TAENIASIS AMONG REFUGEES ON THE THAILAND-BURMA BORDER

By

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A THESIS

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CERTIFICATE OF APPROVAL

This is to certify that the Master's thesis of

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Abstract

Background: Neurocysticercosis (NCC), caused by *Taenia solium* larval infection, is a leading cause of acquired epilepsy in developing countries. Case reports of NCC are increasing among refugees resettled to non-endemic countries including the United States, but little is known about *T. solium* infection within refugee camps. Heavily-infected pigs can indicate areas where the risk of *T. solium* taeniasis is elevated so identifying these pigs could guide treatment and screening programs in areas with limited resources such as refugee camps. We sought to examine factors associated with being a tapeworm carrier in the Ban Mai Nai Soi refugee camp, including owning a heavily-infected pig.

Methods: We carried out a random sample and a targeted sample of households within the camp. All participants were asked to submit a fecal sample and to complete an interview. Fecal samples were analyzed for presence of *Taenia* sp. antigens using ELISA or for presence of *Taenia* sp. eggs or proglottids using light microscopy. A pig was determined to be heavily-infected by tongue examination for characteristic cysts. Generalized estimating equations (GEE) models were used to characterize the association between owning a heavily-infected pig and taeniasis as well as the association between other demographic measures and meat consumption practices and taeniasis in the camp.

Results: Among the random sample, 3% (18/552) were positive for taeniasis. After accounting for household clustering and sampling weight, the prevalence of taeniasis in

the random sample was 2.8% (95% CI: 1.4, 4.2%). Among pigs sampled in all households, 2.5% (18/722) were tongue-positive. After accounting for household clustering and sampling weight, the prevalence of tongue-positive pigs was 2.5% (95% CI: 0.8, 4.2%). Owning a tongue-positive pig was not significantly associated with taeniasis upon univariate (OR = 2.43; 95% CI: 0.60, 9.76) or multivariate (OR = 2.30; 95% CI: 0.62, 8.46) GEE analysis. Multivariate GEE analyses indicated that the number of household residents, self-report of worm passage, and eating pork outside of camp more than 5 times per month were significantly associated with taeniasis while having a latrine within the yard had a protective association with taeniasis.

Conclusion: The prevalence of human taeniasis in this population is comparable to estimates from other *Taenia spp.* endemic regions. However, owning a heavily-infected pig, as measured by tongue palpitation, did not accurately predict taeniasis infection. The association between eating pork outside of the camp more than 5 times a month and taeniasis suggests that pigs within the camp may be protected from *T. solium* infection. Furthermore, self-report of worm passage may be a useful initial screening for determining taeniasis-negative status.

Introduction

Neurocysticercosis (NCC), an infection of the central nervous system with the larval form of the pork tapeworm *Taenia solium*, is a major cause of acquired epilepsy in the developing world.[1-3] Cysticercosis is considered endemic in the majority of sub-Saharan African countries, much of Central and South America, China, India, and much of Southeast Asia.[4] While insufficient data make it impossible to precisely estimate the prevalence of NCC worldwide, a recent meta-analysis estimates that roughly 30% of people with epilepsy living in *T. solium* endemic regions have brain lesions consistent with NCC.[5] Clinical manifestations of NCC include hydrocephalus, meningitis, stroke, cognitive impairments, seizures and other motor disturbances, and death.[6-8] However, symptoms of NCC may be delayed for several years or symptoms may never appear. Furthermore, morphological presentations in the central nervous system may vary by endemic region.[1] Even when NCC is suspected, it is difficult to diagnose in the absence of brain imaging which is not available to the vast majority of communities affected by NCC. Despite the global burden and severe symptoms, the World Health Organization considers NCC a major neglected disease due to the lack of knowledge regarding transmission, imprecision of current diagnostic tools, and inability of intervention studies to show consistent, sustainable results.[3,4]

Humans are the definitive host for *T. solium*. In its adult form, *T. solium* is attached to the small intestine and resides in the host (taeniasis), rarely causing symptoms (Figure 1). As the tapeworm grows, eggs and proglottids are shed in the host's stool. Pigs, as an

intermediate host, acquire cysticercosis by ingesting *T. solium* eggs shed in the feces of a tapeworm carrier. Ingested eggs hatch and the resulting embryos actively cross the intestinal wall and enter the bloodstream of the intermediate host. Larval cysts can then form throughout the body. Finally, the life cycle is completed when a human consumes pork containing *T. solium* cysts that develop into adult tapeworms. Humans can also be infected with the larval form of *T. solium* if tapeworm eggs are ingested. As in pigs, resulting cysts can develop throughout the body, including the central nervous system leading to NCC.

Neurocysticercosis is a disease of poverty. Allowing pigs to roam free and scavenge for food enables owners to cheaply feed their animals. However, pigs, which are coprophagic, can then easily access feces containing *Taenia spp.* eggs where sanitation is limited. Pigs affected by cysticercosis are sold at a reduced price in informal markets, perpetuating the economic status of their owners as well as the *Taenia spp.* lifecycle.[9] Estimates of the annual economic loss due to pork contaminated with *Taenia spp.* among communities in Taiwan, Korea, and Indonesia were US $18 million, $13 million, and $2.4 million, respectively.[10] Reducing the economic and health impacts of *Taenia spp.* infection in communities where pig rearing is an essential source of income and protein is especially important.

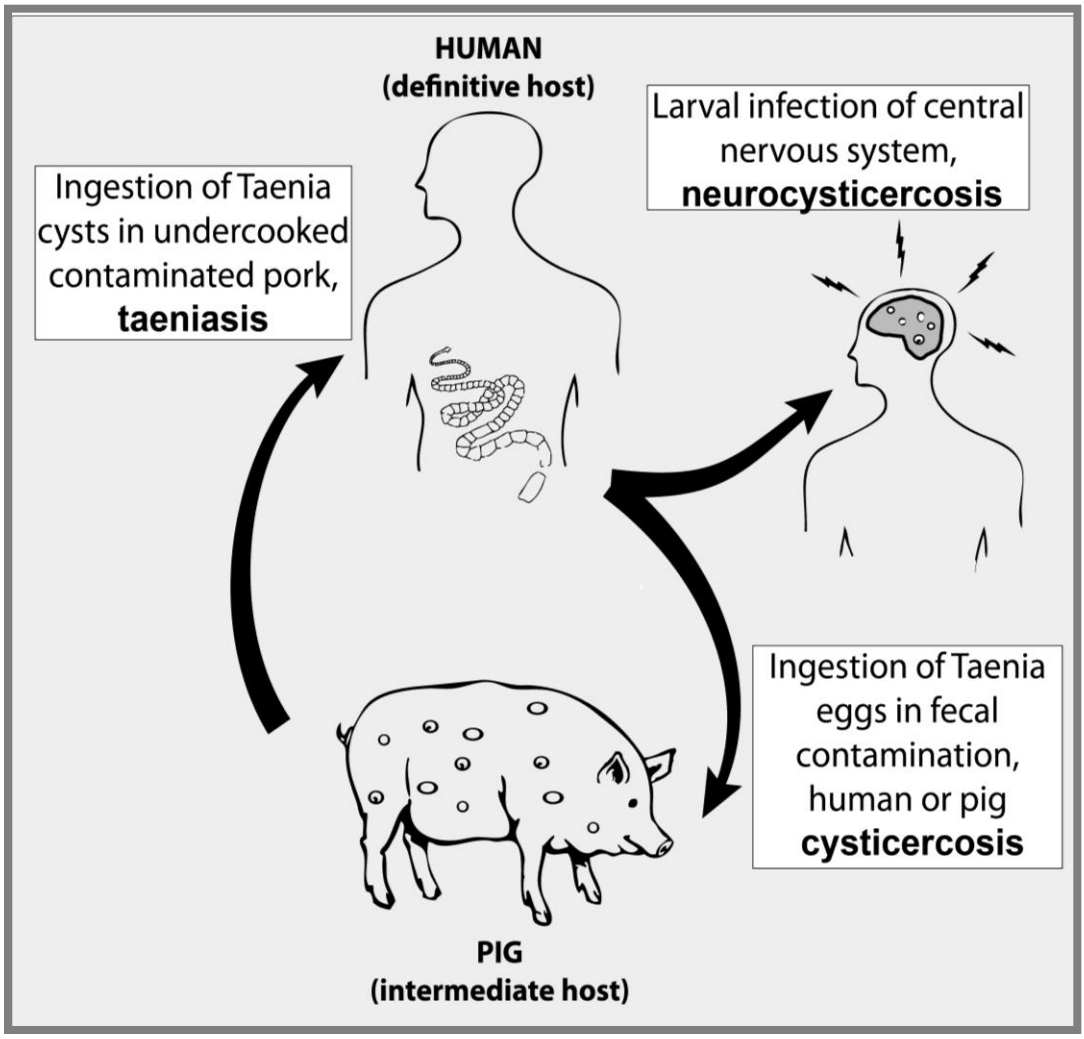


Figure 1: The lifecycle of the pork tapeworm, *Taenia solium*

Cysticercosis has been reported in many countries in Southeast Asia including Vietnam, Cambodia and Laos.[11,12] Seroprevalence studies show human exposure to *Taenia spp.* eggs in Vietnam, China, and Indonesia is common, while variable prevalence estimates of taeniasis have been reported in India, Vietnam, China, Indonesia, and Nepal.[13] The wide range of reported prevalence indicates that endemicity may vary by socio-economic group within countries as well as between countries.[13] Furthermore, in Southeast Asia, *T. solium* faces competition from *T. saginata* and *T. asiatica* in humans and *T. hydatigena* and *T. asiatica* in pigs. It has been hypothesized that this competition may mitigate *T. solium* transmission in areas of Southeast Asia.[14,15] The unique ecology of parasites in this region makes characterization of *Taenia spp.* transmission crucial to the effective management and prevention of disease among humans and pigs.

Refugee and migrant populations are of special concern with regards to NCC in the United States. Multiple case reports of NCC among resettled Burmese refugees have been reported and a recent seroprevalence survey shows a high proportion of refugees from Southeast Asia have antibodies against *T. solium* cysts.[16-20] These previous studies suggest that *T. solium* infection may be endemic in Burma or in camps where Burmese refugees reside before resettlement. Furthermore, while the diagnosis of NCC in the U.S. is largely restricted to immigrant populations or populations that have traveled to *T. solium* endemic regions,[3,8,21] imported taeniasis poses a risk to the individual, his or her family and neighbors, and the larger community.[22] In fiscal year 2012, 14,020 refugees from Burma were resettled in the United States, representing 24% of all refugees resettled in the US for that year. Since 2004, 934 Burmese refugees have been resettled in

Oregon, representing 11% of all refugees resettled in the state.[23] However, little information exists on the transmission of *T. solium* along the Thailand-Burma border and the underlying risk for taeniasis and cysticercosis among this growing and vulnerable population in the United States.

Many strategies have been proposed and attempted with the goal of controlling the transmission of *T. solium* and improving human and animal health. Mass treatments of both humans and pigs have been shown to decrease infection rates, but eradication of the parasite from treatment areas was not achieved.[24] Furthermore, mass treatment is expensive and infection rates may return to pre-intervention levels if treatment is interrupted.[24,25] Besides being cost prohibitive in areas where refugees reside before resettlement, the short life span of many pigs before slaughter makes mass treatment or vaccination of pigs unfeasible as a method of control. Previous studies have shown that highly infected pigs can indicate areas where the risk for taeniasis is elevated in endemic regions.[26,27] A recent study reported that the prevalence of taeniasis was 8 times higher among those who lived within 100 meters of a heavily infected pig.[27] Furthermore, this study used a simple, low-cost method of determining whether a pig was heavily infected with *T. solium* cysts; cysts on a pig's tongue that can be seen and palpated can indicate whether a pig is heavily infected.[28] Identifying heavily infected pigs will indicate areas where focused screening and treatment may help reduce transmission especially in communities with limited resources.

Research Question

We examined whether owning a heavily infected pig was associated with taeniasis in the Ban Mai Nai Soi refugee camp on the Thailand-Burma border. We hypothesized that owning a heavily infected pig is associated with being a tapeworm carrier in this refugee community. Furthermore, we examined whether other demographic measures and meat consumption practices were associated with taeniasis in the camp. Characterizing the relationship between pigs heavily-infected with *Taenia solium* cysticercosis and taeniasis will allow us to recommend strategies to prevent taeniasis and NCC in this population.

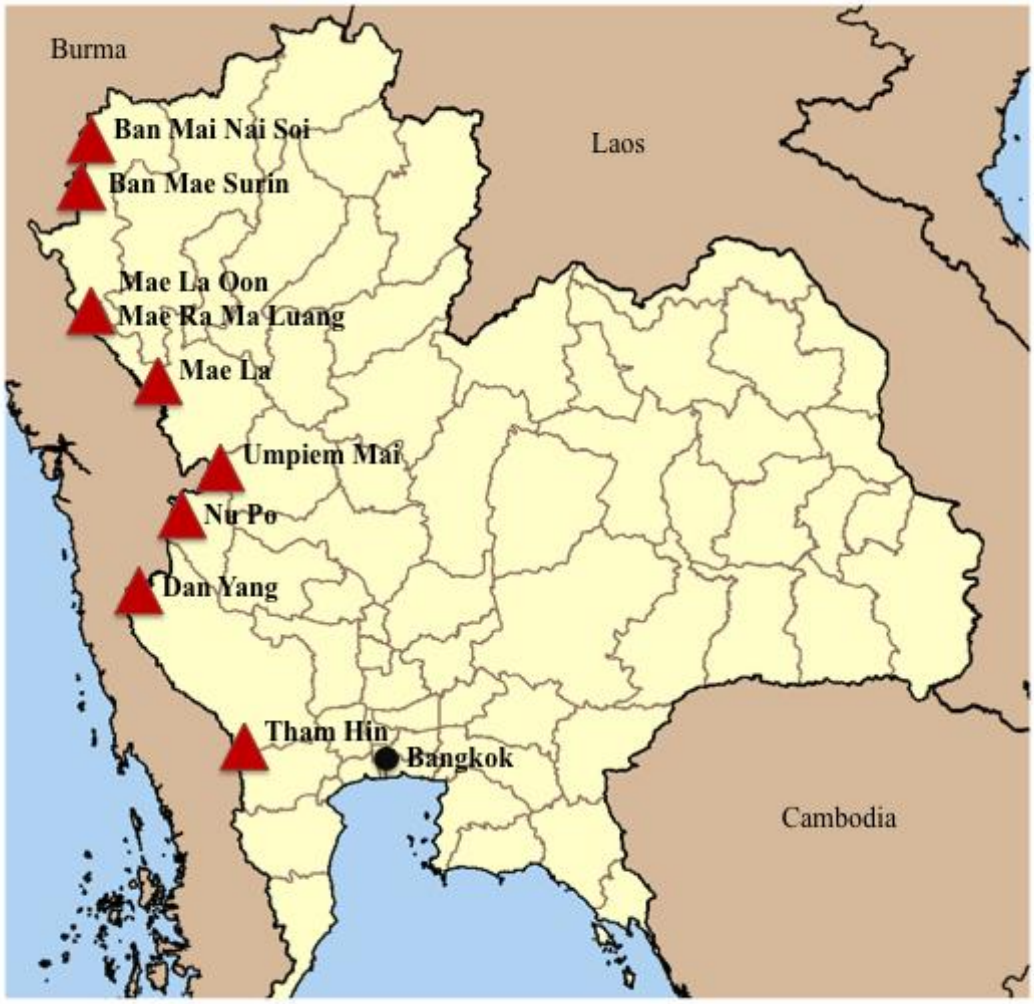


Figure 2: Refugee camps along the Thailand-Burma border

Methods

Study Design

We conducted a cross-sectional study utilizing an adaptive cluster sampling method with households as a sampling unit.

Population

As of October 2012, 142,039 individuals were verified as living within 9 camps along the Thailand-Burma border.[29] Of these residents, 83,800 were officially registered with the MOI/UNHCR. An additional 17,079 internally displaced people were living in established camps within Burma.[29] The Ban Mai Noi Soi refugee camp is located in the Mae Hong Son province of Thailand close to the Burmese border (Figure 2). Approximately 12,944 individuals are verified as living within the camp as of December 2012. Of these residents, 3,332 are officially registered with the MOI/UNHCR.[30] The vast majority (93.7%) of the population living in the camp are of the Karenni ethnicity, with fewer individuals identifying with the Karen (2.5%) and Shan (3.3%) ethnicities.[30] Domestic livestock production, including chicken (70%) and pig (61%) rearing is common with refugees.[31]

The Ban Mai Nai Soi camp is managed by the Camp Committee, comprised of camp residents, under the authority of the Royal Thai Government. The Thai Ministry of the Interior controls camp operations through district authorities and implements refugee policy set by the Thai National Security Council. The Karenni Health Department, in

conjunction with the non-governmental organization International Rescue Committee (IRC) manages health clinics within the camp.

Sampling Strategy

We used adaptive cluster sampling to recruit study participants with the goal of increasing the sample of pigs as the prevalence of heavily-infected pigs was expected to range from 3-13%.[28] This strategy was developed to efficiently sample rare events that tend to cluster.[32] A simple random sample was selected from all houses within the camp (random sample). If a random sample household reported that they owned pigs, the field team would visit surrounding houses (targeted sample). Up to four targeted-sample houses were sampled for each random sample house, one in each direction relative to the initial house.

A depiction of our sampling strategy can be seen in Figure 3. If a targeted sample house reported that they owned pigs, these pigs were examined for tongue cysts. If no cysts were visible on any of the pigs' tongues, the field team would record the number of pigs owned by the household and continue sampling other targeted sample houses surrounding that house, again one house in each direction relative to the current house for up to four houses. If the field team discovered a tongue cyst and the cyst was confirmed by the primary investigator, the field team would perform all activities as if the house were a random sample house. Again, in this case the field team would continue sampling other targeted sample houses surrounding that house.

If a targeted sample house reported that they did not own pigs, the field team would discontinue sampling in that direction. Field teams would discontinue sampling households when their access to additional targeted sample households was impeded by a stream, or a road that cars could travel on, or if houses in all directions did not own pigs.

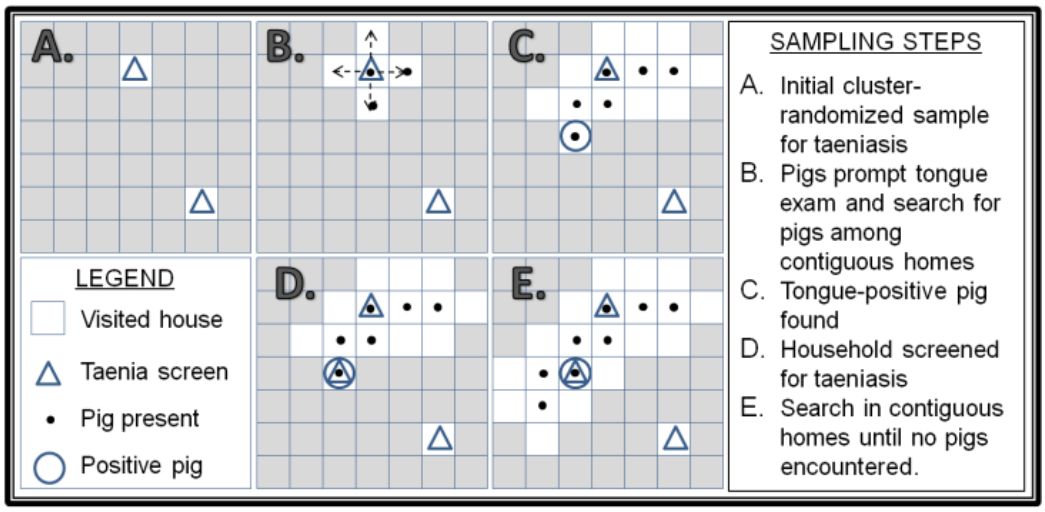


Figure 3: Adaptive cluster sampling strategy to recruit study participants

Field Team Personnel

Four field teams were created consisting of a veterinarian, an animal handler, a medical assistant, a lab technician, two data collectors, and one veterinary technician from the Thai Department of Livestock Development (DLD). International Rescue Committee (IRC) and Camp Committee staff assisted in recruiting camp residents to work as animal handlers, medical assistants, lab technicians, and data collectors.

Human Sample

Inclusion and exclusion criteria for both the human and pig samples can be found in Table 1. Field teams visited residents in their homes to explain the study, request participation, and obtain verbal consent. An assent script was used with children under 17 years old. All consent and interview procedures were conducted using the potential participant's primary language. After verbal consent or assent was obtained, field teams conducted a household census with the head of household and interviewed each individual household member (Appendix I). Questionnaires covered water and sanitation, animal raising practices, demographics, and pork consumption practices.

All participants were asked to provide a stool sample. Each participant was provided with a 500-mL plastic container and a bar of soap in a plastic bag and instructed to collect one entire feces in the container, secure the lid, and wash their hands with soap and water when finished. Each stool container was labeled with a unique specimen ID code and the participant's name or a unique shape matched to a corresponding shape drawn on the participant's forearm if the participant could not read. Participants were asked to store

their specimens overnight at ambient temperature. Field teams returned the subsequent workday to collect stool specimens.

Table 1: Inclusion and exclusion criteria

Sample	Inclusion Criteria	Exclusion Criteria
Human	• Reside in a random sample or targeted sample household	• No screening exclusion criteria
Pig	• Owned by a random sample or targeted sample household	• Pregnant sow • Piglet less than four weeks old

Pig Sample

Once verbal consent was obtained from the pig owner, the veterinary team helped to safely restrain the pig while the veterinarian visually inspected and felt each side of the tongue for cysts. Pigs that were confirmed tongue-positive were marked with spray paint and investigators offered to either purchase the pig from the owner or treat the pig. Purchased pigs were removed from the community for necroscopy.

Sample Processing, Storage, and Shipping

All stool samples were processed on a daily basis in the camp laboratory. Field lab technicians visually examined whole stool samples for any tapeworm segments or scoloces and collected an aliquot of feces. Any tapeworm segments or scoloces were preserved with 80% ethanol, while aliquots were stored on ice. At the end of each day, human stool samples were registered, repacked on ice and shipped to Chiang Mai University by bus along with any tapeworm material that was found.

Lab Methods

Chiang Mai University laboratory workers prepared fecal samples by the addition of 0.15 M phosphate-buffered saline (pH 7.4) containing 0.3% Tween in approximately 2:1 buffer volume to feces volume and adjusted 5% formalin solution.[33] Fecal samples diluted in buffer were shaken vigorously and centrifuged at approximately 2,000 x g at room temperature for approximately 5 minutes to form a fecal supernatant that was able to be micro-pipetted. Flat-bottomed microtiter plates were coated with 100 µl per well of hyperimmune rabbit anti-*T. solium* IgG at a concentration of 5µg/ml in 0.05 M NaHCO@INa_2CO_3 buffer (pH 9.6) and left overnight at 4°C. The wells were then washed three times with PBS, 0.1% Tween and blocked with 100 µl /well of PBS, 0.3% Tween for 1 hr. The plates were washed again and 50 µl of fecal supernatant was added to each well in which 50 µl of heat-inactivated fetal calf serum is present. Samples were then incubated for 1 hr. The wells were washed three times as before and 100 µl of the anti-T. *solium* IgG peroxidase conjugate diluted 1: 1,500 in PBS, 0.3% Tween is added to each well and incubated for 1 hr. After three washes with PBS, 0.1% Tween, 100 µl of substrate solution containing 5-amino-salicyclic acid (Sigma) and 0.005% hydrogen peroxide in 0.1 M phosphate buffer containing 1 mM Na_2EDTA (pH 6.0) was added to each well and incubated for 25 min. The optical densities (OD) of the plates were read at an absorbance of 450 nm. Procedures were carried out at room temperature unless otherwise stated.

Case Definitions

Heavily-infected pig: any pig with a visible and palpable tongue cyst confirmed by the primary investigator (tongue-positive). The sensitivity and specificity of the so-called tongue test in this environment is unknown, although a previous study has estimated the sensitivity and specificity of the tongue test at 70% and 100%, respectively.[28]

Taeniasis: the presence of *Taenia sp.* material (eggs, proglottids, or scoleces) in feces, or a positive ELISA for *Taenia sp.* antigens in feces (OD of sample relative to the OD of the positive control $\geq$ 40%). The sensitivity of microscopy is limited, while both the sensitivity and specificity of the ELISA coproantigen test for detecting *Taenia spp.* has been estimated at 99%.[34]

Treatment

Participants with taeniasis were given a single oral dose of niclosamide (2g if > 50 kg; 1.5 g if between 35 and 50 kg; 1.0 g if equal to or less than 34 kg) followed by a single dose of bisacodyl (10 mg if > 50 kg; 5 mg if between 35 and 50 kg). Participants were asked to collect all stools for 24 hours following ingestion of niclosamide.[35] Again, field teams returned the day after treatment to collect post-treatment stool samples. Treatment for other parasitic worms was also provided including mebendazole (as a treatment for ascaris, ancylostoma, enterobiasis, and trichuris), ivermectin (as a treatment for strongyloides), and praziquantel (as a treatment for schistosomiasis). Female participants

requiring treatment were asked if they were pregnant and if they stated they were, treatment was deferred until the third trimester, or post-delivery.

Pigs with tongue cysts confirmed by the lead investigator (tongue positive) were either purchased or treated. When owners did not want to sell, pigs were treated orally oxfendazole (30 mg/kg) and the owner was instructed that the pig should not be consumed for 20 days.[36] Field teams offered vitamins to pig owners who participated and instructed owners how to administer vitamins to their animals.

Statistical Analyses

All statistical analyses were performed with Stata version 12.1 (StataCorp. 2011. *Stata Statistical Software: Release 12*. College Station, TX: StataCorp LP). The crude prevalence of human taeniasis was calculated as the proportion of taeniasis-positive individuals among all individuals in random sample households. The crude prevalence of heavily-infected pigs was calculated as the proportion of pigs with confirmed tongue cysts in the total sampled population of pigs. The prevalence of heavily-infected pigs and the prevalence of taeniasis were also adjusted for household clustering and sampling weight using survey data analysis tools in Stata.

Generalized estimating equations (GEE) were used in both univariate and multivariate analyses to adjust for the effect of intra-household clustering as well as sampling weight. Univariate analysis was used to test the association between taeniasis-status and the primary exposure, owning an infected pig. Potential covariates included sex, age,

education, employment, years lived in the camp, previous proglottid expulsion, number of pigs owned, whether they own an infected pig, how often they consume raw pork, how often they consume raw beef, when they were last in Burma, how often they eat pork outside of the camp, whether the main floor of the house is elevated, and what type of pig meat they consume. Variables significant upon univariate analysis ($p<.25$) were included in a multivariate GEE model. Once a multivariate model was built, only variables significant at alpha=.05 or specific variables of interest were retained in the final model. The quasilikelihood under the independence model criterion (QIC) was used to select the working correlation structure while the simplified version, QIC_u was used to compare the fit of resulting models.[37]

Human Subjects Protections and Animal Welfare

This research was approved by the Institutional Review Boards at Oregon Health and Science University and Chiang Mai University Faculty of Medicine as well as the Institutional Animal Care and Use Committees at Oregon Health and Science University and Chiang Mai University Faculty of Veterinary Medicine.

Results

Study Sample

Results from the human sample can be found in Figure 4. We interviewed a total of 777 individuals in 213 different households, representing roughly 6% (777/12,944) of the total camp population. Of these interviewees, 75% (582/777) provided a stool sample for

testing: 95% (552/582) from random sample households, and 5% (30/582) from targeted sample households. The random sample (n=552) was used to determine the prevalence of taeniasis and the association between owning an infected pig and taeniasis. The combined random and targeted samples (n=582) were used to determine the association between other factors and taeniasis.

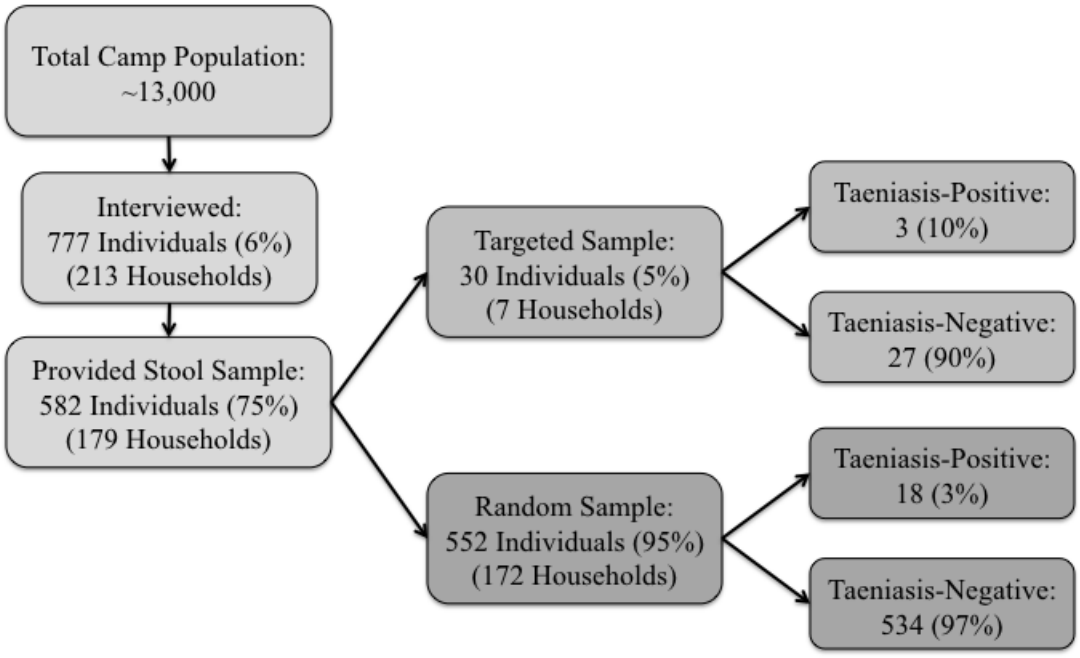


Figure 4: Results from the human study

Prevalence of Taeniasis

Among the 552 individuals in the random sample, 3% (18/552) were positive for taeniasis (2 via ELISA and 16 via microscopy), while among the 30 individuals in the targeted sample, 10% (3/30) were positive for taeniasis (none via ELISA and 3 via microscopy). After accounting for household clustering and sampling weight, the prevalence of taeniasis in the random sample was 2.8% (95% CI: 1.4, 4.2%).

Interview Results

There were significant differences between taeniasis-positive and taeniasis-negative individuals (Table 2). Taeniasis-positive individuals were older ($p<.001$), had less education ($p<.05$), and lived in the camp for longer than taeniasis-negative individuals ($p<.01$). Furthermore, a greater proportion of taeniasis-positive individuals reported passing worms ($p<0.001$), ever eating raw pork ($p<.0001$), and ever eating raw beef ($p<.001$). The frequency of pork consumption outside of the camp ($p=.025$) and the years since visiting or living in Burma ($p=.013$) varied by taeniasis status. Upon univariate GEE analysis, eating raw pork, eating raw beef, self-report or worm passage, and visiting Burma more than 5 years ago were most strongly associated with taeniasis. The odds of eating raw pork among those with taeniasis was 7.08 times the odds of eating raw pork among those without taeniasis (95% CI: 2.22, 22.57) while the odds of eating raw beef among those with taeniasis was 4.22 times the odds of eating raw beef among those without taeniasis (95% CI: 1.50, 11.87). The odds of reporting worm passage among those with taeniasis was 23.93 times the odds of reporting worm passage among those without taeniasis (95% CI: 7.69, 74.43). Finally, the odds of having been in Burma more than 5 years ago among those with taeniasis was 8.84 times the odds of having been in Burma more than 5 years ago among those without taeniasis (95% CI: 1.22, 64.12).

Table 2: Descriptive statistics stratified by taeniasis status and GEE univariate analyses

Variable	Taeniasis-Negative (n = 561) Median (IQR) †	Taeniasis-Positive (n = 21) Median (IQR) †	P-value	OR (95% CI)
Age (years)	18 (8, 35)	47 (32, 65)	0.0001	1.04 (1.02, 1.06)
Education (years)	1 (0, 5)	0 (0, 0)	0.0205	0.86 (0.70, 1.05)
No. Household Residents	5 (4, 6)	5 (4, 7)	0.3001	1.32 (1.05, 1.65)
Years Resided in Camp	11 (5, 16)	13 (11, 17)	0.0090	1.11 (1.01, 1.23)
	Proportion (CI) ‡	**Proportion (CI)** ‡		
Eat Pork Outside Camp			0.025	
Never	0.77 (0.73, 0.80)	0.57 (0.35, 0.79)		Ref
1-2 Times per Month	0.11 (0.08, 0.14)	0.10 (0.00, 0.22)		1.12 (0.23, 5.53)
3-5 Times per Month	0.05 (0.03, 0.07)	0.19 (0.02, 0.36)		4.32 (1.00, 18.71)
> 5 Times per Month	0.07 (0.05, 0.09)	0.14 (0.00, 0.30)		2.84 (0.64, 12.55)
Eats Raw Pork	0.26 (0.22, 0.30)	0.67 (0.46, 0.87)	<0.0001	7.08 (2.22, 22.57)
Eats Raw Beef	0.25 (0.21, 0.28)	0.62 (0.41, 0.83)	0.0001	4.22 (1.50, 11.87)
Seen Worm Segments in Stool			<0.001	
No	0.83 (0.80, 0.86)	0.24 (0.05, 0.43)		Ref
Yes	0.12 (0.09, 0.15)	0.71 (0.52, 0.91)		23.93 (7.69, 74.43)
Don't Know	0.05 (0.03, 0.07)	0.05 (0.00, 0.14)		5.15 (0.57, 46.81)
Last in Burma			0.013	
Never Been	0.32 (0.28, 0.36)	0.05 (0.00, 0.14)		Ref
> 5 years ago	0.50 (0.46, 0.54)	0.81 (0.64, 0.98)		8.84 (1.22, 64.12)
≤ 5 years ago	0.18 (0.14, 0.21)	0.14 (0.00, 0.30)		4.45 (0.44, 44.73)
Owns Tongue-Positive Pig*	0.04 (0.03, 0.06)	0.11 (0.00, 0.26)	0.193	2.43 (0.60, 9.67)
Seen Pork Cysts in Own Meat*	0.38 (0.34, 0.43)	0.38 (0.13, 0.62)	0.9417	1.19 (0.41, 3.44)

*Descriptive statistics from primary households only.
†P-values calculated via Kruskal-Wallis equality-of-populations rank test
‡P-values calculated via Pearson's chi-squared test

Ever eating raw pork (χ_5^2=149.82, p<.001) and ever eating raw beef (χ_5^2=129.14, p<.001) were strongly correlated with age (Figure 5). Furthermore, ever eating raw pork and ever eating raw beef were strongly correlated (χ_1^2=331.17, p<.001).

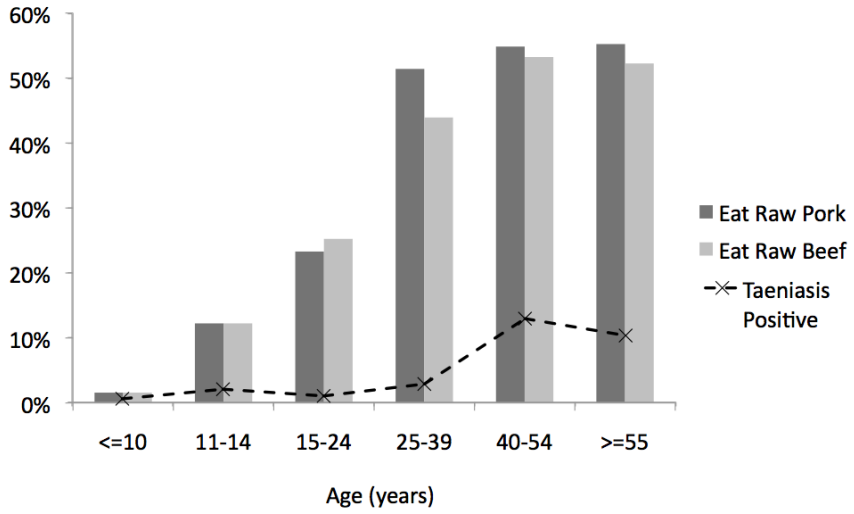


Figure 5: Proportion of study sample consuming undercooked meat and taeniasis status by age group

Prevalence of Heavily-Infected Pigs

A total of 722 pigs were examined in 424 households: among the 269 pigs in the random sample, 4% (10/269) were tongue positive, while among the 453 pigs in the targeted sample, 2% (8/453) were tongue positive (Figure 6). When these two samples were combined, 2.5% (18/722) pigs were positive via tongue palpitation. After accounting for household clustering and sampling weight, the prevalence of heavily-infected pigs in the combined samples was 2.5% (95% CI: 0.8%, 4.2%). Among the random sample, the prevalence of heavy-infection was 3.0% (95% CI: 0.6%, 5.4%) while among the targeted sample, the prevalence of taeniasis is 1.3% (95% CI: 0.3%, 2.4%).

Another method of measuring an individual's exposure to a heavily infected pig is self-report of cysts in the body cavity of one's own pigs. Among individuals in random sample households, 38.4% (208/542) of participants reported ever finding cysts in their pig's muscles or intestines after slaughter. After accounting for household clustering and sampling weight, 35.5% of participants reported ever finding cysts in their pig's meat (95% CI: 28.3%, 43.7%). Among taeniasis-negative individuals, 35.3% reported ever finding cysts in their pig's meat (95% CI: 28.1%, 42.5%) while among taeniasis-positive individuals, 41.7% reported ever finding cysts in their pig's meat (95% CI: 15.8%, 67.6%).

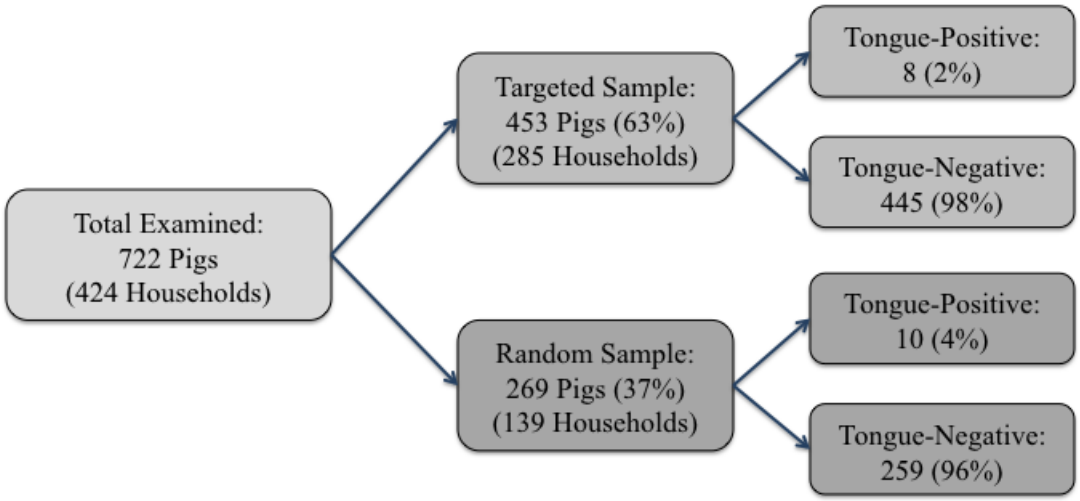


Figure 6: Results from the pig study

Heavily-Infected Pigs and Taeniasis

Univariate analysis indicated that among individuals in random sample households, owning an infected pig was not significantly associated with taeniasis (OR = 2.43, 95% CI: 0.60, 9.76). Factors significantly associated with taeniasis among individuals in random sample households included number of household residents, years resided in camp, worm passage self-report, eating raw pork, eating raw beef, older age groups, and visiting or living in Burma more than 5 years ago (Table 2, Appendix III). After adjusting for the number of household residents, having a latrine within the yard, age group, and pig ownership, owning an infected pig remained not significantly associated with taeniasis (OR = 2.30, 95% CI: 0.62, 8.46; Table 3).

Table 3: Heavily infected pigs and taeniasis: GEE multivariate logistic regression

Model	Exposure Variable	OR (95% CI)	QIC_u
1†	Own Infected Pig	2.30 (0.62, 8.46)	150.302
2‡	Seen Cysts in Own Pork	0.77 (0.23, 2.60)	132.514

†Adjusted for number of residents, having a latrine within the yard age group, and pig ownership.
‡Adjusted for number of residents, ever eating raw pork, having a latrine within the yard age group, and pig ownership.

Univariate analysis indicated that among individuals in random sample households, self-report of cysts in one's own pork was not significantly associated with taeniasis (OR = 1.19, 95% CI: 0.41, 3.44). After adjusting for the number of household residents, ever eating raw pork, having a latrine within the yard, age group, and pig ownership, self-report of cysts in one's own pork remained not significantly associated with taeniasis and in fact crossed the null value after adjustment (OR = 0.77, 95% CI: 0.23, 2.60; Table 3).

Other Variables and Taeniasis

In order to explore the association between other demographic measures, meat consumption practices and taeniasis, data from both primary and secondary houses were pooled. Univariate analysis indicated that number of household residents, years resided in camp, worm passage self-report, ever eating raw pork, ever eating raw beef, age equal to or greater than 40 years, ever eating raw meat, and visiting or living in Burma more than 5 years ago were significantly associated with taeniasis (Table 2, Appendix III). After adjusting for other factors associated with taeniasis, number of household residents, self-report of worm passage, and eating pork outside of camp more than 5 times per month remained significantly associated with taeniasis while having a latrine within the yard had a protective association with taeniasis (Table 4). People with taeniasis were 4.25 times more likely than people without taeniasis to have eaten pork outside the camp more than 5 times a month (95% CI: 1.04, 17.46). However, people with taeniasis were 0.25 times less likely than people without taeniasis to have a latrine within the yard (95% CI: 0.07, 0.94). Finally, those with taeniasis were 18.73 times more likely than those without taeniasis to have reported previously passing a worm (95% CI: 4.53, 77.49).

Table 4: Other factors associated with taeniasis: GEE multivariate logistic regression

Model	Variable	OR (95% CI)	QIC_u
3†	No. of Household Residents	1.49 (1.17, 1.91)	142.338
	Self-Report of Worm Passage	18.73 (4.53, 77.49)	
	Ever Eat Raw Pork	2.02 (0.48, 8.52)	
	Eat Pork Outside of Camp 1-2 Times Per Month	1.00 (0.18, 5.54)	
	Eat Pork Outside of Camp 3-5 Times Per Month	2.52 (0.43, 14.91)	
	Eat Pork Outside of Camp >5 Times Per Month	4.25 (1.04, 17.46)	
	Have Latrine Within Yard	0.25 (0.07, 0.94)	

†Adjusted for all variables in table in addition to age group.

Given that worm passage self-report is the variable most strongly associated with taeniasis, it may be a useful screening tool in this population. The sensitivity of worm passage self-report is 75% (95% CI: 50.9%, 91.3%) while the specificity is 87.4% (95% CI: 84.3%, 90.1%). Using the prevalence of taeniasis (2.8%) as the pre-test probability, the positive predictive value of worm passage self-report is 15.1% (95% CI: 11.3%, 20.0%) while the negative predictive value is 99.2% (95% CI: 98.2%, 99.6%).

Table 5: Self-report of worm passage by taeniasis status

	Taeniasis-Positive	**Taeniasis-Negative**	
	Count (%)	**Count (%)**	**Total**
Self-Report Positive	15 (2.8)	66 (12.1)	81
Self-Report Negative	5 (0.9)	458 (84.2)	463
Total	20	524	544

Discussion

The prevalence of taeniasis in the camp is comparable to estimates from other regions where *Taenia solium* is endemic.[38,26,27] However, the specific species contribution to the estimate of 2.8% (95% CI: 1.4, 4.2%) has yet to be confirmed; it is unknown what proportion of the taeniasis estimate is *T. solium*, *T. saginata,* or *T. asiatica*. Nevertheless, the prevalence of taeniasis in this population suggests that the risk and prevalence of NCC may also be comparable to other endemic regions. Previous studies have found that *Taenia* egg detection underestimates the true prevalence of taeniasis, suggesting that the

burden of disease in this community may in fact be greater than estimates reported here.[15,39]

Owning a tongue-positive pig was not shown to be significantly associated with taeniasis in this population. This method of screening has been suggested as a means of identifying geographic areas of high risk for taeniasis, but it may not be an appropriate tool in this population.[27] Indeed, histology reports from 6 of the tongue-positive pigs in this study (out of 18 total) subsequently revealed the cysts to be sarcocystosis, caused by the protozoa *Sarcocystis* rather than *Taenia solium* cysticercosis. While the association between owning a tongue-positive pig and taeniasis was not significant, it was nonetheless positive (OR = 2.30, 95% CI: 0.62, 8.46). This may be explained by the commonalities in the life cycles of *Taenia solium* and *Sarcocystis*. Humans are the definitive host and pigs (as well as cows in the case of *Sarcocystis*) are the intermediate hosts of both parasites. Therefore, while we did not confirm the presence of *T. solium* cysts in any pigs, some pigs may indeed have *T. solium* cysticercosis given the positive (albeit not significant) association between tongue positivity and taeniasis and the common lifecycle of *T. solium* and *Sarcocystis.*

There are multiple potential reasons why pigs in this environment may not present with *T. solium* tongue cysts. At this point we do not have any definitive evidence that pigs in this population have *T. solium* cysticercosis. Pigs in the camp may indeed not be exposed to *T. solium* and may be free of cysticercosis. Alternatively, pigs may have a light *T. solium* cyst burden and therefore may not present with tongue cysts.[28] Pigs are required

to be kept in pens throughout the camp, reducing their ability to roam free and thereby limiting their exposure to proglottids or large quantities of eggs shed from adult tapeworm carriers. Pigs in this setting may have light exposure to *T. solium* eggs through contaminated feed or water, and subsequently may develop a lower burden of cysts. Furthermore, *T. solium* in Southeast Asia may be distinct from *T. solium* endemic in other regions of the world, making tongue palpitation an inaccurate marker for a heavily-infected pig in this environment. Competition from other *Taenia* species, including *T. hydatigena* and *T. asiatica* may mitigate *T. solium* transmission among pigs in the camp, as has been suggested in other regions of Southeast Asia.[14,15] Finally, all pigs examined in the camp were either Thai indigenous or crossbred with an exotic species (data not shown). These breeds may have very different reactions to infection with *Taenia* species compared with pig breeds studied in other regions of the world where *T. solium* is endemic. Clearly, many questions remain regarding the exposure of pigs to *Taenia* species in the camp.

Another method of determining whether a participant has owned a pig with *T. solium* cysticercosis is asking whether a participant has seen pig cysts in their pig's meat after slaughter. We found that self-report of pig cysts is not significantly associated with taeniasis in this population (OR = 0.77; 95% CI: 0.23, 2.60). This may be explained by the discovery of *T. hydatigena* cysts upon necropsy of tongue-positive pigs purchased from the camp. In fact, *T. hydatigena* is very prevalent in Southeast Asia; one study from Laos estimated the prevalence of *T. hydatigena* at 22.4% via carcass inspection and 68.5% via antigen-capture ELISA positivity.[15] It is likely that the high prevalence of

self-report of pig cysts in the camp, 35.5% (28.3%, 43.7%), is a reflection of a high prevalence of *T. hydatigena* in the camp. This would also support our finding that there is not an association between self-report of pig cysts and taeniasis.

We found that having more household residents, eating pork outside the camp more than five times a month, being over 40 years old, and self-report of worm passage were positively associated with taeniasis, while having a latrine within the yard was negatively associated with taeniasis. People with taeniasis were 4 times more likely than people without taeniasis to have eaten pork outside the camp more than 5 times per month. This may indicate that consuming pork outside the camp carries greater risk for acquiring adult *T. solium* infection and that pork within the camp is relatively protected from *T. solium* infection. This is consistent with the lack of evidence of *T. solium* cysticercosis among pigs in the camp. Further studies must elucidate whether pigs in the camp have been exposed to *T. solium*.

The small yet significant association between increasing numbers of residents in the household and presence of taeniasis (OR=1.49) may be a marker for household hygiene or socioeconomic status. Similarly, the protective effect of having a latrine within the yard may be a marker for hygiene or mobility. One would expect not having a latrine within the yard to be associated with pig infection, upstream of taeniasis, since pigs must consume eggs in feces from a tapeworm carrier in order to develop *T. solium* cysticercosis (Figure 1). However, since anyone in the camp is able to obtain materials

for and construct a latrine, those without a latrine may be less connected with the camp community or uninterested in using a latrine and likely have other poor hygiene practices.

The factor most strongly associated with taeniasis was self-report of worm passage. The odds of self-reporting passage of a worm was nearly 20 times higher among people with current taeniasis infection compared to those who were not infected. While we found that the positive predictive value of worm passage self-report was only 15%, the negative predictive value was quite high at 99.2%. Therefore, inquiring about previous worm passage may be a useful initial screening for the diagnosis of taeniasis since we know that 99% of camp residents who report never passing a worm will in fact be taeniasis negative. While only 15% of camp residents who report previous worm passage will indeed be taeniasis positive, in a community such as the Ban Mai Nai Soi refugee camp where resources are limited, this screening question may provide a practical method to focus diagnostic tests on a sub-population at increased risk for taeniasis.

Eating raw pork was strongly associated with taeniasis upon univariate analysis (OR=7.08), yet upon multivariate analysis it was positively, but not significantly, associated with taeniasis (OR=2.02, 95% CI: 0.48, 8.52). Since consuming pork containing viable *T. solium* cysts is required in order to contract *T. solium* taeniasis, it is curious to see that this variable is not significant upon multivariate analysis. The most obvious conclusion would be that a *Taenia* species other than *T. solium* is causing taeniasis in the camp. However, when eating raw beef was included in the model, it too was positively, but not significantly associated with taeniasis. As discussed above, both

raw pork and raw beef consumption were strongly correlated with age. Therefore, controlling for age group in our analyses may in fact over-correct for the effect of eating raw pork. Another issue that became apparent during the interview process was the understanding of the words "raw" and "undercooked". Our data collectors had difficulty interpreting these concepts and camp residents did not intuitively know what these words meant. With the aid of pictures, data collectors were able to explain "raw" meat to participants, however some questions remain about the level of understanding. Finally, this may simply be a sample size issue. Surveying a greater number of individuals in the camp may result in a more precise estimate of the association between eating raw pork and taeniasis.

Strengths and Limitations

As with all survey-based research, this study suffers from obvious limitations. Self-reported data are subject to recall error and bias. Participants may not have accurately reported consuming raw pork, eating pork outside of camp, or any other interview variable. As a result, the measure of association between these factors and taeniasis may be altered. However, there is no reason to think that inaccurate reporting would differ by taeniasis status, reducing the likelihood that the measures of association reported here are significantly biased in either direction. Of greater concern is our inability to survey all members living in sampled households. Many household members were working outside the camp during the day and were therefore not available for interview. If eating pork outside the camp is indeed a risk factor for taeniasis, those who work outside the camp may have a higher prevalence of taeniasis compared with the general camp population.

Therefore, the prevalence of taeniasis reported here (2.8%) may be an underestimate of the true burden of disease in the camp. As far as outcome ascertainment, there are some concerns regarding lab testing. ELISA results did not overlap with microscopy results, meaning that none of the samples that were positive for taeniasis via microscopy were also positive for taeniasis via the ELISA coproantigen test. This throws into question the accuracy of the ELISA results; one would expect stool samples containing *Taenia spp.* eggs or proglottids to produce a strong positive ELISA coproantigen test.[34] However, excluding the two samples that were taeniasis positive via the ELISA coproantigen test does not appreciably change the results reported here. Despite these limitations, this cross sectional study provides essential knowledge about the factors potentially associated with taeniasis in this refugee population. No previous studies have examined the transmission of *T. solium* within a refugee camp. Not only is this information important in evaluating the risk for imported taeniasis and NCC to the United States, these results can be used to form recommendations about methods for interrupting the transmission of *T. solium* within the Ban Mai Nai Soi refugee camp, affecting the well-being of the nearly 13,000 residents of the camp.

Conclusions and Recommendations

Groups that have a stake in the health of the residents of the Ban Mai Nai Soi refugee camp include the Camp Commander and the Thai Ministry of the Interior, the Karenni Health Department and Camp Committee, the International Organization for Migration, the Centers for Disease Control and Prevention, and healthcare providers caring for

refugees after resettlement to the United States. Recommendations based on our findings are organized by stakeholder.

Thai Ministry of the Interior/Camp Commander: Pigs raised in the Ban Mai Nai Soi camp may be protected from cysticercosis. We recommend continuing to enforce pig corral policies within the camp that may be contributing to the health of the population. Given that the camp residents struggled to understand the concept of "undercooked meat", we also recommend the implementation of programs to educate camp residents on the risks of raw meat consumption.[25] We found that having a latrine within the yard was protective against taeniasis. Therefore we also recommend educating camp residents in the Ban Mai Nai Soi camp and in other camps along the border about the health benefits of having and using a latrine within their yards.

Karenni Health Department/Camp Committee: Self-report of worm passage might be a useful initial screening for determining taeniasis-negative status. Consider integrating a question about previous worm passage during clinic visits. Given the prevalence of taeniasis is comparable to other endemic regions, clinicians should consider NCC in patients with unexplained neurological symptoms.

International Organization for Migration/Centers for Disease Control and Prevention: Once individuals are removed from an environment where they are at risk for taeniasis, as is the case when they are resettled to the United States, mass treatment with niclosamide may be a good prevention method. Again, clinicians caring for refugees

during the resettlement process should consider NCC in patients with unexplained neurological symptoms.

U.S. Healthcare Providers: As above, clinicians should consider NCC in patients with unexplained neurological symptoms. Clinicians should also be aware of the potential for imported taeniasis and should ask resettled Burmese refugees about previous worm passage.

Future Studies

While this study has provided crucial information on the transmission of *Taenia spp.* within the Ban Mai Nai Soi refugee camp, many questions remain. Most importantly, the *Taenia* species must be confirmed in the camp. PCR using taeniid material collected during the study will identify which species are present in this population. Given that this may be a region where multiple *Taenia* species are endemic, identifying which species are present in the camp will have important consequences for future prevention measures. Pending pig serology results will also reveal whether pigs in the camp have been exposed to *T. solium* eggs, a crucial piece of information since tongue palpitation does not identify heavily infected pigs in this population. We also hope to perform similar cross sectional studies in other communities and refugee camps in the region. This will help us determine whether the Ban Mai Nai Soi camp is indeed a protected community and will help inform prevention practices throughout the region. Finally, our survey did not consider *T. solium* cysticercosis among dogs. While *T. solium* in dogs is more poorly understood than in pigs or humans, reports of *T. solium* cysticercosis have suggested that

dogs may be an important step in the lifecycle of the tapeworm.[40] Anecdotal evidence in the Ban Mai Nai Soi camp points to dogs being a common food source and are free to roam in the camp. Future studies in this region should include dog surveys to gain a more complete understanding of *T. solium* transmission.

References

1. Garcia HH, Del Brutto OH, et al. Neurocysticercosis: updated concepts about an old disease. *Lancet Neurology.* 2005;4:653-661.

2. Garcia HH, Gonzalez AE, Evans CAW, et al. *Taenia solium* cysticercosis. *Lancet.* 2003;362:547-556.

3. Coyle CM, Mahanty S, Zunt JR, et al. Neurocysticercosis: Neglected but Not Forgotten. *PLoS Neglected Tropical Diseases.* 2012;6(5):e1500. doi:10.1371/journal.pntd.0001500

4. Savioli LS, Daumetric D. First WHO report on neglected tropical diseases: working to overcome the global impact of neglected tropical diseases. Geneva: World Health Organization 2010.1 2010.1 pp.1-184.

5. Ndimubanzi PC, Carabin H, Budke CM, et al. A Systematic Review of the Frequency of Neurocysticercosis with a Focus on People with Epilepsy. *PLoS Neglected Tropical Diseases.* 2010;4(11):e870. doi:10.1371/journal.pntd.0000870

6. Scharf D. Neurocysticercosis; Two hundred thirty-eight cases from a California hospital. *Archives of Neurology.* 1988;45:777-780.

7. McCormick GF, Zee C-S, Heiden J. Cysticercosis ceribri; review of 127 cases. *Archives of Neurology.* 1982;39:534-539.

8. Wallin MT, Kurtzke JF. Neurocysticercosis in the United States: a review of an important emerging infection. *Neurology.* 2004;63:1559-1964.

9. Bulletin of the World Health Organization. The marketing of cysticercotic pigs in the Sierra of Peru. *Academic OneFile.* 1993;19:http://go.galegroup.com/ps/i.do?id=GALE%7CA13913989&v=2.1&u=ohsu&it=r&p=AONE&sw=w

10. Fan PC, Chung WC. Sociocultural factors and local customs related to taeniasis in East Asia. *Karohsiung Journal of Medical Sciences.* 1997;13:647-652.

11. Erhart A, Dorny P, Vam De N, et al. *Taenia solium* cysticercosis in a village in northern Vietnam: seroprevalence study using an ELISA for detecting circulating antigen. *Transactions of the Royal Society of Tropical Medicine and Hygiene.* 2002;96:270-272.

12. Dorny P, Somers R, Thi Dang TC, Khong Nguyen VK, Vercruysse J. Cysticercosis in Cambodia, Lao PDR and Vietnam. *Southeast Asian Journal of Tropical Medicine and Public Health.* 2004;35:223-226.

13. Rajshekhar V, Joshi DD, QuocDoanh N, van De N, Xiaonong Z. *Taenia solium* taeniosis/cysticercosis in Asia: epidemiology, impact and issues. *Acta Tropica.* 2003;87:53-60.

14. Conlan JV, Vongxay K, Fenwick S, Blacksell SD, Thompson RCA. Does interspecific competition have a moderating effect on *Taenia solium* transmission dynamics in Southeast Asia? *Trends in Parasitology*. 2009;25:398-403.

15. Conlan JV, Vongxay K, Khamlome B, et al. A cross-sectional study of *Taenia solium* in a multiple taeniid-endemic region reveals competition may be protective. *American Journal of Tropical Medicine and Hygiene.* 2012;87:281-291.

16. O'Neal SE, Townes JM, Wilkins PP, et al. Seroprevalence of antibodies against *Taenia solium* cysticerci among refugees resettled in United States. *Emerging Infectious Diseases.* 2012;18(3):431-438.

17. O'Neal SE, Robbins NM, Townes JM. Neurocysticercosis among resettled refugees from Burma. *Journal of Travel Medicine.* 2012;19:118-121.

18. Yeaney GA, Kolar BS, Siberstein HJ, Wang HZ. Case 163: solitary neurocysticercosis. *Radiology.* 2010;257:581-585.

19. Pluschke M, Bennett G. Orbita cysticercosis. *Australian and New Zealand Journal of Ophthamology.* 1998;26:333-336.

20. Hewagama SS, Darby JD, Sheorey H, Daffy JR. Seizures related to praziquantel therapy in neurocysticercosis. *Medical Journal of Australia.* 2010;193:246-247.

21. Sorvillo FJ, DeGiorgio C, Waterman SH. Deaths from Cysticercosis, United States. *Emerging Infectious Diseases.* 2007;13:230-235.

22. O'Neal SE, Noh J, Wilkins P, et al. *Taenia solium* tapeworm infection, Oregon 2006-2009. *Emerging Infectious Diseases.* 2011;17(3):1030-1036.

23. United States Office of Refugee Resettlement. Fiscal year 2012 refugee arrivals. http://www.acf.hhs.gov/programs/orr/resource/refugee-arrival-data

24. Garcia HH, Gonzalez AE, Gilman RH, et al. Combined human and porcine mass chemotherapy for the control of *T. solium*. *American Journal of Tropical Medicine and Hygiene.* 2006;74:850-855.

25. Garcia HH, Gonzalez AE, Del Brutto OH, et al. Strategies for the elimination of taeniasis/cysticerocsis. *Journal of the Neurological Sciences.* 2007;262:153-157.

26. Lescano AG, Garcia HH, Gilman RH, et al. Swine cysticercosis hotspots surrounding *Taenia solium* tapeworm carriers. *American Journal of Tropical Medicine and Hygiene.* 2007;76;376-83.

27. O'Neal SE, Moyano LM, Ayvar V, et al. Geographic correlation between tapeworm carriers and heavily infected cysticercotic pigs. *PLoS Neglected Tropical Diseases.* 2012;6(12): e1953. doi:10.1371/journal.pntd.0001953.

28. Gonzalez AE, Cama V, Gilman RH, et al. Prevalence and comparison of serologic assays, necropsy, and tongue examination for the diagnosis of porcine cysticercosis in Peru. *American Journal of Tropical Medicine and Hygiene.* 1990;43(2):194-195.

29. The Border Consortium. Refugee and IDP Camp Populations: October 2012.

30. The Border Consortium. Programme Report: July – December 2012.

31. European Commission DG ECHO, Livelihoods vulnerability analysis in Burmese refugee camps in Thailand, Final Report – October 2009.

32. Thompson SK. Adaptive Cluster Sampling. *Journal of the American Statistical Association.* 1990;85:1050-1059.

33. Allan JC, Velasquez-Tohom M, Torres-Alvarez R, et al. Field trial of the coproantigen-based diagnosis of Taenia solium taeniasis by enzyme-linked immunosorbent assay. *American Journal of Tropical Medicine and Hygiene.* 1996;54:352-6.

34. Allan JC, Criag PS. Coproantigens in taeniasis and echinococcosis. *Parasitology International.* 2006;55:S75-S80.

35. Pearson RD, Hewlett EL. Niclosamide therapy for tapeworm infections. *Annals of Internal Medicine.* 1985;102:550-551.

36. Gonzalez AE, Garcia HH, Gilman RH, et al. Effective, single-dose treatment of porcine cysticercosis with oxfendazole. *American Journal of Tropical Medicine and Hygiene.* 1996;54:391-394.

37. Cui J. QIC program and model selection in GEE analyses. *The Stata Journal.* 2007;7:209-220.

38. Garcia HH, Gilman RH, Gonzalez AE, et al. Hyperendemic human and porcine *Taenia solium* infection in Peru. *American Journal of Tropical Medicine and Hygiene.* 2003;68(3):268-275.

39. Flisser A, Vazquez-Mendoza A, Martinez-Ocana J, Gomez-Colin E, Leyva RS, Medina-Santillan R. Short report: evaluation of a self-detection tool for tapeworm carriers for use in public health. *American Journal of Tropical Medicine and Hygiene.* 2005;72(5)510-512.

40. Ito A, Putra MI, SubaharR, et al. Dogs as alternative intermediate hosts of *Taenia solium* in Papua (Irian Jaya), Indonesia confirmed by highly specific ELISA and immunoblot using native and recombinant antigens and mitochondrial DNA analysis. *Journal of Helminthology.* 2002;76(4):311-314.

Appendix I: Data Collection Forms

Household Form – English

TAENIA SOLIUM INFECTION ALONG THE THAI-BURMA BORDER *Version 2.0 : 20120828*

Interview data collection form

SITE: ☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐ SECTOR : ☐☐☐☐ HOUSE No: ☐☐☐☐

DATE: ☐☐ DAY ☐☐ MON ☐☐ YEAR TEAM: ☐☐☐☐ INTEVIEWER : ☐☐☐☐

1. HOUSING

1a. Number of residents in house: ☐

1b. Main floor elevated above ground? ☐ Yes ☐ No

1c. Main floor material : ☐ Dirt ☐ Cement ☐ Bamboo

2. WATER AND SANITATION

2a. Latrine within house/yard? ☐ Yes ☐ No

2b. Water from tap to house? ☐ Yes ☐ No

3. HOUSEHOLD ANIMALS

"How many of each of these animals to you own?"

3a. Pigs : ☐
3b. Cows : ☐
3c. Goats : ☐
3d. Sheep : ☐
3e. Buffalo : ☐
3f. Chickens: ☐
3g. Ducks: ☐
3h. Geese: ☐
3i. Dogs : ☐
3j. Cats : ☐
3k. Other: ☐

↳ ☐

4. PIG RAISING

4a. "Where do you keep your pigs?"
☐ In the yard ☐ Beneath the house ☐ Community corrals ☐ Outside camp

4b. "Do you allow your pigs to roam free…
4b1. …inside the yard?" ☐ Always ☐ Sometimes ☐ Never
4b2. …outside of the yard?" ☐ Always ☐ Sometimes ☐ Never

4c. "How do you keep your pigs from roaming?"
☐ Keep in a corral ☐ Tie with a rope ☐ Within fenced yard ☐ Let pigs roam

4d. "What do you feed you pigs?"
☐ Commercial feed ☐ Tables scraps ☐ Vegetation ☐ Other ☐

4e. "Can your pigs get into human feces in any way?"
☐ Yes ☐ No If yes, how: ☐

4f. "Where do you get water for your pigs?"
☐ Water station ☐ Tap to house ☐ River/stream ☐ Other ☐

5. PIG MEAT

5a. "What kind of pig meat does your family eat?" ☐ From regular pigs ☐ From wild boar ☐ Do not eat pig meat

5b. "Where do you get pig meat?"
☐ From our own pigs ☐ Friend/neighbor in camp ☐ From store in camp ☐ From outside camp ☐ Do not eat pig meat

5c. "Have you ever seen cysts in pig meat?" ☐ Yes, in the muscles ☐ Yes, in the intestines ☐ No, have not seen cysts

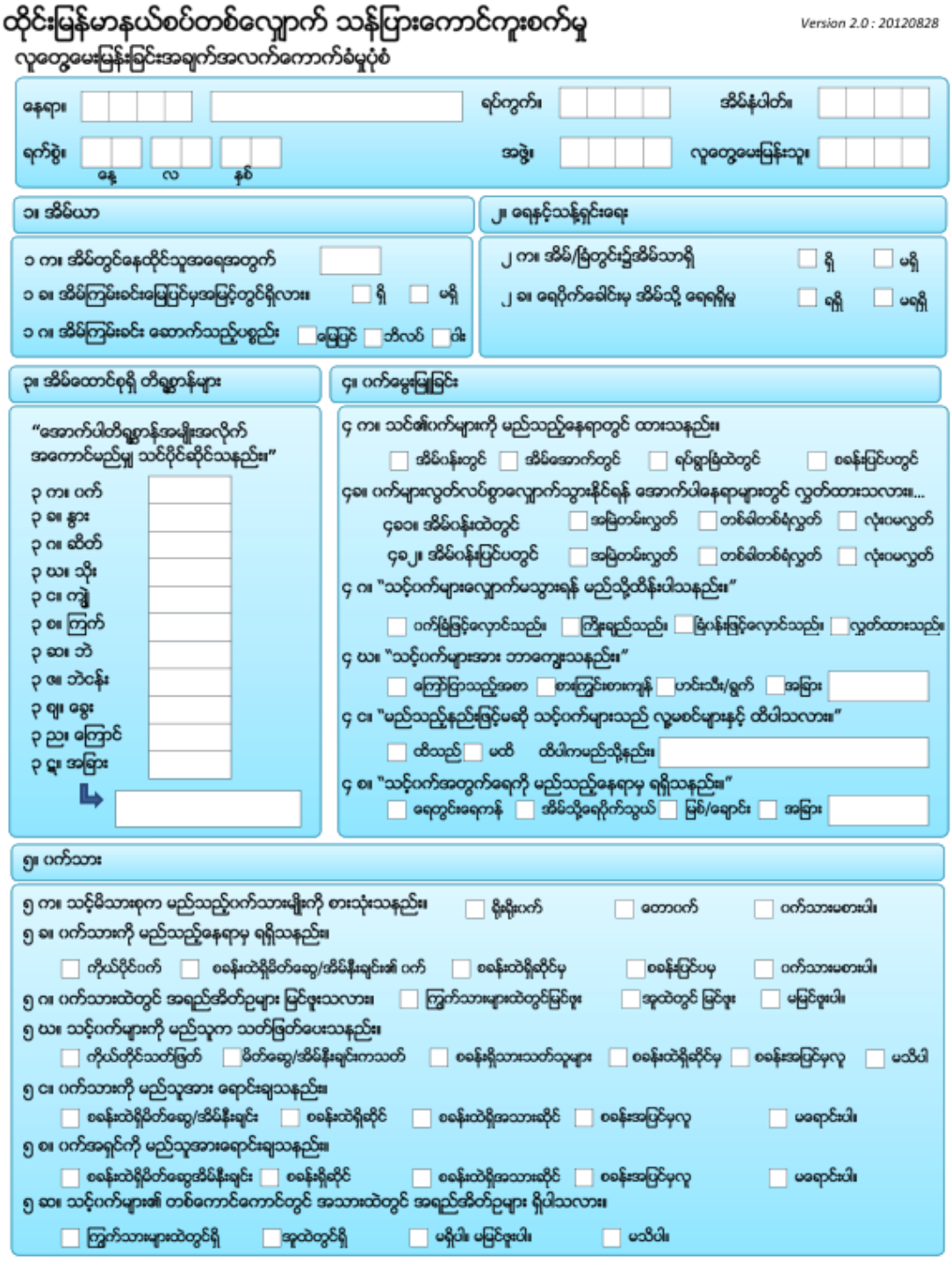
5d. "Who slaughters your pigs?"
☐ Slaughter our own pigs ☐ Friend/neighbor in camp ☐ Butcher in camp ☐ Store in camp ☐ Someone outside camp ☐ Don't know

5e. "Who do you sell pig meat to?"
☐ Friend/neighbor in camp ☐ Store in camp ☐ Butcher in camp ☐ Someone outside camp ☐ Do not sell pig meat

5f. "Who do you sell live pigs to?"
☐ Friend/neighbor in camp ☐ Store in camp ☐ Butcher in camp ☐ Someone outside camp ☐ Do not sell pig meat

5g. "Have any of your pigs ever had cysts in the meat?"
☐ Yes, in the muscles ☐ Yes, in the intestines ☐ No, have not seen cysts ☐ Don't know

Household Form – Burmese



ထိုင်းမြန်မာနယ်စပ်တစ်လျှောက် သန်ပြားကောင်ကူးစက်မှု

Version 2.0 : 20120828

လူတွေ့မေးမြန်းခြင်းအချက်အလက်ကောက်ခံမှုပုံစံ

နေရာ၊ ရပ်ကွက်၊ အိမ်နံပါတ်၊

ရက်စွဲ၊ နေ့ လ နှစ် အဖွဲ့၊ လူတွေ့မေးမြန်းသူ၊

၁။ အိမ်ယာ

၁ က။ အိမ်တွင်နေထိုင်သူအရေအတွက်

၁ ခ။ အိမ်ကြမ်းခင်းမြေပြင်မှအမြင့်တွင်ရှိလား။ ရှိ မရှိ

၁ ဂ။ အိမ်ကြမ်းခင်း ဆောက်သည့်ပစ္စည်း မြေပြင် ဘီလပ် ဓါး

၂။ ရေနှင့်သန့်ရှင်းရေး

၂ က။ အိမ်/မြို့တွင်း၌အိမ်သာရှိ ရှိ မရှိ

၂ ခ။ ရေပိုက်ခေါင်းမှ အိမ်သို့ ရေရရှိမှု ရရှိ မရရှိ

၃။ အိမ်ထောင်စုရှိ တိရစ္ဆာန်များ

"အောက်ပါတိရစ္ဆာန်အမျိုးအလိုက် အကောင်မည်မျှ သင်ပိုင်ဆိုင်သနည်း။"

၃ က။ ဂွေး
၃ ခ။ နွား
၃ ဂ။ ဆိတ်
၃ ဃ။ သိုး
၃ င။ ကြွေ
၃ စ။ ကြက်
၃ ဆ။ ဘဲ
၃ ဇ။ ဘဲငန်း
၃ ဈ။ ခွေး
၃ ည။ ကြောင်
၃ ဋ။ အခြား

၄။ ဂက်ခွေးမြွေခြင်း

၄ က။ သင်၏ဂက်များကို မည်သည့်နေရာတွင် ထားသနည်း။
အိမ်ဝန်းတွင် အိမ်အောက်တွင် ရပ်ရွာမြို့ထဲတွင် စခန်းပြင်ပတွင်

၄ခ။ ဂက်များလွတ်လပ်စွာလျှောက်သွားနိုင်ရန် အောက်ပါနေရာများတွင် လွှတ်ထားသလား။...
၄ခ၀။ အိမ်ဝန်းထဲတွင် အမြဲတမ်းလွှတ် တစ်ခါတစ်ရံလွှတ် လုံးဝမလွှတ်
၄ခ၂။ အိမ်ဝန်းပြင်ပတွင် အမြဲတမ်းလွှတ် တစ်ခါတစ်ရံလွှတ် လုံးဝမလွှတ်

၄ ဂ။ "သင့်ဂက်များလျှောက်မသွားရန် မည်သို့ထိန်းပါသနည်း။"
ဂက်မြဲခြင့်လှောင်သည်။ ကြိုးချည်သည်။ မြဲဝန်းခြင့်လှောင်သည်။ လွှတ်ထားသည်။

၄ ဃ။ "သင့်ဂက်များအား ဘာကျွေးသနည်း။"
ကြော်ပြာသည့်အစာ စားကြွင်းစားကျန် ဟင်းသီး/ရွက် အခြား

၄ င။ "မည်သည့်နည်းဖြင့်မဆို သင့်ဂက်များသည် လူမစင်များနှင့် ထိပါသလား။"
ထိသည် မထိ ထိပါကမည်သို့နည်း။

၄ စ။ "သင့်ဂက်အတွက်ရေကို မည်သည့်နေရာမှ ရရှိသနည်း။"
ရေတွင်းရေကန် အိမ်သို့ရေပိုက်သွယ် မြစ်/ချောင်း အခြား

၅။ ဂက်သား

၅ က။ သင့်မိသားစုက မည်သည့်ဂက်သားမျိုးကို စားသုံးသနည်း။ မွှေးဂက် တောဂက် ဂက်သားမစားပါ။

၅ ခ။ ဂက်သားကို မည်သည့်နေရာမှ ရရှိသနည်း။
ကိုယ်ပိုင်ဂက် စခန်းထဲရှိမိတ်ဆွေ/အိမ်နီးချင်း၏ ဂက် စခန်းထဲရှိဆိုင်မှ စခန်းပြင်ပမှ ဂက်သားမစားပါ။

၅ ဂ။ ဂက်သားထဲတွင် အရည်အဆိတ်ဥများ မြင်ဖူးသလား။ ကြွက်သားများထဲတွင်မြင်ဖူး အူထဲတွင် မြင်ဖူး မမြင်ဖူးပါ။

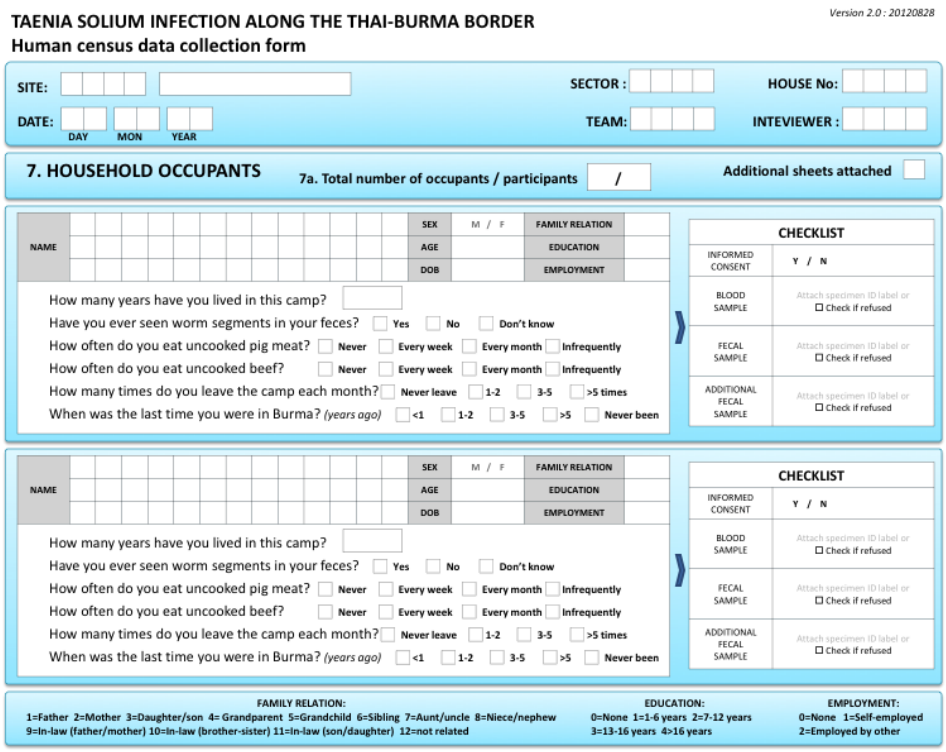
၅ ဃ။ သင့်ဂက်များကို မည်သူက သတ်ဖြတ်ပေးသနည်း။
ကိုယ်တိုင်သတ်ဖြတ် မိတ်ဆွေ/အိမ်နီးချင်းကသတ် စခန်းရှိသားသတ်သူများ စခန်းထဲရှိဆိုင်မှ စခန်းအပြင်မှလူ မသိပါ

၅ င။ ဂက်သားကို မည်သူအား ရောင်းချသနည်း။
စခန်းထဲရှိမိတ်ဆွေ/အိမ်နီးချင်း စခန်းထဲရှိဆိုင် စခန်းထဲရှိအသားဆိုင် စခန်းအပြင်မှလူ မရောင်းပါ။

၅ စ။ ဂက်အရှင်ကို မည်သူအားရောင်းချသနည်း။
စခန်းထဲရှိမိတ်ဆွေအိမ်နီးချင်း စခန်းရှိဆိုင် စခန်းထဲရှိအသားဆိုင် စခန်းအပြင်မှလူ မရောင်းပါ။

၅ ဆ။ သင့်ဂက်များ၏ တစ်ကောင်ကောင်တွင် အသားထဲတွင် အရည်အဆိတ်ဥများ ရှိပါသလား။
ကြွက်သားများထဲတွင်ရှိ အူထဲတွင်ရှိ မရှိပါ။ မမြင်ဖူးပါ။ မသိပါ။

Human Census Form – English



TAENIA SOLIUM INFECTION ALONG THE THAI-BURMA BORDER
Human census data collection form

Version 2.0 : 20120828

SITE: | SECTOR : | HOUSE No:
DATE: DAY MON YEAR | TEAM: | INTEVIEWER :

7. HOUSEHOLD OCCUPANTS — 7a. Total number of occupants / participants / — Additional sheets attached

NAME | SEX M / F | FAMILY RELATION | AGE | EDUCATION | DOB | EMPLOYMENT

How many years have you lived in this camp?
Have you ever seen worm segments in your feces? Yes No Don't know
How often do you eat uncooked pig meat? Never Every week Every month Infrequently
How often do you eat uncooked beef? Never Every week Every month Infrequently
How many times do you leave the camp each month? Never leave 1-2 3-5 >5 times
When was the last time you were in Burma? *(years ago)* <1 1-2 3-5 >5 Never been

CHECKLIST

	Y / N
INFORMED CONSENT	
BLOOD SAMPLE	Attach specimen ID label or ☐ Check if refused
FECAL SAMPLE	Attach specimen ID label or ☐ Check if refused
ADDITIONAL FECAL SAMPLE	Attach specimen ID label or ☐ Check if refused

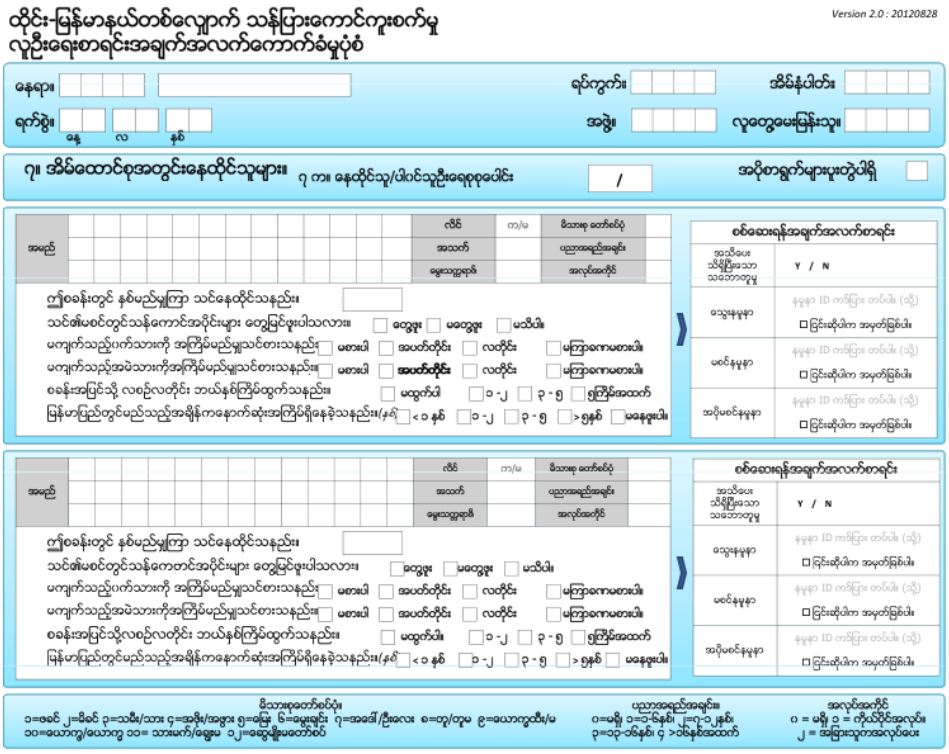
(duplicate of the above)

FAMILY RELATION:
1=Father 2=Mother 3=Daughter/son 4= Grandparent 5=Grandchild 6=Sibling 7=Aunt/uncle 8=Niece/nephew 9=In-law (father/mother) 10=In-law (brother-sister) 11=In-law (son/daughter) 12=not related

EDUCATION:
0=None 1=1-6 years 2=7-12 years 3=13-16 years 4>16 years

EMPLOYMENT:
0=None 1=Self-employed 2=Employed by other

Human Census Form – Burmese



ထိုင်း-မြန်မာနယ်တစ်လျှောက် သန်ပြားကောင်ကူးစက်မှု
လူဦးရေစာရင်းအချက်အလက်ကောက်ခံမှုပုံစံ

Version 2.0 : 20120828

နေရာ။ | ရပ်ကွက်။ | အိမ်နံပါတ်။
ရက်စွဲ။ နေ့ လ နှစ် | အဖွဲ့။ | လူတွေ့မေးမြန်းသူ။

၇။ အိမ်ထောင်စုအတွင်းနေထိုင်သူများ။ ၇ က။ နေထိုင်သူ/ပါဝင်သူဦးရေစုစုပေါင်း / — အပိုစာရွက်များယူတွဲပါရှိ

အမည် | လိင် က/မ | ဒီသားစု တော်စပ်ပုံ | အသက် | ပညာအရည်အချင်း | မွေးသည့်ရာဇမ် | အလုပ်အကိုင်

ဤစခန်းတွင် နှစ်မည်မျှကြာ သင်နေထိုင်သနည်း။
သင်၏မစင်တွင်သန်ကောင်အပိုင်းများ တွေ့မြင်ဖူးပါသလား။ တွေ့ဖူး မတွေ့ဖူး မသိပါ။
မကျက်သည့်ဂက်သားကို အကြိမ်မည်မျှသင်စားသနည်း မစား၊ပါ အပတ်တိုင်း လတိုင်း မကြာခဏစား၊ပါ။
မကျက်သည့်အပဲသားကိုအကြိမ်မည်မျှသင်စားသနည်း မစား၊ပါ **အပတ်တိုင်း** လတိုင်း မကြာခဏစား၊ပါ။
စခန်းအပြင်သို့ လစဉ်လတိုင်း ဘယ်နှစ်ကြိမ်ထွက်သနည်း။ မထွက်ပါ ၁ -၂ ၃ - ၅ ၅ကြိမ်အထက်
မြန်မာပြည်တွင်မည်သည့်အချိန်ကနောက်ဆုံးအကြိမ်ရှိနေခဲ့သနည်း။(နှစ်) < ၀ နှစ် ၀ -၂ ၃ - ၅ > ၅နှစ် မဖေနဖူး၊ပါ။

စစ်ဆေးရန်အချက်အလက်စာရင်း

အသိပေး သိရှိပြီးသော သဘောတူမူ	Y / N
သွေးနမူနာ	နမူနာ ID ကဒ်ပြား တပ်ပါ။ (သို့) ☐ ငြင်းဆိုပါက အမှတ်ခြစ်ပါ။
မစင်နမူနာ	နမူနာ ID ကဒ်ပြား တပ်ပါ။ (သို့) ☐ ငြင်းဆိုပါက အမှတ်ခြစ်ပါ။
အပိုမစင်နမူနာ	နမူနာ ID ကဒ်ပြား တပ်ပါ။ (သို့) ☐ ငြင်းဆိုပါက အမှတ်ခြစ်ပါ။

(duplicate of the above)

ဒီသားစုတော်စပ်ပုံ။
၁=ဖခင် ၂=သမီး/သား ၃=အဖိုး/အဖွား ၄=မြေး/မြေး ၆=မွေးချင်း ၇=အဖေဒါ/ဦးလေး ၈=တူ/တူမ ၉=ယောကျ်ားလေး/မ
၁၀=ယောကျ်/ယောကျ် ၁၁= သားမက်/ဓမ္မေမ ၁၂=ဆွေမျိုးမတော်စပ်

ပညာအရည်အချင်း။
၀=မရှိ ၁=၁-၆နှစ်၊ ၂=၇-၁၂နှစ်၊ ၃=၁၃-၁၆နှစ်၊ ၄ > ၁၆နှစ်အထက်

အလုပ်အကိုင်
၀ = မရှိ ၁ = ကိုယ်ပိုင်အလုပ်။ ၂ = အခြားသူကအလုပ်ခေး

Veterinary Form

TAENIA SOLIUM INFECTION ALONG THE THAI-BURMA BORDER
Veterinary data collection form

Version 2.0 : 20120828

SITE: SECTOR : HOUSE No:

DATE: DAY MON YEAR TEAM: INTEVIEWER :

6. HOUSEHOLD PIG CENSUS

Additional sheets attached ☐

6a. Total number of pigs reported by owner 6b. Total number of pigs found by team

	IDENTIFYING CHARACTERISTICS	SEX (M=Male F=Female)	AGE	TIME OWNED	SOURCE OF PIGLET (I=Inside camp O=Outside of camp)		CONDITION OF PIG (CM=castrated male LF=lactating female PF=pregnant female)			RESTRAINT TYPE (C=corralled T=tied R=roaming)			CONDITION OF CORRAL (A=Adequate (Pig can get out) I=Inadequate (Pig cannot get out))		TONGUE EXAM (+=Positive (cyst present) –=Negative (no cysts))		SPECIMEN ID#
#	Breed, coloring, etc	M / F	months	months	I	O	CM	LF	PF	C	T	R	A	I	+	–	
1																	Attach specimen ID label or ☐ Check if owner refused
2																	Attach specimen ID label or ☐ Check if owner refused
3																	Attach specimen ID label or ☐ Check if owner refused
4																	Attach specimen ID label or ☐ Check if owner refused
5																	Attach specimen ID label or ☐ Check if owner refused
6																	Attach specimen ID label or ☐ Check if owner refused
7																	Attach specimen ID label or ☐ Check if owner refused

Adult Consent Form – English

INFORMED CONSENT TO PARTICIPATE IN A RESEARCH STUDY

INSTITUTIONS:	**MOPH/CDC TUC; IRC Thailand; CMU FMV Thailand; CMU FM Thailand; OHSU USA**
INVESTIGATORS:	**Seth O'Neal, Chris Phares, Hnin Phyu, Prapas Patchanee, Saruda Tiwananthagorn**
STUDY:	**Taenia solium infection along the Thai-Burma border**

ADULT VERBAL CONSENT SCRIPT
(Use for people≥18 years old)

Participant name:

We want to invite you to participate in a research study conducted by the Thailand Ministry of Public health / US Centers for Disease Control Collaboration (TUC), the Faculty of Veterinary Medicine at Chiang Mai University (CMU FMV), the Faculty of Medicine at Chiang Mai University (CMU FM), the International Rescue Committee (IRC), and Oregon Health & Science University (OHSU).

There have been a number of people from communities in Mae Hong Son Province who have been diagnosed with a parasite called *Taenia solium*. This parasite can infect the brain causing seizures, severe headaches and even death. The parasite also infects pigs leaving small cysts in the meat which are dangerous to eat. If you eat these cysts in pork you may get a tapeworm in your intestine, which puts you and your family at risk for getting seizures. We would like to understand how common this disease is in both people and pigs in communities in Mae Hong Son Province. We also want to better understand the ways the disease is spread in these communities in order to design programs to control it.

If you decide to participate we will ask you some questions about your living conditions, whether you own pigs, and how they are raised, sold and eaten. These questions will take about 30 minutes to answer. If you do have pigs, we will examine them to see if they have parasites. We will also ask you to provide a stool sample so that we can test whether there is a tapeworm living in your intestine. If we find that you have a tapeworm or other harmful parasite in your intestine we will give you medication to treat it. Finally, we will ask you to give a few drops of blood from your finger so that we can test for signs of the parasite in your body. In total we expect that about 2500 people from several different communities will participate in this investigation.

Your participation is voluntary and you may choose not to participate. You can also ask questions anytime, or decide to stop participating at any point if you don't want to continue. We will not share your name or your information with anyone else.

Would you like to participate in this evaluation?

☐ Yes, I want to participate.

☐ No, I do not want to participate.

☐ Yes, I agree that my children can participate.

☐ No, I do not want my children to participate.

Names of participating children:

1 _____

2 _____

3 _____

4 _____

5 _____

6 _____

_____ _____

Signature of person obtaining verbal consent Date

သုတေသနပြုလေ့လာခြင်းတွင်ပါဝင်ရန် အသိပေးသိရှိပြီးသောသဘောတူညီချက်

အဖွဲ့အစည်းများ။	MOPH/CDC TUC; IRC ထိုင်းနိုင်ငံ။ CMU FMV ထိုင်းနိုင်ငံ။ CMU FM ထိုင်းနိုင်ငံ။ OHSU အမေရိကန်နိုင်ငံ။
စုံစမ်းစစ်ဆေးသူများ။	ဆက်သ် အို နီးလ်။ ခရစ် ဖာရက်စ်၊ နင်းဖြူ၊ ပရာပတ်စ် ပတ်ခဲ့နီး။ ဆရူဒါ တိပါနန်ထာဂွန်။
လေ့လာချက်။	ထိုင်း-မြန်မာနယ်စပ်တစ်လျှောက် သန်ပြားကောင်ကူးစက်မှု။

အရွယ်ရောက်ပြီးသူ၏ နှုတ်ဖြင့်သဘောတူညီမှုစာလွှာ
(၁၈နှစ်နှင့်အထက်ရှိသည့်လူများအတွက်သုံးရန်)

ပါဝင်သူအမည်။

ထိုင်းပြည်သူ့ကျန်းမာရေးပန်ကြီးဌာန/ရောဂါထိန်းချုပ်ပူးပေါင်းလုပ်ဆောင်ရေး အမေရိကန်ဌာနများ (TUC)၊ ချင်းမိုင်တက္ကသိုလ် တီရွှာန်ဆေးပညာဌာန (CMU FMV)၊ ချင်းမိုင်တက္ကသိုလ်ဆေးပညာဌာန (CMU FM)၊ အပြည်ပြည်ဆိုင်ရာကယ်ဆယ်ရေးကော်မတီ(IRC)နှင့် အော်ရေဂွန်ကျန်းမာရေးနှင့်သိပ္ပံတက္ကသိုလ် (OHSU) တို့ကပြုလုပ်သည့် သုတေသနလေ့လာမှုတစ်ခုတွင်ပါဝင်ရန် သင့်အားကျွန်ုပ်တို့ ဖိတ်ခေါ်လိုပါသည်။

ဝဲဟောင်ဆောင်ပြည်နယ်ရှိ ရပ်ရွာများတွင် *Taenia solium (သန့်ပြားကောင်) ခေါ်* ကပ်ပါးကောင်ရှိသည်ဟုရှာဖွေတွေ့ရှိသူများရှိနေပါသည်။ ထိုကပ်ပါးကောင်သည် ဦးနှောက်တွင်ပိုးပင်စေပြီး ဂက်ခူးပြန်ရောဂါ၊ ပြင်းထန်စွာခေါင်းကိုက်ခြင်းနှင့် အသက်ပင်သေစေခြင်းတို့ကို ဖြစ်ပေါ်စေပါသည်။ ၎င်းကပ်ပါးကောင်သည် ဂက်များတွင်လည်းကူးစက်ကာ အသားထဲတွင်အရည်အိတ်ငယ်လေးများဥဒရဖထားခဲ့သဖြင့် ထိုအသားသည် စားသုံးရန်အန္တရာယ်ရှိသည်။ အကယ်၍သင်သည် ထိုဂက်သားထဲရှိ အရည်အိတ်များကိုစားမိပါက သင်၏အူထဲတွင် တုတ်ပြားကောင်တစ်ကောင်ရရှိနိုင်ပြီး သင်နှင့်သင့်မိသားစုအား ဂက်ရှုပြန်ရောဂါရရှိမည့်အန္တရာယ်ကျရောက်စေနိုင်ပါသည်။ ကျွန်ုပ်တို့သည် ဝဲဟောင်ဆောင်ရှိ ရပ်ရွာများအတွင်းရှိ လူများနှင့်ဂက်များတွင် ဤရောဂါမည်မျှဖြစ်လေ့ဖြစ်ထရှိသည်ကို သိရှိနားလည်လိုပါသည်။ ထိုရောဂါကို ထိန်းချုပ်မည့် အစီအစဉ်များ ဒီဇိုင်းရေးဆွဲရန်အတွက် ဤရပ်ရွာများအတွင်း ဤရောဂါပြန့်နှံပုံများကိုလည်း ပို၍ကောင်းစွာ သိရှိနားလည်လိုပါသည်။

အကယ်၍သင်ပါဝင်ရန်ဆုံးဖြတ်ပြီးပါက သင်၏နေထိုင်မှုအခြေအနေများအကြောင်း၊ သင့်တွင်ကိုယ်ပိုင်ဂက်များရှိမရှိနှင့် ထိုဂက်များကို မည်သို့မွေးမြူသည်၊ ရောင်းချ စားသုံးသည်ဆိုသည့်အကြောင်း မေးခွန်းအချို့ကို သင့်အား ကျွန်ုပ်တို့မေးမြန်းပါမည်။ ထိုမေးခွန်းများကိုဖြေရန် ပီနစ် ခုဝမျှ ကြာမြင့်ပါမည်။ အကယ်၍သင့်တွင် ဂက်များရှိပါက ဂက်များတွင် ကပ်ပါးကောင်များရှိမရှိကျွန်ုပ်တို့ စစ်ဆေးပေးပါမည်။ သင်၏အူထဲတွင်လည်း တုတ်ပြားကောင်ရှိမရှိစစ်ဆေးနိုင်ရန်အတွက် သင်၏မစင်နမူနာတစ်ခုကိုပေးရန် သင့်အားတောင်းခံပါမည်။ အကယ်၍သင်၏အူထဲတွင် တုတ်ပြားကောင် သို့မဟုတ် အခြားအန္တရာယ်ရှိသည့်ကပ်ပါးကောင်များရှိကြောင်း ကျွန်ုပ်တို့တွေ့ရှိပါက ၎င်းကိုကုသရန် သင့်အား ကျွန်ုပ်တို့ဆေးပေးပါမည်။ နောက်ဆုံးအနေဖြင့် သင့်ခန္ဓာကိုယ်ထဲတွင်ကပ်ပါးကောင်လက္ခဏာများရှိမရှိစစ်ဆေးနိုင်ရန် သင်၏လက်ချောင်းထိပ်မှ သွေးစက်အနည်းငယ်ကိုပေးရန် တောင်းခံပါမည်။ ဤပူးစပ်းလေ့လာခြင်းတွင် ရပ်ရွာအသီးသီးမှစုစုပေါင်း လူ ၂၅၀၀ ခန့် ပါဝင်ကြမည်ဖြစ်သည်။

သင်၏ပါဝင်မှုသည် မိမိအလိုဆန္ဒအရသာဖြစ်ပြီး မပါဝင်ရန်လည်းရွေးချယ်နိုင်ပါသည်။ မည်သည့်အချိန်တွင်မဆို မေးခွန်းများမေးနိုင်ပါသည်။ သို့မဟုတ် ဆက်လက်ပါဝင်လိုခြင်းမရှိတော့ပါကလည်း မည်သည့်အရှိန်တွင်မဆို ပါဝင်ခြင်းမှရပ်နားရန် ဆုံးဖြတ်နိုင်ပါသည်။ သင်၏ သတင်းအချက်အလက်များကို မည်သူကိုမှ မျှဝေပြောပြမည်မဟုတ်တော့ပါ။

ဤဆန်းစစ်သုံးသပ်ခြင်းတွင် သင်ပါဝင်လိုပါသလား။

□ ဟုတ်ကဲ့၊ ကျွန်ုပ်ပါဝင်လိုပါသည်။
□ ဟင့်အင်း။ ကျွန်ုပ်မပါဝင်လိုပါ။

□ ဟုတ်ကဲ့၊ ကျွန်ုပ်၏ ကလေးများပါဝင်နိုင်ရန် သဘောတူပါသည်။
□ ဟင့်အင်း။ ကျွန်ုပ်၏ ကလေးများပါဝင်နိုင်ရန် သဘောမတူပါ။

ပါဝင်သည့်ကလေးများ၏အမည်၊
၁။ _____
၂။ _____
၃။ _____
၄။ _____
၅။ _____
၆။ _____

_____ _____
နှုတ်ဖြင့်သဘောတူညီမှုရယူသူ၏ လက်မှတ် ရက်စွဲ

Minor Assent Form – English

INFORMED CONSENT TO PARTICIPATE IN A RESEARCH STUDY

INSTITUTIONS:	**MOPH/CDC TUC; IRC Thailand; CMU FMV Thailand; CMU FM Thailand; OHSU USA**
INVESTIGATORS:	**Seth O'Neal, Chris Phares, Hnin Phyu, Prapas Patchanee, Saruda Tiwananthagorn**
STUDY:	**Taenia solium infection along the Thai-Burma border**

MINOR VERBAL ASSENT SCRIPT
(Use for people≤17 years old)

Participant name:

We are inviting you to participate in a research study. There have been a number of people from this area who have a parasite called *Taenia solium*. This parasite can make people sick or even die. The parasite can also live in pigs which makes the meat dangerous to eat. We want to understand how many people in your community have this parasite so we can figure out how to keep more people from getting sick.

If you want to participate in the investigation we will poke your finger to collect a few drops of blood. We will also ask you to give a stool sample in a plastic cup. We will test the blood drops and stool to see whether you have the parasite. If you do have the parasite we will give you medicine to treat it.

You don't have to participate if you don't want to. If you do want to participate we will ask your parents to make sure that it is okay. You can ask us questions if you don't understand.

Would you like to participate?

☐ Yes, I want to participate.

- ☐ Parent or guardian consents to participation of their child.
- ☐ Parent or guardian denies participation of their child.

☐ No, I do not want to participate.

_____ _____
Signature of person obtaining verbal consent Date

Minor Assent Form – Burmese

သုတေသနပြုလေ့လာခြင်းတွင်ပါဝင်ရန် အသိပေးသိရှိပြီးသောသဘောတူညီချက်

အဖွဲ့အစည်းများ။	MOPH/CDC TUC; IRC Thailand; CMU FMV Thailand; CMU FM Thailand; OHSU USA
စုံစမ်းစစ်ဆေးသူများ။	ဆက်သ် အို နီးဂ်၊ ခရစ် ဖာရက်စ်၊ နင်းဖြူ၊ ပရာပတ်စ် ပတ်ဒ်နီး။ ဆရူဒါ တိပါနန်ထာဂွန်။
လေ့လာချက်။	ထိုင်း-မြန်မာနယ်စပ်တစ်လျှောက် သန်ပြားကောင်ကူးစက်မှု။

ငယ်ရွယ်သူ၏ နှုတ်ဖြင့်သဘောတူညီမှုစာလွှာ
(၁နှစ်အောက်ရှိလူများအတွက်သုံးရန်)

ပါဝင်သူအမည်။

သုတေသနလေ့လာမှုတစ်ခုတွင်ပါဝင်ရန် သင့်အားကျွန်ုပ်တို့ ဖိတ်ခေါ်လိုပါသည်။ ဤရုပ်ရှာဒေသတွင် *Taenia solium (သန်ပြားကောင်) ခေါ်* ကပ်ပါးကောင်ရှိသည်ဟုရှာဖွေတွေ့ရှိသူများရှိနေပါသည်။ ဤကပ်ပါးကောင်က လူများအားဗျားနာစေပြီး အသက်ပင်သေစေနိုင်ပါသည်။ ၎င်းကပ်ပါးကောင်သည် ဂက်များ၏ခန္ဓာကိုယ်တွင်း၌လည်းအသက်ရှင်နိုင်သဖြင့် အသားကိုစားသောက်ရန် အန္တရာယ်ဖြစ်စေသည်။ သင်၏ ရပ်ရွာဒေသအတွင်းရှိလူအများအား ဗျားနာခြင်းကင်းဝေးအောင်မည်သို့လုပ်ဆောင်နိုင်မည်ကိုဖော်ထုတ်နိုင်ရန် သင့်ဒေသရှိလူမည်မျှတွင် ဤကပ်ပါးကောင်ရှိသည်ကို ကျွန်ုပ်တို့သိရှိနားလည်လိုပါသည်။

အကယ်၍ သင်သည်ဤစူးစမ်းလေ့လာရေးတွင်ပါဝင်လိုပါက သွေးစက်အနည်းငယ်ရရှိရန် သင့်လက်ချောင်းကို သွေးဖောက်ပါမည်။ သင်၏ မစင်နမူနာကိုလည်း ပလပ်စတစ်ခွက်တစ်ခုတွင်ထည့်၍ပေးရန်သင့်အားတောင်းဆိုပါမည်။ သင့်တွင် ကပ်ပါးကောင်ရှိမရှိကိုသိရှိရန် သွေးစက် အနည်းငယ်နှင့်မစင်ကို ကျွန်ုပ်တို့စစ်ဆေးပါမည်။ အကယ်၍ သင့်တွင်ကပ်ပါးကောင်များရှိပါက ကုသရန်သင့်အားဆေးပေးပါမည်။

အကယ်၍ သင်မလိုလားပါက ပါဝင်ရန်မလိုပါ။ အကယ်၍သင်ပါဝင်လိုပါက ပါဝင်ရန်သင့်မသင့်ကို သင့်မိဘများအားမေးမြန်းပါမည်။ အကယ်၍ သင်နားမလည်ပါက ကျွန်ုပ်တို့အား မေးခွန်းများမေးမြန်းနိုင်ပါသည်။

သင်ပါဝင်လိုပါသလား။

□ ဟုတ်ကဲ့။ ကျွန်ုပ်ပါဝင်လိုပါသည်။

□ မိဘသို့မဟုတ် အုပ်ထိန်းသူမှ ၎င်းတို့သားသမီး၏ပါဝင်မှုကို သဘောတူပါသည်။
□ မိဘသို့မဟုတ် အုပ်ထိန်းသူမှ ၎င်းတို့သားသမီး၏ပါဝင်မှုကို ငြင်းဆိုပါသည်။

□ ဟင့်အင်း။ ကျွန်ုပ်မပါဝင်လိုပါ။

_____ _____

နှုတ်ဖြင့်သဘောတူညီမှုရယူသူ၏ လက်မှတ် ရက်စွဲ

Appendix II: Complete descriptive statistics

Variable	Taeniasis-Negative (n = 561)		Taeniasis-Positive (n = 21)		p-value
	Median (IQR)		Median (IQR)		
Age	18 (8, 35)		47 (32, 65)		0.0001
Number of Residents	5 (4, 6)		5 (4, 7)		0.3001
Years of Education	1 (0, 5)		0 (0, 0)		0.0205
Years Reside	11 (5, 16)		13 (11, 17)		0.009
Number of Pigs	1 (1, 2)		2 (1, 2)		0.5215
	N	Proportion (95% CI)	N	Proportion (95% CI)	p-value
Female	292	0.52 (0.48, 0.57)	9	0.43 (0.22, 0.64)	0.389
Employment					0.045
None	440	0.81 (0.78, 0.84)	13	0.62 (0.41, 0.83)	
Self-Employed	35	0.06 (0.04, 0.09)	4	0.19 (0.02, 0.36)	
Employed by Other	69	0.13 (0.10, 0.15)	4	0.19 (0.02, 0.36)	
Self-Report of Worm Passage					0.000
No	458	0.83 (0.80, 0.86)	5	0.24 (0.05, 0.43)	
Yes	66	0.12 (0.09, 0.15)	15	0.71 (0.52, 0.91)	
Don't Know	29	0.05 (0.03, 0.07)	1	0.05 (0.00, 0.14)	
Eat Raw Pork Ever	145	0.26 (0.22, 0.30)	14	0.67 (0.47, 0.87)	0.000
Eat Raw Beef Ever	137	0.25 (0.21, 0.28)	13	0.62 (0.41, 0.83)	0.000
Eat Pork Outside of Camp					0.025
Never	423	0.77 (0.73, 0.80)	12	0.57 (0.35, 0.79)	
1-2 times per month	61	0.11 (0.08, 0.14)	2	0.10 (0.00, 0.22)	
3-5 times per month	29	0.05 (0.03, 0.07)	4	0.19 (0.02, 0.36)	
> 5 times per month	37	0.07 (0.05, 0.09)	3	0.14 (0.00, 0.30)	
Last In Burma					0.013
Never	176	0.32 (0.28, 0.36)	1	0.05 (0.00, 0.14)	
> 5 years ago	276	0.50 (0.46, 0.54)	17	0.81 (0.64, 0.98)	
<= 5 years ago	97	0.18 (0.14, 0.21)	3	0.14 (0.00, 0.30)	
Eat Regular Pork Meat	537	0.96 (0.94, 0.97)	20	0.95 (0.86, 1.00)	0.915
Eat Boar Meat	288	0.51 (0.47, 0.55)	11	0.52 (0.31, 0.74)	0.925
Don't Eat Pork or Boar Meat	3	0.01 (0.00, 0.01)	0	0.00 (0.00, 0.00)	0.737
Main Floor Elevated	485	0.87 (0.84, 0.90)	16	0.76 (0.58, 0.94)	0.150
Main Floor Cement, Bamboo	545	0.99 (0.98, 1.00)	20	0.95 (0.86, 1.00)	0.181
Latrine in Yard	482	0.86 (0.83, 0.89)	17	0.81 (0.64, 0.98)	0.494
Water From Tap to House	89	0.16 (0.13, 0.19)	2	0.10 (0.00, 0.23)	0.477
Own Pig	431	0.77 (0.73, 0.80)	18	0.86 (0.71, 1.00)	0.341
Own Tongue-Positive Pig*	24	0.04 (0.03, 0.06)	2	0.11 (0.00, 0.26)	0.193
Age Group					0.000
<= 10	190	0.34 (0.30, 0.38)	1	0.05 (0.00, 0.14)	
11-14	49	0.09 (0.06, 0.11)	1	0.05 (0.00, 0.14)	
15-24	103	0.18 (0.15, 0.22)	1	0.05 (0.00, 0.01)	
25-39	104	0.19 (0.15, 0.22)	3	0.14 (0.00, 0.30)	
40-54	54	0.10 (0.07, 0.12)	8	0.38 (0.17, 0.59)	
>=55	61	0.11 (0.08, 0.13)	7	0.33 (0.13, 0.54)	
Seen Pork Cyst in Own Meat*	202	0.38 (0.34, 0.43)	6	0.38 (0.13, 0.62)	0.942

*Descriptive statistics from Primary households only.

Appendix III: Complete univariate logistic regression results

Variable	Primary and Secondary Houses	Primary Houses
No. of Residents	1.32 (1.05, 1.65)	1.33 (1.05, 1.67)
Sex		
Male	Ref	Ref
Female	0.65 (0.24, 1.72)	0.62 (0.22, 1.69)
Years of Education	0.86 (0.70, 1.05)	0.86 (0.70, 1.06)
Employment		
None	Ref	Ref
Self-Employed	1.92 (0.49, 7.60)	1.57 (0.33, 7.59)
Employed by Other	1.83 (0.51, 6.52)	1.84 (0.51, 6.57)
Years Resided in Camp	1.11 (1.01, 1.23)	1.12 (1.01, 1.24)
Seen Worm Segments		
No	Ref	Ref
Yes	23.93 (7.69, 74.43)	24.76 (7.58, 80.91)
Don't Know	5.15 (0.57, 46.81)	5.44 (0.58, 50.61)
Eat Raw Beef		
No	Ref	Ref
Infrequently	4.07 (1.42, 11.70)	4.06 (1.38, 11.99)
Monthly	0.00 (0.00, 0.01)	0.00 (0.00, 0.01)
Weekly	32.30 (1.78, 586.01)	33.09 (1.81, 604.37)
Eat Raw Pork Ever		
No	Ref	Ref
Yes	7.08 (2.22, 22.57)	7.86 (2.25, 27.38)
Eat Raw Beef Ever		
No	Ref	Ref
Yes	4.22 (1.50, 11.87)	4.21 (1.46, 12.16)
Eat Pork Outside of Camp		
Never	Ref	Ref
1-2 Times Per Month	1.12 (0.23, 5.53)	1.15 (0.23, 5.74)
3-5 Times Per Month	4.32 (1.00, 18.71)	4.20 (0.91, 19.47)
> 5 Times Per Month	2.84 (0.64, 12.55)	2.94 (0.65, 13.36)
Eat Pork Outside of Camp Ever		
No	Ref	Ref
Yes	0.86 (0.19, 3.96)	0.88 (0.19, 4.10)
No. of Pigs Own	0.94 (0.76, 1.17)	0.92 (0.73, 1.18)
Eat Regular Pork Meat		
No	Ref	Ref
Yes	1.07 (0.16, 7.22)	1.02 (0.15, 6.89)
Eat Boar Meat		
No	Ref	Ref
Yes	0.73 (0.28, 1.90)	0.70 (0.26, 1.88)
Main Floor Elevated		
No	Ref	Ref
Yes	0.64 (0.20, 2.03)	0.63 (0.20, 1.99)
Main Floor Cement or Bamboo		
No	Ref	Ref

Yes	0.20 (0.04, 1.08)	0.20 (0.04, 1.06)
Latrine in Yard		
No	Ref	Ref
Yes	0.37 (0.12, 1.17)	0.36 (0.11, 1.13)
Water From Tap to House		
No	Ref	Ref
Yes	0.47 (0.10, 2.10)	0.48 (0.11, 2.16)
Owns Pig		
No	Ref	Ref
Yes	1.44 (0.41, 5.10)	1.40 (0.39, 5.00)
Owns Tongue-Positive Pig		
No	Ref	Ref
Yes	2.68 (0.84, 8.56)	2.43 (0.60, 9.76)
Age Group		
<= 10	Ref	Ref
11-14	4.77 (0.32, 71.63)	4.80 (0.32, 72.54)
15-24	3.21 (0.21, 49.84)	3.24 (0.21, 50.42)
25-39	8.77 (0.89, 86.28)	8.78 (0.89, 86.64)
40-54	30.67 (3.69, 255.05)	28.09 (3.26, 242.16)
>=55	20.49 (2.53, 166.05)	20.53 (2.53, 166.88)
Eats Raw Meat Ever		
No	Ref	Ref
Yes	6.07 (1.87, 19.74)	6.23 (1.83, 21.20)
Last in Burma		
Never	Ref	Ref
> 5 years ago	8.84 (1.22, 64.12)	8.69 (1.18, 63.94)
<= 5 years ago	4.45 (0.44, 44.73)	4.30 (0.41, 45.07)
Seen Cysts in Own Pork		
No	Ref	Ref
Yes	1.28 (0.46, 3.52)	1.19 (0.41, 3.44)