

The epidemiology of swine trichinellosis in China during 1999 – 2004

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Summary

The epidemiology of swine trichinellosis in China during 1999 – 2004 was reported in this paper. The seroepidemiological survey of swine trichinellosis was carried out by ELISA in 4 Provinces or Autonomous Regions (P/A), the seroprevalence was from 1.63 % to 15.21 %. The prevalence of *Trichinella* infection in swine slaughtered at abattoirs varied from 0.0001 % to 23 % in 7 P/A. Both of the seroprevalence and prevalence of swine trichinellosis in China has obviously decreased compared with that in 1990's. The decrease was probably due to a combination of factors, including development of industrialized pig farms, application of commercial grain forages, the improvement of pig production practices and the shortening of swine feeding time. At present, swine trichinellosis in China still is mainly transmitted by garbage (ie. feeding pigs with raw swill). *Trichinella* infected pigs are predominately from the small farms of suburbs where pigs are fed on swill from the restaurants and from some mountainous areas where pigs are raised outdoors. Pigs were sometimes slaughtered clandestinely at home in rural and mountainous areas without veterinary inspection. The prevalence of *Trichinella* infection in pork sold at the market was from 0.52 % to 3.66 % in 3 P/A. 17 outbreaks of human trichinellosis, with 828 cases and 11 deaths, were recorded in 8 P/M of China during 2000 – 2004. Out of 17 outbreaks, 13 (76.47 %) outbreaks were caused by eating raw or poorly cooked pork. Hence, the pig-rearing mode should be changed and all pigs should be raised in piggery, and the mandatory inspection of meat be further strengthen for the control of trichinellosis.

Key words: trichinellosis; epidemiology; swine; pork; China

Introduction

Trichinellosis is a serious parasitic zoonosis which is widely distributed in the world. Human infection is commonly

resulted from the ingestion of raw or undercooked meat containing *Trichinella* larvae. Pork and its products are closely associated with outbreak of human trichinellosis. Although human trichinellosis is relatively rare in many European Union (EU) countries, *Trichinella*-infected pork products were sometimes brought from Eastern Europe to the EU as gift, which caused several outbreaks of human trichinellosis (Pozio & Marucci, 2003). Out of 548 outbreaks of human trichinellosis occurred in China during 1964 – 1999, 525 outbreaks were caused by eating pork (Wang & Cui, 2001a). Pork is the predominant source of outbreaks of human trichinellosis in China. The global prevalence of swine trichinellosis is difficult to evaluate but about 10 000 porcine infections were reported by the Office International des Epizooties in 1998 (Dupouy-Camet, 2000). The epidemiology of swine trichinellosis in China before 1999 was reported (Wang & Cui, 2001b). Over the past six years, some surveys on the epidemiology of swine trichinellosis have been carried out by Chinese parasitologists. However, almost all studies on swine trichinellosis in China have been published in Chinese and are relatively inaccessible to the many people whose main language is not Chinese. In order to know the recent nationwide status of swine *Trichinella* infection in China, the Chinese publications on epidemiology of swine trichinellosis in China during 1999 – 2004 were systematized and analyzed in this paper.

Seroprevalence of swine trichinellosis

The seroepidemiological survey of swine trichinellosis was carried out by indirect ELISA in 4 Provinces or Autonomous Regions (P/A) of China. Specific anti-*Trichinella* antibodies (IgG) were determined by indirect ELISA using the excretory-secretory (ES) antigen of *T. spiralis* muscle larvae. The ELISA method was performed as described before (Li *et al.*, 1991). The mean O.D. value of negative sera from 135 healthy pigs was 0.12. The positive cutoff was determined to be 4 times of the mean of negative sera.

Table 1. Seroprevalence of swine trichinellosis in China by indirect ELISA

Location	Year	No. examined	No. positive	% positive	References
Gongxi	2001	11 310	1 720	15.21	Yao <i>et al.</i> , 2004
	2002	32 253	4 539	14.07	Yao <i>et al.</i> , 2004
	2003	9 003	1 350	15.00	Liu, 2004
Henan	2000	220	12	5.45	Li <i>et al.</i> , 2000
	2002	201 104	3 288	1.63	Wang & Wang, 2002
Sichuan	2003	10 260	638	6.22	Jia <i>et al.</i> , 2004
Yunnan	2003	231	20	8.66	Wang <i>et al.</i> , 2003



Fig. 1. Map of China indicating the provinces where the surveys on swine trichinellosis were performed during 1999 – 2004

The seroprevalence was from 1.63 % to 15.21 % (Table 1). The feeding mode of swine was closely associated with the seroprevalence of swine *Trichinella* infection. A serological survey was carried out to detect *Trichinella* infection in abattoirs in Nanning city of Gongxi. The overall seroprevalence was 16.48 % (840/5101), but varied from 9.36 % (46/491) in swine from pig farms to 17.22 % (794/4610) in pigs raised outdoors (or pastured freely) (Cao *et al.*, 2002).

Prevalence of swine trichinellosis

The epidemiological surveys of swine trichinellosis was carried out by direct microscopy examination (trichinelloscopy) or artificial digestion method in slaughterhouses of 7 P/A during 1999 – 2004 (Fig.1), the results were showed in Table 2. Although the prevalence in Qinghai province was up to 23 % (115/500), the number of samples was too

small to reflect the actual situation of swine *Trichinella* infection (Yuan *et al.*, 2004). Henan was the most affected province, with the prevalence ranging from 0.07 % to 1.26 %. Generally, the prevalence of porcine *Trichinella* infection in small pig farms in suburbs of the cities was higher than that in large industrialized pig farms. For example, the average prevalence of swine trichinellosis was 0.07 % (34/49 851) in Zhengzhou area of Henan province, but the prevalence was up to 4.25 % (17/400) in pigs raised in hogery of the suburbs of Zhengzhou city (Zhu, 2001). Surprisingly, the prevalence was up to 52.94 % (144/272) in pigs raised in the suburbs of Shengyang city of Liaoning province, even reached to 100 % (48/48) in Dongling area (Zhang *et al.*, 2000), where the first emperor's cemetery of Qing dynasty's is located and has become a famous touring area with many hotels and restaura-

Table 2. Prevalence of trichinellosis in pigs slaughtered in abattoirs by using trichinoscopy or artificial digestion method in 6 provinces of China

Location	Year	No. Examined	No. infected	% infected	Methods	References
Gongxi	2001	11319	14	0.1237	Digestion	Yao <i>et al.</i> , 2004
	2002	32536	5	0.0154	Digestion	Yao <i>et al.</i> , 2004
	2003	9196	13	0.1414	Digestion	Liu, 2004
Henan	1999	24661	129	0.5231	Trichinelloscopy	Wang & Xiao, 2000
	2000	25301	54	0.2134	Trichinelloscopy	Wang <i>et al.</i> , 2000
	2001	49851	34	0.0682	Trichinelloscopy	Zhu, 2001
	2002	591401	7451	1.2599	Trichinelloscopy	Wang & Wang, 2002
	2004	977500	137	0.0140	Trichinelloscopy	Zhang <i>et al.</i> , 2004
Hubei	1999	521400	60	0.0001	Trichinelloscopy	Xu <i>et al.</i> , 2004
	2000	243400	71	0.0003	Trichinelloscopy	Xu <i>et al.</i> , 2004
	2001	231500	48	0.0002	Trichinelloscopy	Xu <i>et al.</i> , 2004
	2002	241700	51	0.0002	Trichinelloscopy	Xu <i>et al.</i> , 2004
	2003	237500	70	0.0003	Trichinelloscopy	Xu <i>et al.</i> , 2004
Liaoning	2000	1587668	261	0.0164	Trichinelloscopy	Ji, 2000
Qinghai	1999	252	40	15.8730	Trichinelloscopy	Zhai <i>et al.</i> , 1999
	2004	500	115	23.0000	Trichinelloscopy	Yuan <i>et al.</i> , 2004
Sichuan	1999	6687	6	0.0897	Trichinelloscopy	Jia and Yin, 1999
	2003	10260	3	0.0290	Trichinelloscopy	Jia <i>et al.</i> , 2004
Yunnan	1999	4314000	1329	0.3100	Trichinelloscopy	Qian <i>et al.</i> , 1999

Table 3. Prevalence of *Trichinella* infection in pork sold at the market in China

Location	Year	No. examined	No. infected	% infected	Methods	References
Henan	2001	382	6	1.57	Digestion	Xu B.L., <i>et al.</i> , 2001
Inner Mongolia	2003	92	3	3.26	Trichinelloscopy	Hu & Wang, 2003
Qinghai	2000	82	3	3.66	Trichinelloscopy	Xu Y.F., <i>et al.</i> , 2001
	2002	90	3	3.33	Trichinelloscopy	Chen, 2003
	2003	87	2	2.30	Trichinelloscopy	Wang, 2003
	2004	88	3	3.41	Trichinelloscopy	Chen, 2004

rants. Out of 19 pigs infected with *Trichinella* detected by microscopy examination in abattoirs in Nanning city of Guangxi during 2001 – 2002, 16 pigs were from the mountainous areas where pigs were raised in open areas, only 3 pigs from the industrialized pig farms (Yao *et al.*, 2004).

Interestingly, the prevalence of *Trichinella* infection varied among domestic pigs with different colors. An epidemiological survey carried out in the slaughterhouse of Luohe city of Henan province showed the prevalence was 0.36 % (99/27 500) in black swine, while the prevalence was 0.76 % (171/22 500) in white swine, suggesting that the susceptibility of different stains of domestic swine to *Trichinella* infection are probably distinct (Liu *et al.*, 2001).

Prevalence of *Trichinella* in pork sold at the market

In some rural areas of China, pigs are often raised in backyard under poor hygienic condition. In some mountainous areas, pigs are frequently raised in open areas where they feed on raw waste products or animal carcasses and are exposed to rodents and wildlife. These pigs are slaughtered at home without sanitary inspection. Thus, the prevalence of *Trichinella* infection in pork sold at the markets in rural areas was higher. From 1999 to 2004, prevalence of *Trichi-*

nella infection in pork sold at the market was investigated by direct microscopic examination or artificial digestion method in three provinces of China. The results showed that the prevalence of *Trichinella* in pork varied from 0.52 % to 3.66 % (Table 3).

Outbreaks of human trichinellosis due to consumption of pork

From 2000 to 2004, 17 outbreaks of human trichinellosis, with 828 cases and 11 deaths, were recorded in 8 P/M of China (Su *et al.*, 2002; Yao *et al.*, 2002; Xu, 2002; Luo *et al.*, 2004). The epidemic foci of human trichinellosis were still mainly located in southwestern, central and northeastern parts of China over the past five years. All of 11 deaths occurred in the southwestern China (Sichuan, Yunnan and Tibet) where the minority nationalities have the habit of eating raw meat. Pork is still the predominant source of outbreaks of human trichinellosis in China. Out of 17 outbreaks, 13 (76.47 %) outbreaks were caused by eating raw or poorly cooked pork, 2 (11.77 %) outbreaks caused by eating raw dog meat and 2 (11.77 %) outbreaks by eating game meat (wild boar and bear).

Control of swine trichinellosis

In order to interrupt the transmission of trichinellosis in Yunnan province located in the southwestern part of China, the control measures (including health education, improvement of pig feeding, eradication of rats and so on) were applied in Guangnan county of Yunnan during 1998 – 2000. The seroprevalence of swine trichinellosis decreased from 8.66 % (20/231) before interventions to 0 % (0/154) after interventions. None of 13 409 pigs slaughtered in the surveillance sites were found to be infected with *Trichinella* after interventions (Pang *et al.*, 2002).

In addition, the development of industrialized pig farms and improvement of pig production practices were obviously associated with the decrease of prevalence of swine trichinellosis in China. After the establishment of industrialized pig farms in Nanyang area of Henan province, the prevalence has decreased from 34.2 % (1 243/3 630) in 1986 to 0.52 % (129/24 661) in 1999 (Wu *et al.*, 1986; Wang *et al.*, 2000). The prevalence of swine trichinellosis in Xiangfan area of Hubei province has markedly decreased from 6.76 % (19 637/290 294) in 1997 (Xu & Cao, 1997) to 0.0001 % (60/521 400) in 1999 (Xu *et al.*, 2004). A cross-sectional epidemiological survey carried out in Nanyang area of Henan province showed the prevalence of swine trichinellosis was 0.10 % (26/ 25 178) in pigs reared in large professional farms where commercial grain or granule forage was used, while the prevalence was 22.76 % (28/123) in pigs raised in small piggery in the suburbs of Nanyang city where the garbage or swill from the restaurants or hotels were used (Wang *et al.*, 2000).

The treatment-prophylaxis was also applied to the control of swine trichinellosis in some severe endemic areas. The pigs were fed on forage contained of abendazole for 3 – 4 months, the prevalence of swine trichinellosis decreased from 32.2 % before prophylaxis to 0.12 % after prophylaxis in Nanyang area of Henan province (Wang & Cui, 2001b). However, the method is not widely used in the endemic areas because nothing is known about the side effects of the drug residues in pork.

The vaccine against trichinellosis in domestic swine has been attractive, and some vaccines (using the adult, muscle and newborn larvae as antigens) and their new adjuvants (Cholera toxin-B subunit, Saponin and cytokines) have been developed for vaccinating experimental mice and swine, but all of the vaccines have not been completely successful (Shen *et al.*, 1999; Dou *et al.*, 1999; Jiang *et al.*, 2003).

Discussion

Prior to 1999, the prevalence of swine trichinellosis ranged from 0.12 % to 34.2 % in 5 P/A/M of China (Wang & Cui, 2001b). The average prevalence in China during 1999 – 2004 has markedly decreased compared with that in 1990's. The decrease was probably due to a combination of factors, including development of industrialized pig farms, application of commercial grain forages, the improvement of pig production practices and the shorten-

ing of pig feeding time from 12 – 18 months to 4 – 8 months (decreasing the opportunity of infection). At present, swine trichinellosis in China still is mainly transmitted by garbage (ie. feeding pigs with swills containing raw pork scraps). The prevalence is higher in small farms of suburbs of cities where pigs are often fed on garbage or swill from the restaurants or hotels. In some mountainous areas of southwestern China, pigs are frequently raised in open areas there they feed on raw waste products or animal carcasses. The appearance of ecological (organic or green) pig farms, where pigs were fed outdoors and pastured freely, may increase the risk of transmission of *Trichinella* from wildlife to domestic swine (Murrell & Pozio, 2000). Hence, in order to eradicate swine trichinellosis, the pig-rearing mode should be changed, all pigs should be raised in piggery and all swill must be boiled for 30 minutes before being fed to pigs so that the *Trichinella* larvae contained in the swill can be completely killed.

Although the policy that pigs must be collectively slaughtered and quarantined for trichinellosis in the appointed public abattoirs was carried out in China since 1996, some pigs were clandestinely slaughtered at home in rural and mountainous areas without veterinary inspection. The mandatory inspection of pork should be further strengthened in above areas. It is clear from the experience of European countries that the mandatory inspection of pork is highly effective for the control of trichinellosis, particularly when coupled with trace-back procedures to identify farms with problems (Murrell & Pozio, 2000). The direct microscope examination is not only time-consuming for a mass of pork, but lower sensitivity when pigs were lightly infected. The prevalence of *Trichinella* infection in pork sold at market in Henan province was 0.52 % (2/382) by trichinoscopy, but up to 1.57 % (6/382) by artificial digestion (Xu, B. L., *et al.*, 2001). Another study showed the prevalence of swine *Trichinella* infection in Xuchang city of Henan province was 2.61 % (8/306) by artificial digestion, but no *Trichinella* larvae were detected by trichinelloscopy in 306 portions of pork (Li *et al.*, 2000). The pooled sample digestion method for *Trichinella* testing recommended by International Commission on Trichinellosis should be extensively applied throughout the country (Gamble *et al.*, 2000).

Acknowledgements

We are grateful to the editors of Chinese Journal of Parasitology and Parasitic Diseases for supplying the relevant materials. This paper was supported by the Innovation Grant of Department of Science and Technology of Henan Province (No.0321001900).

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RECEIVED MARCH 2, 2005

ACCEPTED OCTOBER 20, 2005