

[Original]

Risk of *Toxoplasma gondii* Infection in Slaughterhouse Workers in Kitakyushu City

Masahiro HORIO¹, Kazuhiro NAKAMURA² and Masaaki SHIMADA³

¹ Department of Parasitology and Tropical Public Health, School of Medicine, University of Occupational and Environmental Health, Japan. Yahatanishi-ku, Kitakyushu 807-8555, Japan

² Kitakyushu Municipal Meat Inspection and Control Center. Kokurakita-ku, Kitakyushu 802-0012, Japan

³ Research Center for Tropical Infections Diseases, Institute of Tropical Medicine, Nagasaki University. Sakamoto, Nagasaki 852-8523, Japan

Abstract: To clarify the risk of *Toxoplasma gondii* infection among slaughterhouse workers, we investigated *Toxoplasma* antibody in workers and swine in the meat center of Kitakyushu City and discussed the result from the standpoint of working conditions. Among 67 slaughterhouse workers, 22 were positive for *Toxoplasma* antibody (positive rate, 32.8%), while among 208 swine, 19 were positive (positive rate, 9.1%). When classified by ages of workers, positive rates in workers were 0% at the age of 30 or less and around 40% at the age of 31 and over. Especially, positive rate became as high as 66.7% in workers aged 61 and over. Positive rates for *Toxoplasma* antibody in workers classified by duration of employment were 25% for 5 years or less and 41.5% for 6 years and over. Moreover, there was no difference in positive rates of *Toxoplasma* antibody between swine slaughterers (positive rate, 32.4%) and cattle slaughterers (33.9%). Although overall positive rate of *Toxoplasma* antibody in slaughterers was higher, positive antibody in younger slaughterers or that of shorter duration of employment was considerably low. In addition, since positive rate of *Toxoplasma* antibody in swine brought to the slaughterhouse has decreased remarkably in comparison to the previous study, risk of toxoplasmosis in slaughterhouse workers also seemed to have decreased.

Key words: *Toxoplasma*, antibody, positive rate, Meat Center, Kitakyushu.

(Received 15 May 2001, accepted 10 July 2001)

Introduction

Although it has been reported that positive rates of *Toxoplasma* antibody in slaughterers are higher in Japan, there is extremely little supporting evidence. Moreover, data from actual investigations have rarely been published.

In 1963, Kobayashi *et al.* [1] investigated positive rates of *Toxoplasma* antibody in

workers of the Shibuya slaughterhouse in Tokyo. They reported that the actual positive rate of *Toxoplasma* antibody in slaughterhouse workers was 68%, which was markedly higher than the rate in the general population. Thereafter, no further reports have been published except for those describing recent decreases in the general population and inspectors (veterinarians) [1–4].

Therefore, we investigated changes in positive rate of *Toxoplasma* antibody in actual Meat Center workers in Kitakyushu City. In addition, a questionnaire survey was conducted to determine the relation between toxoplasmosis and working at the Meat Center.

Although toxoplasmosis has been reported to induce abortion, fetal hydrocephalus, retinochoroiditis and lymphadenitis, it was not thought to be very important, because most of the lesions were subclinical. Recently, however, in Europe and America, it has been reported that *Toxoplasma* induced toxoplasmic encephalitis with severe symptoms in patients with immunodeficiency, such as HIV infection. Thus, toxoplasmosis has become a focus of renewed attention [5]. Therefore, it seems to be important to understand the current status of toxoplasmosis in Japanese slaughterers in such backgrounds.

Materials and Methods

Test serum

Sera used in this investigation were obtained from 67 workers at the Meat Center in Kitakyushu City in 1992 and 1993, and from 208 swine brought into the same Meat Center in 1992. For comparison, we also investigated the sera of 40 citizens (other than slaughterers) of Kitakyushu City and 38 cats bred in Kitakyushu City area. Presence of infection was serodiagnostically investigated by an applied latex-agglutination test of toxotest-MT (Eiken Chemical Co., Ltd.). Positive infection was judged by agglutination titers as=1: 32 in humans [6], and=1: 64 in swine and cats [7].

Questionnaire survey

A questionnaire survey was conducted to clarify the relation between working conditions at the Meat Center and toxoplasmosis. Items on the questionnaire were gender, age, duration of employment, details of working, kinds of domestic animals exposed to and experience with breeding cats.

Data analysis

Data were analyzed with SPSS Release 10.0 (SPSS Inc.). To compare antibody titers between 1992 and 1993, a statistical analysis was made using the paired *t*-test after the logarithmic transformation (Log base 2) of the value of titers.

Questionnaires were analyzed to assess the association between *Toxoplasma* infection

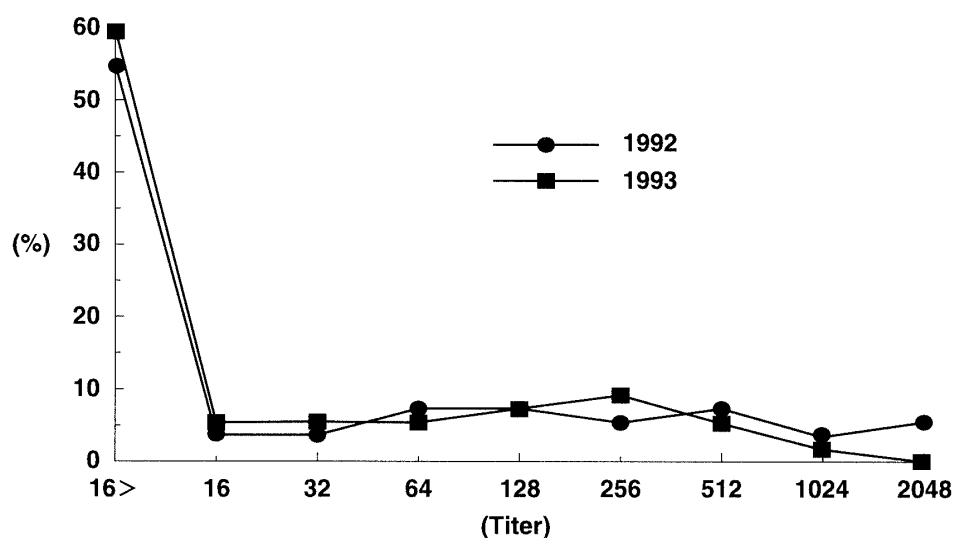


Fig. 1. Distribution of *Toxoplasma* antibody titer of workers in a meat center.

Table 1. Sex difference of *Toxoplasma* infection

Serodiagnosis	Male	Female	Total
Positive	8 (25%)	14 (40%)	22 (33%)
Negative	24	21	45
Total	32	35	67

Chi-square = 1.705 $P=0.192$

and the job characteristics of the workers. The age and the periods of working were stratified. Frequencies of infection were calculated for all questionnaire data.

Proportions were compared using the Chi-Square test or Fisher's exact test, if a cell contained ≤ 5 expected value. When the categories were ordinal such as age group and the period of working, Somer's D test was applied to determine if there is any trend.

Results

Positive rates of Toxoplasma antibody and distribution of Toxoplasma antibody titers

Apparent bimodality was observed in distribution of *Toxoplasma* antibody titers by the latex-agglutination test, showing a bottom at 1: 16 and 2 peaks at 1: 64 and 1: 512 as shown in Fig. 1. Therefore, there was no problem in considering agglutination titers $\geq 1: 32$ as positive.

Positive rates of *Toxoplasma* antibody in Meat Center workers are shown in Table 1. Overall positive rate was 33%, which consisted of 25% in males and 40% in females. Positive rates in females tended to be higher than those in males. However, there was no significant difference. As shown in Table 2, in comparison according to age, positive

Table 2. Serodiagnosis of *Toxoplasma* infection with age group

Serodiagnosis	Age group (years old)				
	29 or Less	30 to 39	40 to 49	50 to 59	60 or More
Positive	0 0.0%	2 15.4%	11 44.0%	3 27.3%	6 54.6%
Negative	7 100.0%	11 84.6%	14 56.0%	8 72.7%	5 45.5%
Total	7	13	25	11	11

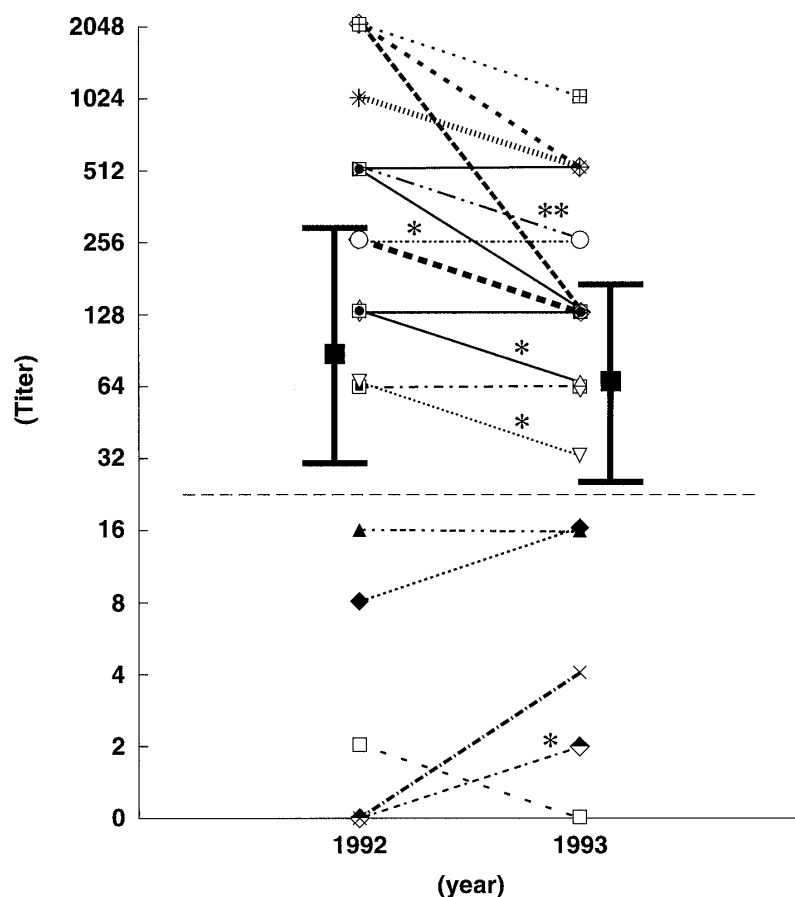
Somers's $d=0.339$ $P=0.019$ 

Fig. 2. Changes of *Toxoplasma* antibody titers from 1992 to 1993. The boxes indicate the mean of 23 cases and the bars indicate 95% CI (confidence interval).
*: 2cases, **: 3cases

rates tended to increase with age, and there were no positive subjects aged less than 30 years, which was especially noted. In addition, there were no subjects who converted from negative to positive in 1992 and 1993.

Figure 2 shows the change of antibody titers in the subjects that gave us paired serum samples, either of which reacted in the latex-agglutination test. Out of 17 positive

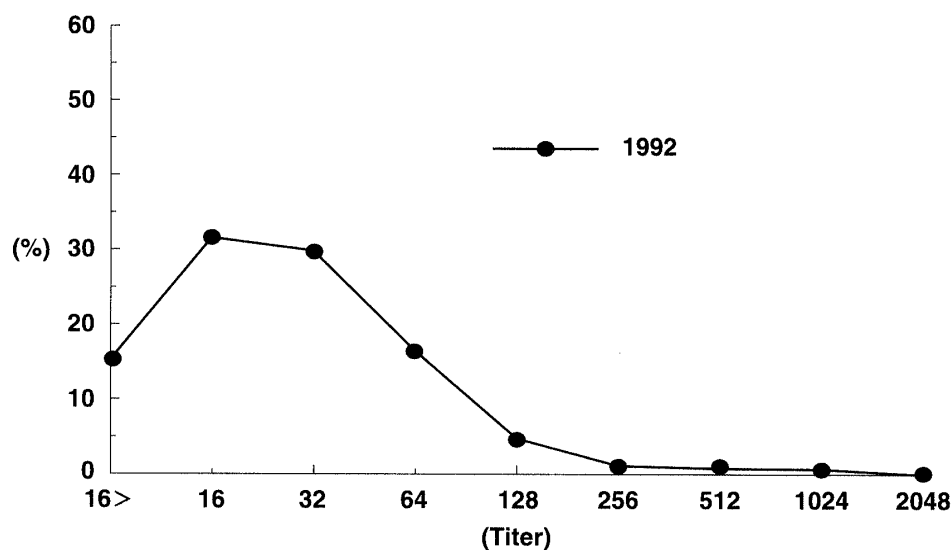


Fig. 3. Distribution of *Toxoplasma* antibody titer of swine slaughtered in a meat center.

Table 3. Serodiagnosis of *Toxoplasma* infection with the period of working

Serodiagnosis	Period of working (years)			Total
	9 or less	10 to 19	20 or more	
Positive	4 14.8%	6 33.3%	12 54.6%	22
Negative	23 85.2%	12 66.7%	10 45.5%	45
Total	27	18	22	67

Somer's $d=0.414$ $P=0.003$

subjects, no case showed an increase of titer during the period of a year. The decline of mean titer of 23 subjects was statistically significant (paired t-test, $P=0.027$).

Overall positive rate of serum reaction in the general population of Kitakyushu City was 19.2%.

Positive rate of *Toxoplasma* antibody in swine was 9.1%. However, as shown in Fig. 3, distribution of antibody titers on latex-agglutination reaction did not show bimodality and it was problematic to consider agglutination titers=1: 32 was positive.

Positive rate of cat's sera was only 5.3%.

Relation between infection and the results of a questionnaire survey

1) Period of working

When we compared positive rate according to period of working, they were apparently higher in workers who had a prolonged duration of employment, as shown in Table 3. This tendency was more apparent and more significant than that according to age.

Table 4. Serodiagnosis of *Toxoplasma* infection with the type of job

Serodiagnosis	Type of Job				Total
	Slaughter	Eviscerator	Inspector	Clerk	
Positive	9 34.6%	13 38.2%	0 0.0%	0 0.0%	22
Negative	17 65.4%	21 61.8%	3 100.0%	4 100.0%	45
Total	26	21	3	4	67

Fischer's Exact test $P=0.377$ **Table 5.** Serodiagnosis of *Toxoplasma* infection in meat handled

Serodiagnosis	Swine			Cattle		
	Yes	No	Total	Yes	No	Total
Positive	11 32.4%	11 33.3%	22	19 33.9%	3 27.3%	22
Negative	23 67.7%	22 66.7%	45	37 66.1%	8 72.7%	45
Total	34	33	67	56	11	67

Swine: Chi-square=0.007 $P=0.932$ Cattle: Fischer's Exact test $P=1.000$

2) Type of job

The relation between type of job and the positive rate of *Toxoplasma* antibody is shown in Table 4. Workers in the slaughterhouse were classified into 4 types, such as slaughterers, eviscerators, inspectors (veterinarians) and clerks. Although positive rates were higher in slaughterers and eviscerators, there was no significant difference between the two. Moreover, there were no positive subjects among inspectors or clerks.

3) Kind of domestic animals dealt with

Jobs in slaughterhouses can also be classified according to the kind of domestic animal slaughtered. The Meat Center investigated in this study dealt with swine and cattle, and types of jobs were relatively specialized. Therefore, workers who dealt with swine only handled swine, while those who dealt with cattle only handled cattle, and there was no interchange. However, there was no difference in positive rates between the two groups, as shown in Table 5.

4) Breeding of cats

Cats are the most important source of *Toxoplasma* infection. Therefore, we also compared positive rate in workers according to their experience with breeding cats. As a result, contrary to our expectation, positive rates of *Toxoplasma* antibody was significantly lower in workers who had experience at breeding cats compared to the rate in other workers, as shown in Table 6.

Table 6. Serodiagnosis of *Toxoplasma* infection with the history of owning cats

Serodiagnosis	Cat owner		Total
	Yes	No	
Positive	2 10.5%	20 41.7%	22
Negative	17 89.5%	28 58.3%	45
Total	19	48	67

Chi-square=5.985 $P=0.014$

Discussion

In 1963, Kobayashi *et al.* [1] investigated positive rates of *Toxoplasma* antibody in workers at the Shibuya slaughterhouse in Tokyo. They reported that positive rates were 68% in slaughterers and 70% in inspectors (veterinarians), which were markedly higher than those in the general population. Thereafter, no investigation was performed on slaughterers. However, concerning inspectors (veterinarians), the positive rate of *Toxoplasma* antibody was reported to have markedly decreased to 23.5% in Kobe, 1986 [4] and 33.6% at the Shibuya slaughterhouse in Tokyo, 1988 [3].

Our investigation of the positive rates of *Toxoplasma* antibody in slaughterhouse workers was the first such study in the Kyushu area performed after a 30-year hiatus in Japan. As a result, the positive rate in slaughterers at the Meat Center in Kitakyushu City was 33%. Concerning higher rates of positive antibody carriers among the general population in Kyushu compared to rates in other areas [8, 9], 33% was thought to be markedly low. However, since antibody carriers comprised 19.2% of the general population in Kitakyushu City, positive rates in slaughterhouse workers were still high.

Moreover, positive rates of the antibody tended to be higher in older workers at the Meat Center in Kitakyushu City, and there were no positive subjects observed among workers aged 30 or less. In addition, since there were no new positive antibody carriers found during a 2-year investigation in 1992 and 1993, the frequency of toxoplasmosis was thought to have markedly decreased in recent years despite higher rates of infection in the past.

Strong evidence to support the idea of a recent decrease in the risk of *Toxoplasma gondii* infection is the apparent tendency of the decrease of antibody titer in positive cases. Out of 17 positive subjects, from whom we obtained paired serum samples, none had an increase in the titer. In most of the cases, it seems that the titer was decreasing gradually.

The infection routes of *Toxoplasma* in humans are 1) peroral of oocysts excreted into the feces of cats, 2) peroral of cysts in meat, 3) invasion of trophozoites in meat through

wounds or mucous membranes, and 4) transplacenta. Toxoplasmosis in slaughterhouse workers tended to be due to routes 2) and 3) as mentioned above. From the results of our questionnaire, almost all slaughterhouse workers were ignorant of the risk of toxoplasmosis and *Toxoplasma* itself. In addition, as far as we observed the life style of workers, it was difficult to presume that physical contact with raw meat has decreased.

Therefore, decrease in the positive rates of *Toxoplasma* antibody among slaughterhouse workers was, as suggested by Kobayashi *et al.* [3], presumed to be due to the rapid decrease in rates of infection, especially in swine and cats, followed by decrease in the frequency of toxoplasmosis in humans. For example, in Japan, positive rate of antibody in swine was reported to be 24% on average in 1954 and 1976. However, it has also been reported that positive rate of antibody has rapidly decreased since 1980, and actual rate of positive antibody carriers was in the range of 0.33 [10] and 1.8% [11] in the latter half of 1980. Although in our investigation, positive rate of *Toxoplasma* antibody was as high as 9.1% in swine brought into the Meat Center, the distribution of antibody titers in latex-agglutination reaction did not show bimodality. Therefore, it was presumed that positive cases had a higher possibility of being false-positive, and that the number of true-positive swine was considerably smaller.

Moreover, the rate of positive antibody carriers was also higher at around 40% in cats [3], though an investigation performed in Saitama prefecture in 1989 and 1991 showed that they had decreased to 10.5% [12]. In our investigation, only 5.6% of cats in Kitakyushu City was positive for antibodies.

Our investigation supported the opinion that decrease in positive rate of *Toxoplasma* antibody in the Meat Center workers was mainly due to decrease in the rate of infection in cats and swine, which are sources of infection.

The rates of positive antibody carriers in the Meat Center workers in Kitakyushu City classified by job type were higher in actual slaughterers and eviscerators. Since there was no significant difference between the two, this result suggested that there was no difference in the chances of infection due to the animal organs handled. Although it was surprising that there were no infected subjects among inspectors (veterinarians), the reason may be that all of them have been engaged in the inspection of meat in recent years after a revolutionary decrease in the infection rates of *Toxoplasma* in domestic animals. Moreover, another reason might be due to more thorough sanitary control by inspectors (veterinarians) than slaughterers.

In Japan, since swine are thought to be the main source of *Toxoplasma* infection in slaughterhouses, swine have been a focus of toxoplasmosis investigations. However, our investigation demonstrated that there was no difference in rates of infection between workers who handled swine and those who handled cattle.

According to a personal communication from a veterinarian, the reason for focusing on swine was simple, because swine have a higher sensitivity to *Toxoplasma* and mass

abortion or stillbirth frequently occurred in the past. Although *Toxoplasma* could infect cattle, most of the cases were subclinical infections. Therefore, cattle have not been regarded as a source of infection. However, our results suggest that cattle should also be reconsidered as a source of *Toxoplasma* infection.

Cats are the final hosts of *Toxoplasma* and excrete a large number of oocysts in feces right after infection, which then become a source of infection for many other animals, including humans. However, in our study, the rate of positive antibody carriers in subjects who have had experience in cat breeding was unexpectedly and markedly low. This result suggests that the source of *Toxoplasma* in slaughterhouse workers is not likely to be cats at home, but domestic animals being slaughtered.

Conclusion

The Meat Center workers had a higher positive rate of *Toxoplasma* antibody. However, in this study, it was assumed that the risk of toxoplasmosis in slaughterhouse workers has decreased dramatically along with that in the general population due to decrease in positive rates in swine.

However, since positive rate of antibody has no relation with types of job or kinds of domestic animals, and low positive rate in subjects with experience in breeding cats, investigation of *Toxoplasma* antibody titers in other animals or more minute investigations of slaughterhouse workers as well as comparative studies are thought to be appropriate for the future.

Acknowledgments

We received great cooperation from all workers at the Meat Center in Kitakyushu City and we would like to express our appreciation to them. We also appreciate DVM Shimoda of Shimoda Animal Clinic for providing cat sera.

References

1. Kobayashi A, Ishi T, Koyama T *et al* (1963): Studies on *Toxoplasma* 5. Incidence of *Toxoplasma* antibodies in abattoir workers, plug handlers, man-making workers and normal residents. *Jpn J Parasitology* 12: 126–135
2. Kobayashi A (1977): Studies on Toxoplasmosis. *Jikei Medical J* 92: 614–633
3. Kobayashi A (1989): Toxoplasmosis. *Saishin-Igaku* 44: 744–751 (in Japanese)
4. Konishi E, Takahashi J, Sato R, Takao T & Anada S (1986): A survey of meat inspectors in Hyogo Prefecture, Japan, for the presence of anti-*Toxoplasma gondii* antibodies by enzyme-linked immunosorbent assay. *Jpn J Parasitology* 35: 373–375 (in Japanese)
5. Kanbara K (*ed*) (1991): Diagnosis development of parasitic diseases and case reports. *Medicine*

- and Drug Journal, Osaka pp29–37
6. Tsubota N, Hiraoka K, Sawada Y, Watanabe T & Ohshima M (1977): Studies on latex agglutination test for toxoplasmosis. (2) Evaluation of the microtiter test as a serologic test for toxoplasmosis in man. *Jpn J Parasitology* 26: 286–290
 7. Tsubota N, Hiraoka K, Sawada Y, Ohshima M & Hoshino M (1977): Studies on latex agglutination test for toxoplasmosis. (3) Evaluation of the microtiter test as a serologic test for toxoplasmosis in some animals. *Jpn J Parasitology* 26: 291–298
 8. Sato A, Shimozone H & Takemoto T (1971): Preliminary survey on toxoplasmosis in southern Kyushu. *Jpn J Parasitology* 21 (Suppl): 32
 9. Suzuki H, Yamamoto Y & Matsumoto K (1987): A seroepidemiological study of *Toxoplasma* infection in Nagasaki by ELISA. *Jpn J Parasitology* 36: 118–124 (in Japanese)
 10. Konishi E, Sato R, Takao T & Anada S (1987): Prevalence of antibodies to *Toxoplasma gondii* among meat animals slaughtered at an abattoir in Hyogo Prefecture, Japan. *Jpn J Parasitology* 36: 198–200 (in Japanese)
 11. Ooba S, Aoyagi K, Katsube Y, Odaka H & Ogiwara T (1984): The antibody possession of *Toxoplasma* of cat, dog, swine and cattle. *J Vet Med Sci* 46 (Suppl): 78
 12. Furuya H, Nogami S, Inoue, I, Takahashi D, Mizusawa H & Tohyama H (1993): Seroepidemiological survey on *Toxoplasma gondii* infection in kittens. *Jpn J Parasitology* 42: 388–391
-

北九州市のと畜場における作業行動とトキソプラズマ症へのリスク

堀尾 政博¹, 中村 和弘², 嶋田 雅暁³¹産業医科大学医学部 寄生虫学・熱帯医学教室²北九州市立食肉センター³長崎大学熱帯医学研究所 資料情報センター

要 旨： と畜場におけるトキソプラズマ感染の危険性を明らかにする目的で、北九州市食肉センターにおけると畜従事者の作業行動を調査し、同時にと畜従事者および搬入豚のトキソプラズマに対する抗体陽性率、抗体価の変動との関係を解析した。

その結果、と畜従事者67人中トキソプラズマ抗体陽性22人（陽性率32.8%）、搬入豚は208頭中陽性19頭（陽性率9.1%）であった、と畜従事者の年齢および従業年数別の比較では、30歳以下では0%、31歳以上では40%前後の抗体陽性が認められ、特に61歳以上では66.7%と高率であった。従業年数別では、5年以下で25.0%、6年以上で41.5%の抗体陽性が認められた。また、豚と畜従事者（陽性率32.4%）と牛と畜従事者（33.9%）との間に抗体陽性率の差は認められなかった。

と畜従事者は依然としてトキソプラズマに対する高い抗体陽性率を有しているが、若年層および従業年数が少ない群では抗体陽性率がかなり低くなっている。また、搬入豚の抗体陽性率が昔と比べ著しく低くなっていることから、と畜場におけるトキソプラズマ感染の危険性は低くなってきているものと推察された。

J UOEH (産業医大誌) 23 (3) : 233-243 (2001)