranging from 2.3% to 12.5% (Table 2). The numbers of parturition of dairy cattle ranged between 1 pregnancy and 7 pregnancies, and the T. gondii seroprevalence varied in dairy cattle with different numbers of pregnancies, ranging from 0 to 11.5% (Table 3).

**Discussion**

In this study, we examined the seroprevalence of T. gondii infection in dairy cattle in Guangzhou city, southern China. 5.7% of the 350 tested dairy cattle were seropositive for T. gondii by IHA, which is lower than that reported in Guangxi (9.2%), Liaoning (6.0%), Qinghai (11.8%), Xinjiang (46.4%) in China [16-19] and some other countries [20-25], but higher than that reported in Yunnan province (1.4%) [26]. Different T. gondii seroprevalences in dairy cattle in different countries and regions may be due to different serological tests used and different sources of dairy cattle. T. gondii infection is probably more prevalent in warm and humid areas than in cold and dry regions [1]. This is probably related to conditions relating to the survival of oocysts in the environment.

The ages of the 350 dairy cattle were analyzed for the association with T. gondii seroprevalence (Table 2). The seroprevalence varied in different age groups, ranging from 2.3%-12.5%, with the highest of 12.5% in dairy cattle which were < 6 year old or ≥ 5 year old, although the seroprevalences were not statistically significantly different among the different age groups (\( P > 0.05 \)). The varied seroprevalence in different age groups suggests

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**Table 1 Seroprevalence of Toxoplasma gondii infection in dairy cattle in Guangzhou, southern China**

| Farm | No. examined | No. positive | Prevalence (%) |
|------|--------------|--------------|----------------|
| A    | 80           | 2            | 2.5            |
| B    | 50           | 3            | 6              |
| C    | 60           | 4            | 6.7            |
| D    | 80           | 4            | 5              |
| E    | 80           | 7            | 8.8            |
| **Total** | **350**    | **20**       | **5.7**        |

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**Table 2 Seroprevalence of Toxoplasma gondii in different ages of dairy cattle in Guangzhou, southern China**

| Age (year) | No. examined | No. positive | Prevalence (%) |
|------------|--------------|--------------|----------------|
| 1 ≤ yr < 2 | 44           | 1            | 2.3            |
| 2 ≤ yr < 3 | 51           | 2            | 3.9            |
| 3 ≤ yr < 4 | 54           | 2            | 3.7            |
| 4 ≤ yr < 5 | 25           | 2            | 8              |
| 5 ≤ yr < 6 | 48           | 6            | 12.5           |
| 6 ≤ yr < 7 | 42           | 3            | 7.1            |
| 7 ≤ yr < 8 | 57           | 2            | 3.5            |
| ≥ 8        | 29           | 2            | 6.9            |
| **Total**  | **350**      | **20**       | **5.7**        |
Table 3 Seroprevalence of Toxoplasma gondii in dairy cattle of different pregnancies in Guangzhou, southern China

| No. pregnancies | No. examined | No. positive | Prevalence (%) |
|-----------------|--------------|--------------|----------------|
| 0               | 48           | 1            | 2.1            |
| 1               | 35           | 3            | 8.6            |
| 2               | 41           | 2            | 4.9            |
| 3               | 52           | 6            | 11.5           |
| 4               | 39           | 3            | 7.7            |
| 5               | 48           | 2            | 4.2            |
| 6               | 44           | 2            | 4.5            |
| ≥7              | 17           | 0            | 0              |
| With no history records | 26 | 1 | 3.8 |
| Total           | 350          | 20           | 5.7            |

The possibility of horizontal transmission in the investigated herds.

Of the 350 dairy cattle examined, 322 had record of numbers of previous pregnancies for the analysis of the association between T. gondii seroprevalence and past pregnancies (Table 3). The seroprevalence in the dairy cattle with 3 births was the highest (11.5%), followed by the dairy cattle with 1 pregnancy, but the differences were not statistically significant (P > 0.05).

Conclusions

This survey demonstrated that T. gondii infection is prevalent in dairy cattle of all age ranges in Guangzhou, China, which may represent a potential source for human infection with T. gondii. Therefore, integrated strategies and measures should be executed to control and prevent T. gondii infection in dairy cattle in the study region.

Acknowledgements

This work was supported, in part, by the National Natural Science Foundation of China (Grant Nos. 31172316 and 31101812), the Open Funds of the State Key Laboratory of Veterinary Etiological Biology, Lanzhou Veterinary Research Institute, Chinese Academy of Agricultural Sciences (Grant Nos. SKLVEB2011KFT004, SKLVEB2010KFT009, SKLVEB2009KFT008 and SKLVEB2011KFT010), the Yunnan Provincial Program for Introducing High-level Scientists (Grant No. 2009C2-25), Guangdong Province Science and Technology Project (Grant No. 2008A020100012), Guangzhou City Science and Technology Project (Grant No. 200921-E731) and Guangdong Province Science and Technology Infrastructure Project (Grant No. 2010B06020004).

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Authors’ contributions

XQZ and SJL conceived and designed the study, and critically revised the manuscript. DHRZ, FHZ and HYX performed the experiments, analysed the data and drafted the manuscript. PL, MXJ, LGY, CY and SHT helped in study design, study implementation and manuscript revision. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Received: 6 January 2012 Accepted: 9 March 2012 Published: 9 March 2012

References

1. Dubey JP: Toxoplasmosis of Animals and Humans. Boca Raton, New York: CRC Press Inc.; Second 2010, 1-313.
2. Zhou P, Chen Z, Li HL, Zheng H, He S, Lin RQ, Zhu XQ: Toxoplasma gondii infection in humans in China. Parasit Vectors 2011, 4:165.
3. Montoya JG, Liesenfeld O: Toxoplasmosis. Lancet 2004, 363:1965-1976.
4. Wu SM, Zhu XQ, Zhu DH, Fu BQ, Chen J, Yang JF, Song HQ, Weng YB, Ye DH: Seroprevalence of Toxoplasma gondii infection in household and stray cats in Lanzhou, northwest China. Parasit Vectors 2011, 4:214.
5. Zhao GH, Zhang MT, Lei LH, Shang CC, Cao DY, Tian TT, Li J, Xu YJ, Yao YL, Chen DK, Zhu XQ: Seroprevalence of Toxoplasma gondii infection in dairy goats in Shaanxi Province, Northwestern China. Parasit Vectors 2011, 4:47.
6. Costa GH, da Costa AJ, Lopes WD, Bresciani KD, dos Santos TR, Esper CR, Santana AE: Toxoplasma gondii: infection natural congenital in cattle and an experimental inoculation of gestating cows with oocysts. Exp Parasitol 2011, 127:277-281.
7. Dubey JP, Jones JL: Toxoplasma gondii infection in humans and animals in the United States. Int J Parasitol 2008, 38:1257-1278.
8. Tenter AM: Toxoplasma gondii in animals used for human consumption. Mem Inst Oswaldo Cruz 2009, 104:364-369.
9. Gao XJ, Zhao ZJ, He ZH, Wang T, Yang TB, Chen XG, Shen JL, Wang Y, Lv FL, Hide G, Lun ZR: Toxoplasma gondii infection in pregnant women in China. Parasitology 2012, 139:139-147.
10. Zhang H, Zhou DH, Zhou P, Lun ZR, Chen XG, Lin RQ, Yuan ZG, Zhu XQ: Seroprevalence of Toxoplasma gondii infection in stray and household cats in Guangzhou, China. Zoonoses Public Health 2009, 56:502-505.
11. Zhang H, Zhou DH, Chen YZ, Lin RQ, Yuan ZG, Song HQ, Li SJ, Zhu XQ: Antibodies to Toxoplasma gondii in stray and household dogs in Guangzhou, China. J Parasitol 2010, 96:671-672.
12. Yin CC, He Y, Zhou DH, Yan C, He XH, Wu SM, Zhou Y, Yuan ZG, Lin RQ, Zhu XQ: Seroprevalence of Toxoplasma gondii in rats in southern China. J Parasitol 2010, 96:1233-1234.
13. Yan C, Yue CL, Yuan ZG, He Y, Yin CC, Lin RQ, Dubey JP, Zhu XQ: Toxoplasma gondii infection in domestic ducks, free-range and caged chickens in southern China. Vet Parasitol 2009, 165:337-340.
14. Zou FC, Sun XT, Xie YJ, Li B, Zhao GH, Duan G, Zhu XQ: Seroprevalence of Toxoplasma gondii in pigs in southwestern China. Parasit Vectors 2009, 2:306-307.
15. Wang CR, Qu JH, Gao JF, Liu LM, Wang C, Liu Q, Yan C, Zhu XQ: Seroprevalence of Toxoplasma gondii infection in sheep and goats in northeastern China. Small Ruminant Res 2011, 97:130-133.
16. Lv YC, Cui JZ: Survey of Toxoplasma gondii infection in pigs and cattle in Guangxi Province, China. J Anim Sci Vet Med 1994, 3:26, in Chinese.
17. Liu XJ, Liu CW, Liu YJ, Jin HT, Zhao YK, Chen J, Yang M, Liu Q: Seroprevalence of Toxoplasma gondii infection in slaughtered pigs and cattle in Liaoning Province, northeastern China. J Parasitol 2011.
18. Liu J, Cai JZ, Zhang W, Liu Q, Chen D, Han JP, Liu QR: Seropredisemology of Neospora caninum and Toxoplasma gondii infection in yaks (Bos grunniens) in Qinghai, China. Vet Parasitol 2008, 152:330-332.
19. Xi MY, Ba YC, Li WC: Epidemiic investigation of Toxoplasma gondii infection in pigs, cattle and sheep in Xinjiang. Chin J Vet Parasitol 2007, 15:22-24, in Chinese.
20. Inpankaew T, Pinyopanuwut N, Chiranoi W, Kengradomkit C, Sununta C, Zhang G, Nishikawa Y, Igarashi I, Xuan X, Jittapalapong S: Serodiagnosis of Toxoplasma gondii infection in dairy cows in Thailand. Transbound Emerg Dis 2010, 57:42-45.

21. Yildiz K, Kul O, Balzur C, Kiliç S, Gazyagci AN, Celebi B, Gurcan IS: Seroprevalence of Neospora caninum in dairy cattle ranches with high abortion rate: special emphasis to serologic co-existence with Toxoplasma gondii, Brucella abortus and Listeria monocytogenes. Vet Parasitol 2009, 164:306-310.

22. Santos TR, Costa AJ, Toniollo GH, Luvizotto MC, Benetti AH, Santos RR, Matta DH, Lopes WD, Oliveira JA, Oliveira GP: Prevalence of anti-Toxoplasma gondii antibodies in dairy cattle, dogs, and humans from the Jauru micro-region, Mato Grosso state, Brazil. Vet Parasitol 2009, 161:324-326.

23. Panadero R, Painceira A, López C, Vázquez L, Paz A, Díaz P, Dacal V, Cienfuegos S, Fernández G, Lago N, Díez-Bahos P, Morondo P: Seroprevalence of Toxoplasma gondii and Neospora caninum in wild and domestic ruminants sharing pastures in Galicia (Northwest Spain). Res Vet Sci 2010, 88:111-115.

24. Hamidinejat H, Ghorbanpour M, Nabavi L, Haji Hajikolaie MR, Razi Jalali MH: Occurrence of anti-Toxoplasma gondii antibodies in female cattle in south-west of Iran. Trop Anim Health Prod 2010, 42:899-903.

25. Huong LT, Ljungström BL, Uggla A, Björkman C: Prevalence of antibodies to Neospora caninum and Toxoplasma gondii in cattle and water buffaloes in southern Vietnam. Vet Parasitol 1998, 75:53-57.

26. Huang DS: Survey of Toxoplasma gondii infection in livestock in Yunnan Province. Chin J Zoonoses 1991, 7:33, In Chinese.

doi:10.1186/1756-3305-5-48
Cite this article as: Zhou et al. Seroprevalence of Toxoplasma gondii infection in dairy cattle in southern China. Parasites & Vectors 2012 5:48.