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RESEARCH ARTICLE

A cross-sectional study on porcine cysticercosis in slaughtered pigs from Mandalay City

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Abstract

Cysticercosis is a zoonotic disease that may have a significant impact on the public health. The aims of the present study were to determine the prevalence of porcine cysticercosis caused by Taenia solium and Taenia asiatica in slaughtered pigs from Mandalay city, to determine the predilection site of T. solium cyst and to identify the related factors of cysticercosis in slaughtered pigs. Mandalay slaughterhouse is located in Ma Har Aung Myay Township, Mandalay Region. A crosssectional survey on slaughtered pigs from four different locations was conducted by meat inspection from May to July, 2017. The slaughterhouse was visited 4 days in a week and 8 pigs were inspected per day. Six different samples including tongue, heart, masseter, shoulder, diaphragm and brain were inspected in 414 slaughtered pigs for T. solium cysticercosis while liver samples were inspected for T. asiatica cysticercosis by visual inspection, palpation and incision. A total of 2,484 muscle and brain samples and 414 liver samples were inspected. By using a questionnaire sheet, the information of slaughtered pigs was recorded. The prevalence of T. solium and T. asiatica cysticercus cyst, in slaughtered pigs were 12.3% (51/414) and 6% (25/414), respectively. Tongue was observed as the predilection site of T. solium cysticercosis. By using Chi-square test at P < 0.05, factors associated with T. solium cysticercosis in slaughtered pigs were age (OR=2.248, CI=1.059 -4.771) and sex (OR=2.433, CI=0.848-2.836). There was no associated factor for T. asiatica cysticercosis. This information was useful not only for preventing the occurrence of porcine cysticercosis but also for food safety of public.

Keywords:

Cysticercosis, Taenia solium, Taenia asiatica, slaughtered pigs, meat inspection, Mandalay

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1. Introduction

Cysticercosis and taeniosis, occurred as foodborne zoonotic infections with larval and adult tapeworms, respectively. The important features of these infections are that the larvae are meat-borne (pork) and the adult stage develops only in the intestine of the human host (obligate). *Taenia saginata asiatica* (Taiwan Taenia) and *T. solium* (pork tapeworm) are the most important causes of taeniosis in humans (Murrell, 2005). World Health Organization estimated that 50 million persons, predominantly from developing countries, are infected with taeniosis, and 50,000 people die of the disease, neurocysticercosis each year (Joshi et al., 2007).

Porcine cysticercosis caused by *T. solium* larvae is regarded as one of the most important zoonotic parasites causing great economic losses and affecting many people worldwide (Kavishe et al., 2017). Muscle of tongue was an important site in meat inspection of porcine cysticercosis in Myanmar (Khaing et al., 2015).

Taenia asiatica has similar name of *Taenia saginata asiatica*, Asian Taenia and Taiwan Taenia (Ale et al., 2014). *Taenia asiatica* was mostly found in Asian countries (Eom et al., 2009). In East Asia, many people are fond of eating raw and/or undercooked meat and viscera of pigs (Fan et al., 1992). According to Ooi *et al*. (2013), the predilection site of *T. asiatia* cyst is the liver.

Taenia solium taeniosis has been reported as 5.5% among refugees living on Thailand-Myanmar border (McCleery et al., 2015). The seroprevalence survey of O'Neal et al. (2012) showed that 1 in 4 refugees from Myanmar has antibodies against *T. solium* cyst and suggested that *T. solium* infection might be endemic to Myanmar or camps in Thailand where refugees reside before they are resettled. Recently, *T. saginata* tapeworm infection from Myanmar has also been reported by Won et al. (2018).

The information of *T. asiatica* porcine cysticercosis is still being lacked in Myanmar. The aims of this study were to investigate the prevalence of *T. solium* and *T. asiatica* porcine cysticercosis in slaughtered pigs of Mandalay slaughterhouse, the the predilection site of *T. solium* and *T. asiatica* cyst, and the associated factors of porcine cysticercosis.

2. Materials and methods

2.1 Study design, study period and location

A cross-sectional study was conducted to investigate the prevalence of *T. solium* and *T. asiatica* cysticercosis in slaughtered pigs from Mandalay slaughterhouse located in Ma Har Aung Myay Township, Mandalay City, Myanmar (Fig. 1).

It was visited to conduct meat inspection from May to July 2017. The slaughterhouse was visited 4 days in a week and 8 pigs were inspected per day. Six different samples including tongue, heart, masseter, shoulder, diaphragm and brain were inspected for *T. solium* cysticercosis while liver samples were inspected for *T. asiatica* cysticercosis by visual inspection, palpation and incision at the slaughterhouse.

2.2 Sample size calculation

The population targeted during the sampling period of three months was about 18,000 pigs from the slaughterhouse. The number of pigs to be sampled from the slaughterhouse was calculated using the following formula (Thrusfield, 2005). An expected prevalence of 50% with a confidence level of 95% was used in this unit.

$$= 1.96^{2} P_{exp} (1 - P_{exp}) / d^{2}$$

Where:

n

n	= required sample size,
Рехр	= expected prevalence,
d ²	= desired absolute precision
Pexp	= 0.5





Fig. 1. Location of Mandalay slaughterhouse

Substituting these values in the formula;

 $= (1.96)^2 \times 0.5 (1-0.5) / (0.05)^2$ n = 384

Although 384 appeared as the calculated sample size, 414 pigs (414 × 7= 2898 samples) were inspected for both T. solium and T. asiatica cysts.

2.3 Meat inspection

ination of the presence of *T. asiatica* cyst.

Briefly, long and parallel incision into the mas- 2.4 Questionnaires study seter muscles on both sides of face in an upward direction was made. A deep longitudinal incision covering slaughtered pigs such as age, sex, breed, and source about ¾ the thickness of the tongue and covering the regions of slaughtered pigs was developed. During samwhole length of the tongue was made at the base to pling, the officials of slaughterhouse were asked and examine for cysts. The heart was also visually examined filled up in the questionnaires sheet.

for the presence of cysts. Then it was cut, open and a deep (¾ the thickness of septum) incision into the septum was made to expose any metacestodes. Brain, liver and all the other muscle samples were checked, palpated, incised by surgical blade (0.5cm thickness) and visually examined.

The cysticerci in pigs are conformed by 2 cham-Brain, liver and muscles of tongue, heart, mas- bers; the inner one contains the scolex and the spinal seter, shoulder and diaphragm from each slaughtered cord and is surrounded by the outer compartment that pigs were inspected for the presence of T. solium and T. contains the vesicular fluid (Flisser, 2006). The infected asiatica cysticercosis by using direct knife-eye method sample was cut about 3cm width and 1cm thickness. (Viljoen, 1937). According to Ooi et al. (2013), the pre- They were carried in an ice-box and stored in -10°C at dilection site of T. asiatia cyst is the liver. Therefore, the Department of Pharmacology and Parasitology, Unilivers from slaughtered pigs were focused for the exam- versity of Veterinary Science, Yezin, Nay Pyi Taw, Myanmar.

A questionnaires sheet including information of

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2.5 Statistical analysis

All data were entered in computerized database Table 2. using Microsoft Excel and the Statistical Package for So- 3.3 Prevalence of T. asiatica cyst in slaughtered pigs cial Science (SPSS) Version 16. The association between the factors such as age, sex, breed, and source region ples of 25 pigs were observed as T. asiatica cyst positive, and the occurrence of porcine cysticercosis was analysed indicating an overall prevalence of 6% in the study area. by using Chi-square test at P < 0.05 level of significance.

3. Results

3.1 Descriptive data taken from slaughterhouse officials

According to the questionnaire taken from slaughterhouse officials, the descriptive data concerning the prevalence of T. solium cyst and T. asiatica cyst in slaughtered pigs is shown in Table 1.

3.2 Prevalence and predilection site of T. solium cyst in slaughtered pigs

Out of 414 slaughtered pigs examined, 51 pigs were observed having T. solium cysts and overall prevalence was 12.3% in the study area. All cysts were observed in the tongue muscles. Distribution of positive

samples in five different muscles and brain is shown in

Out of 414 slaughtered pigs examined, liver sam-

3.4 Univariate analysis of hypothesized associated factors of age, sex, breed and location concerning the presence of T. solium cyst in slaughtered pigs

In univariate analysis, hypothesized factors of age and sex were found significantly associated (P < 0.05) with the presence of T. solium cyst in slaughtered pigs while breed and locations were not significantly associated (P > 0.05). The older pigs (>8 months old) were found having 2.2 times higher odds to be infected than younger pigs (≤8 months old) and female pigs had 2.4 times more likely to be infected than male pigs. Distribution and analysis of associated factors for the prevalence of T. solium cyst in slaughtered pigs are shown in Table 3.

No.	Hypothesized risk factors	No. of samples collected (n=414)	Percentage of total
1.	Age		
	≤8 months	127	30.7
	>8 months	287	69.3
2.	Sex		
	Male	188	45.4
	Female	226	54.6
3.	Breed		
	Local breed	194	46.9
	Cross breed	220	53.1
4.	Location		
	Bago	177	42.8
	Nay Pyi Taw	149	36.0
	Sagaing	43	10.4
	Magway	45	11.0

Table 1. Descriptive data of questionnaire taken from slaughterhouse officials



Table 2. Distribution of positive samples in five different not significantly associated (P > 0.05) with the presence muscles and brain

No.	Inspected muscle	No. (%) of positive sample (n=414)
1	Tongue	51 (12.3%)
2	Heart	0
3	Masseter	0
4	Shoulder	0
5	Diaphragmatic muscle	0
6	Brain	0
	Total	51 (12.3%)

3.5 Univariate analysis of hypothesized associated factors of age, sex, breed and location concerning the presence of *T. asiatica* cyst in slaughtered pigs

In univariate analysis, all hypothesized associated factors of age, sex, breed and locations were found

of *T. asiatica* cyst in slaughtered pigs. The older pigs (>8 months old) showed higher prevalence (6.6%) than younger pigs (\leq 8 months old) (4.7%). Female pigs appeared greater prevalence (7.96%) than male pigs (3.7%). Distribution and analysis of associated factors for the prevalence of *T. asiatica* cyst in slaughtered pigs are shown in Table 4.

4. Discussion

The present study was undertaken to record the prevalence of porcine cysticercosis caused by *T. solium* and *T. asiatica* by meat inspection in Mandalay slaugh-terhouse. In this study, 414 pigs were examined and 51 (12.3%) pigs were found presence of *T. solium* cyst and 25 (6%) pigs were found having *T. asiatica* cyst. In this study, the infection rate of *T. solium* cysticercosis was lower than the previous studies of Khaing et al. (2015)

Table 3. Distribution and analysis of associated factors for the presence of T. solium cyst in slaughtered pigs

No.	Hypothesized factor	Positive no. (%)	χ^2	OR (95% CI)	P value
1.	Age				
	≤8 months	9/127 (7)			
	>8 months	42/287 (14.6)	4.6	2.2 (1.059-4.771)	0.031*
2.	Sex				
	Male	14/188 (7.5)			
	Female	37/226 (16.4)	7.6	2.4 (0.848-2.836)	0.006 ^{**}
3.	Breed				
	Local breed	19/194 (9.8)			
	Cross breed	32/220 (14.6)	2.2	1.6 (0.857-2.868)	0.142
4.	Location				
	Bago	28/177 (15.8)			
	Nay Pyi Taw	18/149 (12.1)	0.9	0.7 (0.387-1.382)	0.334
	Sagaing	2/43 (4.7)	3.7	0.3 (0.059-1.135)	0.056
	Magway	3/45 (6.7)	2.5	0.4 (0.11-1.312)	0.114

*=significant association at 0.05 level, **=highly significant association at 0.01 level, OR=odds ratio, CI=confidence interval, P=probability



Table 4. Distribution and analysis of associated factors for the presence of *T. asiatica* cyst in slaughtered pigs

No.	Hypothesized factor	Positive no. (%)	χ^2	OR (95% CI)	P value
1.	Age				
	≤8 months	6/127 (4.7)			
	>8 months	19/287 (6.6)	0.6	1.4 (0.557-3.670)	0.455
2.	Sex				
	Male	7/188 (3.7)			
	Female	18/226 (7.96)	3.3	2.2 (0.914-5.479)	0.071
3.	Breed				
	Local breed	11/194 (5.67)			
	Cross breed	14/220 (6.36)	0.1	1.1 (0.501-2.553)	0.768
4.	Location				
	Bago	14/177 (7.9)			
	Nay Pyi Taw	7/149 (4.7)	1.4	0.6 (0.225-1.462)	0.239
	Sagaing	1/43 (2.3)	1.7	0.3 (0.035-2.168)	0.193
	Magway	3/45 (4.5)	0.1	0.8 (0.228-3.028)	0.779

terhouse, respectively. When compared to other Asian *T. asiatica* cyst. In this study, only livers of slaughtered countries, the prevalence observed in this study was pigs were examined for the presence of T. asiatica higher than Northern India (5.4%) (Saravanan et al., cysts. Fan et al. (1990) reported that T. asiatica cysticer-2014), South-central Cambodia (4.1%) (Adenuga et al., ci were observed only from the liver and never found in 2018) and Hanoi slaughterhouse of Vietnam (0.04%) muscles, viscera or other parts of carcasses. Ooi et al. (De et al., 2014) but lower than Nepal (13.6%) (Joshi et (2013) documented that the pig served as the natural al., 2007). Noval et al. (2002) documented that the intermediate host of T. asiatica and the predilection site prevalence rate variations might link to socio-economic was liver. In the present study, all analyzed factors such facts such as sanitation, pig husbandry techniques and as age, sex, breed and locations were observed no assorate of pork consumption.

This is the first study to investigate the prevalence in Mandalay slaughterhouse by meat inspection was tongue samples were found having cysticercus cyst. 6%. There was very limited information on the prevalence of T. asiatica cysts in pigs. Eom and Rim (1992) found with higher prevalence of T. solium cysticercosis

and Khin Myint Myint (2017), who reported 23.67% in liver of 25,358 pigs at an abattoir in Chenongju City of Nay Pyi Taw area and 27.81% in Ywar Thar Gyi slaugh- Korea from 1989 to 1990 and 256 livers were positive of ciation with infection.

In the present study, tongue, heart, masseter musof T. asiatica porcine cysticercosis in Myanmar. In this cles, shoulder muscles, diaphragmatic muscles and study, the prevalence of *T. asiatica* porcine cysticercosis brain were inspected for *T. solium* cysticercosis. Only 51

In this study, >8months old slaughtered pigs were found that metacestodes of *T. asiatica* inspected in the than ≤8 months old ones. There was association be-tween age and cysticercus infection. Older pigs (>8months) showed higher prevalence of *T. asiatica* cysticerosis than those of \leq 8 months old slaughtered pigs although no significant association with infection. In this study, the reason of higher prevalence in older pigs might be due to more exposure for consumption of tapeworm eggs throughout their lifetime.

Regarding to sex, the prevalence of T. solium cysticercosis in female pigs was found higher than those of male pigs occurring sex was associated factor of porcine cysticercosis in this study. This observation was in accordance with the earlier reports of Khaing et al. (2015) and Khin Myint Myint (2017). In this study, higher prevalence of T. asiatica cyst was found in female slaughtered pigs than male ones. In Myanmar, male pigs were kept for 8 months of age for selling and female pigs were kept for breeding purpose until above 1 year of age and then they were sold (Khin Myint Myint, 2017). Therefore, it could be explained that female pigs were reared for longer period due to breeding purpose to increase the herd size. Thus female pigs have higher possibility of acquiring infection due to contaminated environment.

In the present study, there was higher prevalence in cross breed than local breed although no association between breed and prevalence of both *T. solium* and *T. asiatica* cysticercosis. This observation was similar to the findings of Khin Myint Myint (2017) at Ywar Thar Gyi slaughterhouse. Most of the farming systems in villages are that the pigs are allowed to roam freely in the environment. Therefore, both of breeds might be exposed with poor sanitary environment with contaminated waste.

In reference to source of slaughtered pigs, there were various prevalence of *T. solium* and *T. asiatica* porcine cysticercosis among the four locations showing numerically highest prevalence in Bago region followed by Nay Pyi Taw Area, Magway Region and Sagaing Region although there was no significant association between location and porcine cysitcercosis. No association with location might be due to other factors such as presence or absence of latrine, tapeworm carrier, etc. which could not be evaluated in this study. The absence or poorly constructed pit latrines and presence of bushes in some villages of the study area cause people to defecate on the open ground and thus human faeces contaminate the environment (Yohana et al., 2013).

The combination of flooding and vulnerable water supplies might increase contamination, causing enhances the risk of infection (Wardrop et al., 2015). Therefore possible factor was poor sanitary environment with contaminated waste.

The finding of this study is in accordance with the previous studies reported by Khaing et al. (2015) and Khin Myint Myint (2017) in which tongue was the predilection site of *T. solium* cyst. The findings of *T. asiatica* cysticercus cyst in this study indicated that people should pay attention to prevent human taeniosis by avoiding intake of uncooked or undercooked pig liver. In 2016-2017 fiscal years, total pig population of Myanmar was about 16.3 million (LBVD, 2017). Therefore, household sanitation and personal hygiene are necessary to reduce the transmission of cysticercosis in both humans and animals in Myanmar. The findings from the present study suggest that public is essential to practice cooking pork at 45-50°C till one or a half hours to prevent cysticercosis in human.

5. Conclusions

From the present study, it was concluded that the prevalence of porcine cysticercosis due to *T. solium* and *T. asiatica* cyst, in slaughtered pigs were (51/414) 12.3% and (25/414) 6%, respectively. The predilection site of *T. solium* was tongue. Age and sex of pig were

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associated with *T. solium* porcine cysticercosis but no associated factors were noted in *T. asiatica* porcine cysticercosis.

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Conflict of interest

The authors declare that they have no competing interests.

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