

Taenia solium taeniasis and cysticercosis in three communities in north Vietnam

R. Somers¹, P. Dorny^{1,2}, V. K. Nguyen³, T. C. T. Dang⁴, B. Goddeeris^{5,1}, P. S. Craig⁶ and J. Vercruysse¹

¹ Laboratory of Parasitology, Faculty of Veterinary Medicine, Ghent University, Merelbeke, Belgium

² Institute of Tropical Medicine Antwerp, Belgium

³ National Institute of Veterinary Research, Hanoi, Vietnam

⁴ National Institute of Malaria, Parasitology and Entomology, Hanoi, Vietnam

⁵ Laboratory of Physiology and Immunology of Domestic Animals, Faculty of Agriculture and Applied Biological Sciences, K.U. Leuven, Belgium

⁶ Biosciences Research Institute, University of Salford, UK

Summary

OBJECTIVES (1) To investigate the response to a serum antigen-detecting ELISA for cysticercosis and a stool coproantigen test for taeniasis in two rural communities (mountainous and coastal areas) and one group of (peri-)urban factory workers; and (2) to examine clinical features of human cysticercosis in northern Vietnam.

METHODS Villagers and factory workers and their families were informed and invited to participate in the study. Blood and faecal samples were collected from the participants and a simple questionnaire on taeniasis/cysticercosis completed. Serum was examined for the presence of circulating cysticercus antigen by a monoclonal-based sandwich ELISA. Ag-ELISA positive persons underwent a clinical examination and a computed tomography (CT) scan. Stool samples were examined microscopically for the presence of *Taenia* eggs and for copro-antigens. Tapeworms were identified following therapeutic expulsion using morphology and PCR-RFLP.

RESULTS Circulating cysticercus antigens, suggesting active infection, were detected in 5.3% (16/303), 0.6% (1/175) and 0.0% (0/229) of the sampled individuals from the mountainous, coastal and urban regions, respectively. Clinical examination and CT scan of the cysticercus antigen positive persons showed that active cysticercosis did not cause severe disease in most cases. *Taenia* copro-antigens were found in 0.3% (1/297), 1.8% (3/166) and 0.0% (0/228) of the stool samples from the mountainous, coastal and urban communities, respectively. Three tapeworms were expelled after treatment: two *Taenia solium* and one *Taenia saginata*.

CONCLUSION This survey points to a focal distribution of taeniasis/cysticercosis and suggests that human cysticercosis is rather acquired due to close contact with a *T. solium* carrier and self-infection, than through infection from the environment.

keywords cysticercosis, taeniasis, epidemiology, northern Vietnam

Introduction

Cysticercosis, caused by the larval stage of *Taenia solium*, is a serious health problem in many developing countries (Garcia *et al.* 1993; Craig *et al.* 1996; Schantz 2002). Humans are the only final host of *T. solium*, developing a tapeworm infection, following the ingestion of raw or undercooked contaminated pork. *Taenia* eggs are passed with the stools and contaminate the environment (Schantz *et al.* 1993). When eggs are ingested by pigs or man, larvae may develop throughout the body. In man most clinical symptoms are induced when cysticerci become established in the central nervous

system (Garcia *et al.* 1993; Prabhakar & Singh 2002). Nevertheless, a considerable proportion of cysticercosis patients never develop clinical symptoms (Sanchez *et al.* 1999; Garcia-Noval *et al.* 2001; Fleury *et al.* 2003; Garcia *et al.* 2003).

Cysticercosis and taeniasis are endemic in Asian countries where village pigs are raised (Rajshekhkar *et al.* 2003). Reviewing the available international and national literature, Willingham *et al.* (2003) concluded that human cysticercosis is a serious health problem in Vietnam, but that more studies are needed to estimate the true prevalence and disease burden. Only one detailed human cysticercosis community-based study has been published,

R. Somers *et al.* **Taeniasis and cysticercosis in Vietnam**

confirming the suspicion of an important focus in a village in Bac Ninh province, in the Red River delta (Erhart *et al.* 2002). Reports on taeniasis show prevalences between 0.1% and 7.2% (Willingham *et al.* 2003).

In this study we present the results of two community-based surveys in rural areas and one factory-based survey in a (peri-)urban area on *T. solium* taeniasis and cysticercosis. We assumed different levels of transmission in these study areas because general development and sanitation differ between these regions. In addition, the clinical features of cysticercosis circulating antigen-positive persons were examined.

Materials and methods

Study sites

The study sites were selected based on previous reports of cases of porcine cysticercosis (rural areas), on their accessibility and on the willingness of the representatives of the communities and factory as well as health officials to participate in the study.

Community-based studies were performed in Thuong Giao community, in the mountainous province of Bac Kan, and in three villages of Cuong Gian community, in the coastal province of Ha Tinh. Thuong Giao is located about 250 km north of the capital Hanoi (22°26'N, 105°44'E) and has a population of approximately 3300 inhabitants. The inhabitants are mainly rice growing farmers who keep a few pigs in the backyard. Many pigs are allowed to roam freely. Sanitary facilities are deficient; latrines are made from bamboo, often next to the animal pens. Houses are widespread in the valley and up hill. The population density is approximately 61/km² (Vietnam Administrative Atlas 2003).

Cuong Gian is located 300 km south of Hanoi (18°34'N, 105°50'E). The three selected villages in that community have a population of approximately 1700. Most households are occupied with agricultural-related activities; many middle-aged men work as contract workers. The overall socio-economic standards are better than in the mountainous community. About 30% of households have a toilet. Most families keep pigs in the backyard; older pigs are confined, but piglets can roam freely. Houses are built close to each other, near the main community road. The population density is approximately 455/km² (Vietnam Administrative Atlas 2003).

The factory-based study was done in the capital of Hai Duong Province (20.93°N, 106.32°E). All employees of a factory, mainly women ($n = 278$), and their family members were selected as survey population. Hai Duong town has a population of 127 600 inhabitants. The population

density is 3521/km² in the town and 1002/km² in the rest of the province (Vietnam Administrative Atlas 2003). Due to its location between Hanoi and the harbour town of Hai Phong, industrialization and urbanization are rapid.

Although tap water is widely available in the city and wastewater is drained away in a semi-open sewage system, primitive sanitary conditions can still be found in the centre of the city. Fresh meat and vegetables are bought at the local markets, which are supplied by farmers from the nearby villages. Among the families included in this survey, 25.7% owned pigs.

Surveys

The inhabitants of the selected villages in the mountainous (April 2003) and the coastal (October 2003) communities were informed and invited to participate in the study by the local authorities and health officers. Blood sampling of all age groups and both sexes took place in the community health centres, based on the willingness to participate and after informed consent of the participants. The number of blood samples collected in the studies was determined by the number of inhabitants that presented during the 2 days of sampling. Stool samples were collected at the same place during three consecutive days starting from the first day of blood sampling.

All employees of the factory in Hai Duong were informed and invited to join the study by the leaders of the different sections (June 2004). Blood sampling among the participating employees took place in the factory, based on the willingness to participate and after informed consent of every participant. Stool samples from the employees and their family members were collected at the same place during three consecutive days starting from the first day of blood sampling. Because of logistic reasons no blood samples were taken from family members of the employees.

The blood samples were centrifuged, the serum extracted, aliquoted, and stored at 4–8°C until analyzed (within a week) for circulating antigens. In the rural communities, the stool samples were examined for the presence of *Taenia* and nematode eggs on the day of delivery. In the study in Hai Duong Town, stool samples were transported daily to Hanoi and examined for the presence of helminth eggs on the next day. Approximately 500 µl faecal material was stored in 500 µl PBS with 0.3% Tween 20 at 4°C until examination (within a week) for *Taenia* antigens. All individuals whose stool sample tested positive for *Taenia* antigens received a praziquantel (15 mg/kg) and laxative (Magnesium sulphate, 30 g) treatment, after which all stools were collected during 8 h and examined for the presence of

R. Somers *et al.* **Taeniasis and cysticercosis in Vietnam**

tapeworm material. Recovered proglottids were fixed in ethanol 70% until analysis.

Information on personal eating habits, especially raw pork dishes, the history of passing proglottids, the history of seizures, and the presence of subcutaneous nodules, was obtained by a simple individual questionnaire.

All individuals in the three studies who had an Ag-ELISA positive result were invited to the National Institute of Malariology, Parasitology and Entomology (NIMPE) in Hanoi for an in-depth interview and clinical examination. During this consultation a new blood sample was taken and analyzed for circulating antigens. All these persons underwent a computed tomography (CT) scan in various hospitals in Hanoi. Blind reading of the CT-scans was done by the same radiologist.

The protocol of these surveys was approved by the Ethics Committee of NIMPE, Ministry of Health, Vietnam.

Parasitological techniques

All laboratory tests were performed blinded to the patients' information. Faecal samples were examined for *Taenia* and other helminth eggs with the KATO method as described by Thienpont *et al.* (1986). A copro-antigen ELISA described by Allan *et al.* (1990) was used to detect taeniasis. Samples with an optical density above 0.175 were considered positive. This cut-off was calculated as the mean + 3 SD of a large group of negative control samples.

Proglottids of expelled tapeworms were identified by morphology, using Semichon's acetocarmine staining method (Morgan & Hawkins 1949). For species identification the proglottids were subjected to a Polymerase Chain Reaction, complemented by Restriction Fragment Length Polymorphism analysis (PCR-RFLP) as described by Rodriguez-Hidalgo *et al.* (2002). Two highly specific primer pairs, ITMF/ITMTnR and TAEnF/ITMTnR, were used for the amplification of 370 base pairs (bp) and 890 bp fragments on the mitochondrial 12s rDNA. RFLP of the amplified DNA with the restriction enzymes DdeI and Hpy8I was done for differentiating *T. solium* from *Taenia saginata*, and *T. saginata* from *T. s. asiatica* on the 370 and 890 bp fragments, respectively.

Circulating cysticercus antigen was measured by a monoclonal-based sandwich ELISA (Dorny *et al.* 2002). The optical density of each serum sample was compared with the mean OD of a series of eight negative human serum samples at a probability level of $P < 0.001$ to determine the result in the test (Sokal & Rohlf 1981). The ELISA values are expressed as a ratio by dividing the OD of the test sample by the OD of the cut-off value. An ELISA ratio >1 was considered positive.

Results

A summary of the results of the surveys is given in Table 1. In the two rural communities around 10% of the targeted population participated in the studies. All age categories were covered. More females than males presented for sampling, especially in the working age group. In the factory-based survey more than 80% of the workers, among which 95% females participated in the study. However, only half of these participants provided a stool sample. Eighty-five family members of factory workers also had their stools examined.

Data obtained from the questionnaire showed that eating of raw pork dishes was more common in (peri-)urban Hai Duong than in rural Thuong Giao and Cuong Gian. In contrast, reporting of clinical symptoms suggestive for taeniasis or related to cysticercosis were most common in the rural mountainous Thuong Giao and rare in the coastal Cuong Gian and in Hai Duong city.

In mountainous Thuong Giao 16 individuals (5.3%) were positive for circulating cysticercus antigens. More males were seropositive than females (10/106 *vs.* 6/197). Seropositive individuals were between 14 and 43 years old. Two sero-positives reported seizures and another two had subcutaneous nodules. In coastal Cuong Gian only one individual (0.6%), a 50-year-old man, was positive in the Ag ELISA. In the factory-based study circulating antigens were found in none of the serum samples.

In mountainous Thuong Giao only one tapeworm carrier (0.33%) was identified by both coprological examination and copro-antigen test, a 42-year-old man who had reported to pass proglottids and to eat raw pork dishes. The tapeworm, expelled after praziquantel treatment, was identified as *T. solium* by morphological examination and this was confirmed by PCR-RFLP. In Cuong Gian, three stool samples (1.8%) tested positive in the copro-antigen test, of which two contained *Taenia* eggs on microscopic examination. No *Taenia* eggs were detected in other samples. These two individuals also reported to have seen proglottids in their stool. The three copro-antigen positive samples were from females between 17 and 35 years old, who reported not to eat raw pork dishes. These three persons received praziquantel, after which the stools were collected. A tapeworm was collected only from the two persons that had positive microscopy. One recovered tapeworm was identified as *T. solium*, the other as *T. saginata*, by both morphological examination and PCR-RFLP. In the (peri-) urban study none of the stool samples contained *Taenia* eggs or copro-antigens.

The only tapeworm carrier who was detected in mountainous Thuong Giao had also circulating cysticercus antigens. Three cysticercosis sero-positives in this

R. Somers *et al.* **Taeniasis and cysticercosis in Vietnam****Table 1** Taeniasis/cysticercosis surveys in three areas in north Vietnam: sample composition and results of questionnaire survey and cysticercosis and taeniasis diagnosis

	Thuong Giao	Cuong Gian	Hai Duong
Study site			
Region	Rural mountainous	Rural coastal	(peri-)Urban
Province	Bac Kan	Ha Tinh	Hai Duong
Study population	Community	Community	Factory
Sample size and population			
Blood samples (% of population)	303 (9.6)	175 (10.3)	229 (82.3)
Stools (% of population)	297 (9.0)	166 (9.8)	143 (51.4) + 85*
Age range (years) of the sampled population	4–75	4–74	19–55
Male/female ratio of sampled population	106/197	78/97	11/218
Questionnaire results			
Eating of raw pork dishes	110 (36.3)	28 (16.0)	154 (87.0)
Reported history of passing proglottids (%)	12 (3.9)	4 (2.3)	1 (0.4)
Reported history of seizures	35 (11.6)	0 (0.0)	0 (0.0)
Subcutaneous nodules	8 (2.6)	0 (0.0)	1 (0.4)
Cysticercosis			
Ag-ELISA positives (%)	16 (5.3)	1 (0.6)	0 (0.0)
Taeniasis			
Positives by coprological examination (%)	1 (0.3)	2 (1.2)	0 (0.0)
Positives by copro-Ag test (%)	1 (0.3)	3 (1.8)	0 (0.0)
<i>Taenia</i> recovery post-treatment	1	2	
PCR-RFLP results	<i>Taenia solium</i>	<i>Taenia solium</i> (1), <i>Taenia saginata</i> (1)	
Gastro-intestinal nematodes			
<i>Ascaris lumbricoides</i> (%)	52 (17.5)	125 (75.3)	64 (28.1)
<i>Trichuris trichiura</i> (%)	12 (4.0)	143 (86.1)	84 (36.8)
Hookworms (%)	148 (49.8)	90 (54.2)	4 (1.8)

* Stool samples of family members.

commune had a history of passing proglottids. The only cysticercus antigen positive in coastal Cuong Gian was the father of the *T. solium* carrier.

Infection with gastrointestinal nematodes was common in all study sites. Infection rates of *Ascaris lumbricoides*, *Trichuris trichiura* and hookworms were highest in Cuong Gian. In Thuong Giao about 50% of the sampled individuals passed hookworm eggs with their stools while *Ascaris* and particularly *Trichuris* were less common. In the factory-based study both *Ascaris* and *Trichuris* infections were common while hookworm infection was rare.

From the 16 cysticercus Ag ELISA positive cases in mountainous Thuong Giao, 14 individuals agreed with further examination in Hanoi in December 2003, 9 months after the initial survey. A summary of the results is given in Table 2. In 12 of these persons circulating cysticercus antigens were detected during the follow-up examination; two individuals had become negative. The ELISA ratios were lower than in the initial survey. One of the persons who became negative in the Ag-ELISA had received a 15 mg/kg praziquantel treatment for taeniasis during the initial survey. Clinical examination and CT scan revealed

one case of neurocysticercosis and the presence of subcutaneous cysts in five persons. All these five cases were confirmed to be subcutaneous cysticercosis by biopsy. In seven Ag-ELISA positive persons no evidence of infection by *T. solium* was found. The seizures reported by two patients in the field questionnaire were not confirmed. The Ag positive person in coastal Cuong Gian did not agree with any further examination in Hanoi.

Discussion

This study provides field-based data on taeniasis/cysticercosis in northern Vietnam. The socio-economic situation in this country is changing rapidly and this may have drastic consequences on the transmission of *T. solium*. The present study sites were chosen because they reflect different standards of living of the population. It was hypothesized that conditions for the transmission of *T. solium* were present in the remote mountainous community, i.e. deficient sanitary standards and free roaming of pigs, but that improvement of general standards of living and pig keeping would impede the transmission in the more developed

R. Somers *et al.* **Taeniasis and cysticercosis in Vietnam****Table 2** Community-based survey in Thuong Giao (Bac Kan province) in northern Vietnam: examination and follow-up of antigen-positive individuals

Personal information		Results from community-based survey		Follow-up examination		
Sex	Age	Ag ELISA (RR)	Reported symptoms	Ag-ELISA (RR)	Clinical exam	CT scan
M	24	41.19	SCN	nd	nd	Negative
F	38	35.95	–	2.01	3SCN + HH	Three calcified cysts
M	43	10.47	Seizures	2.72	–	Negative
M	32	5.81	–	1.30	1 SCN	Negative
F	21	4.68	–	1.35	–	Negative
F	40	3.05	–	1.30	–	Negative
M	30	2.61	–	1.59	–	Negative
M	14	2.17	–	1.15	3 SCN	Hypodense reaction
M	42	2.13	–	0.51	1 SCN	Negative
M	28	1.51	SCN	1.27	3 SCN	Negative
M	35	1.40	–	1.08	–	Negative
M	33	1.36	–	0.62	–	Negative
F	34	1.35	–	1.21	Seizures	Negative
F	41	1.31	–	1.23	–	Negative
F	19	1.20	–	nd	nd	Negative
M	38	1.04	Seizures	1.53	HH	Traumatic brain lesion

RR, result ratio; M, male; F, female; nd, not done; SCN, subcutaneous nodules; HH, heavy headache.

coastal community and especially in the urbanised area of Hai Duong. This hypothesis was confirmed in this study as circulating cysticercus antigens were present in 5.3% of the sampled population in Thuong Giao commune (mountainous) while only one person was positive in Cuong Gian (coastal) and no indication of infection was found in Hai Duong town.

We used an antigen-detecting test for measuring infection. Immunodiagnosis of human cysticercosis can be done by both antibody and antigen detecting techniques. Antibody detection tests (ELISA, EITB) are the most appropriate tools for measuring exposure to *T. solium* in sero-epidemiological surveys (Dorny *et al.* 2003). However, the presence of circulating antibodies does not necessarily indicate infection (Garcia *et al.* 2001). Consequently, antibody detection tends to overestimate the prevalence of cysticercosis in endemic areas. In contrast, antigen detection points out infection with viable cysticerci. The Ag-ELISA has proved to be highly sensitive and specific for identifying infected individuals (Erhart *et al.* 2002; Dorny *et al.* 2004a). A hospital-based study in Hanoi showed that circulating antigens were present in 81% of cases of neurocysticercosis, subcutaneous cysticercosis or a combination of both (Nguyen *et al.* 2003).

Nevertheless, the results of these studies must be interpreted cautiously. First, these rural communities were selected because of recent reports of cases of porcine cysticercosis. The investigated communities may therefore

not be representative for the regions. Second, the sample size in the surveys was relatively small and did not always reflect the current age and gender distribution. In all three studies more females than males were sampled. Especially the male working class was underrepresented; a male preference for cysticercosis was found in hospital records in Vietnam (cited by Nguyen *et al.* 2003; Willingham *et al.* 2003), which was confirmed in the present study in Thuong Giao. Finally, in the factory-based study clearly only healthy individuals were sampled. Therefore, the occurrence of cysticercosis in the study area may have been underestimated, as persons with clinical cysticercosis are not likely to work in a factory. Obviously, these methodological issues may have biased the results. Still, the observed trends are clear and suggest a lower infection risk in areas where development has more advanced.

The number of *Taenia* carriers identified in these studies was relatively low (0–1.8%), but was consistent with other studies in Vietnam that used microscopy for diagnosis (0.1–1.6%) (Verle *et al.* 2003; cited by Willingham *et al.* 2003). Both microscopy and a copro Ag ELISA (Allan *et al.* 1990) were used in our survey. Use of the copro Ag ELISA in relatively large field studies increases detection of parasitologically proven intestinal *T. solium* cases by a factor of at least 2.6 in comparison to microscopy (Allan *et al.* 1996). In this study the copro Ag ELISA detected only one more positive case compared to microscopy, and this case could not be confirmed by the treatment and

R. Somers *et al.* **Taeniasis and cysticercosis in Vietnam**

worm recovery method. Although this latter method is not fully reliable (Allan *et al.* 1996), the advantage of using the copro Ag ELISA in this study is questionable. From the 17 persons reporting to have passed proglottids only three were copro-antigen positive, indicating that prevalence of taeniasis determined by self-diagnosis of passing proglottids, e.g. 7.2% in Vietnam (De *et al.* 2001), is probably a serious over-estimation of the true prevalence.

The consumption of traditional dishes with raw pork is considered to be a major risk factor for taeniasis in Vietnam (De *et al.* 1999, 2001; Dorny *et al.* 2004b). Our survey shows that eating these dishes was more common in the urban area than in the rural areas investigated. Although it is obvious that eating these traditional dishes prepared with infected meat holds a high risk for acquiring taeniasis, our results suggest that the popularity of these dishes on itself, might not be the most important factor causing regional differences in taeniasis prevalence in Vietnam. Other dishes containing undercooked pork cannot be excluded as a source of infection.

Comparing the two rural communities, the results of the examination of gastro-intestinal nematode infections suggest a higher environmental faecal contamination in the coastal Cuong Gian compared to the mountainous Thuong Giao. This apparent negative correlation between infection rates with gastro-intestinal nematodes and cysticercosis rates support the results of other studies that close contact with a *T. solium* carrier is probably more important for acquiring cysticercosis than faecal contamination of the environment (Sarti *et al.* 1992; Aranda-Alvarez *et al.* 1995; Schantz 2002). Moreover, family clustering of taeniasis/cysticercosis in this study suggest self- or auto-infection and infection within the family of the carrier.

In contrast to the study in Bac Ninh Province (Erhart *et al.* 2002), where cysticercosis was confirmed by CT scan and biopsy of SCN in all nine examined Ag ELISA positives, only 5 out of 12 Ag positives in this study were confirmed to have cysticercosis by biopsy of subcutaneous cysts, of which one also had cysts in the brain (CT-scan). The low ELISA ratios suggest a low number of cysts. Validation studies of the Ag ELISA are ongoing to determine the association between circulating Ag levels and the number of cysts. We assume that the seven antigen positive individuals without evidence of cysticercosis by biopsy or CT scan, harbour viable cysts in locations other than the brains and the skin. Our study confirms the conclusion that cysticercosis is relatively benign in most cases (Sanchez *et al.* 1999; Garcia *et al.* 2001; Fleury *et al.* 2003).

To conclude, the results of this survey point to a focal distribution of taeniasis/cysticercosis and suggest that general development reduces the transmission of *T. solium*. Human cysticercosis is rather acquired due to close contact

with a *T. solium* carrier and self-infection, than through infection from the environment. Human cysticercosis frequently occurs without brain involvement and consequently clinical symptoms are often lacking. More studies in humans and pigs are needed to determine risk factors, to identify the regions with the highest prevalence and to measure the impact on human health.

Acknowledgements

This study was financed by the Flemish Inter-University Council (VLIR) and the Directorate General of Development Co-operation, Belgium. The authors wish to thank the staff of the Parasitology Department of NIVR, the Clinical Department of NIMPE, the Department of Animal Health of ITM and the Laboratory Department of the Biosciences Research Institute of the University of Salford for technical support, and D. Geysen (ITM) for PCR-RFLP analysis.

References

- Allan JC, Avila G, Garcia-Noval L, Flisser A & Craig PS (1990) Immunodiagnosis of taeniasis by coproantigen detection. *Parasitology* **101**, 473–477.
- Allan JC, Velasquez-Tohom M, Torres-Alvarez R, Yurrita P, Garcia-Noval J. (1996). Field trial of the coproantigen-based diagnosis of *Taenia solium* taeniasis by enzyme-linked immunosorbent assay. *American Journal of Tropical Medicine and Hygiene* **54**, 352–356.
- Aranda-Alvarez JG, Tapia-Romero R, Celis-Quintal G, Grijalva-Otero IE & Correa D (1995) Human cysticercosis: risk factors associated with circulating serum antigens in an open community of San Luis Potosi, Mexico. *Annals of Tropical Medicine and Parasitology* **89**, 689–692.
- Craig PS, Rogan M & Allan JC (1996) Detection, screening and community epidemiology of taeniid zoonoses: cystic echinococcosis, alveolar echinococcosis and neurocysticercosis. *Advances in Parasitology* **38**, 169–250.
- De NV, Son DT, Chuyen LT *et al.* (1999) Helminthic infection in a mountainous commune in Lao Cai Province. *Journal of Malariology, Parasitology and Disease Control* **2**, 73–76.
- De NV, Kim HT, Toan ND *et al.* (2001) Study on epidemiology, diagnosis and treatment of cysticercosis in Bac Ninh Province. *Journal of Malariology, Parasitology and Disease Control* **3**, 87–93.
- Dorny P, Phiri I, Gabriel S, Willingham AL, Speybroeck N & Vercruyse J (2002) A sero-epidemiological study of bovine cysticercosis in Zambia. *Veterinary Parasitology* **104**, 211–215.
- Dorny P, Brandt J, Zoli A & Geerts S (2003) Immunodiagnostic tools for human and porcine cysticercosis. *Acta Tropica* **87**, 79–86.
- Dorny P, Brandt J & Geerts S (2004a) Immunodiagnostic approaches for detecting *Taenia solium* (letter). *Trends in Parasitology* **20**, 259–260.

R. Somers *et al.* **Taeniasis and cysticercosis in Vietnam**

- Dorny P, Somers R, Dang TCT, Nguyen VK & Vercruyse J (2004b) Cysticercosis in Cambodia, Laos, Vietnam. *Southeast Asian Journal of Tropical Medicine and Public Health* 35 (Suppl. 1), 223–226.
- Erhart A, Dorny P, Nguyen VD *et al.* (2002) *Taenia solium* cysticercosis in a village in northern Vietnam: sero-prevalence study using an ELISA for detecting circulating antigen. *Transactions of the Royal Society of Tropical Medicine and Hygiene* 96, 270–272.
- Fleury A, Gomez T, Alvarez I *et al.* (2003) High prevalence of calcified silent NCC in a rural village of Mexico. *Neuro-epidemiology* 22, 139–145.
- Garcia HH, Gilman R, Martinez M & Tsang VCW (1993). Cysticercosis as a major cause of epilepsy in Peru. *Lancet* 341 197–200.
- Garcia HH, Gonzalez AE, Gilman RH *et al.* (2001) Transient antibody response in *Taenia solium* infection in field conditions – a major contributor to high seroprevalence. *American Journal of Tropical Medicine and Hygiene* 65, 31–32.
- Garcia HH, Gilman RH, Gonzales AE *et al.* (2003) Hyperendemic human and porcine *Taenia solium* infection in Peru. *American Journal of Tropical Medicine and Hygiene* 68, 268–275.
- Garcia-Noval J, Moreno E, Mata F *et al.* (2001) An epidemiological study of epilepsy and epileptic seizures in two rural Guatemalan communities. *Annals of Tropical Medicine and Parasitology* 95, 167–175.
- Morgan B & Hawkins P (1949) *Veterinary Helminthology*. Burgess Publishing Company, Minneapolis, Minnesota, pp. 400.
- Nguyen VK, Dang TCT, Somers R *et al.* (2003) *Cysticercosis in Vietnam, current status*. The 4th seminar on Food and Water borne Parasitic Zoonoses, 2–4 December 2003, Bangkok, Thailand, p. 201.
- Prabhakar S & Singh G (2002) *Taenia solium* cysticercosis: an overview of clinical presentations. In *Taenia solium Cysticercosis: from Basic to Clinical Science* (eds G Singh & S Prabhakar) CAB International, Wallingford, pp. 169–176.
- Rajshekhkar V, Joshi DD, Doanh NQ, De NV & Xiaonong Z (2003) *Taenia solium* taeniosis/cysticercosis in Asia: epidemiology, impact and issues. *Acta Tropica* 87, 53–60.
- Rodriguez-Hidalgo R, Geysen D, Benitez-Ortiz W, Geerts S & Brandt J (2002) Comparison of conventional techniques to differentiate between *Taenia solium* and *Taenia saginata* and an improved polymerase chain reaction-restriction fragment length polymorphism assay using a mitochondrial 12S rDNA fragment. *Journal of Parasitology* 88, 1007–1011.
- Sanchez AL, Lindback PM, Schantz PM *et al.* (1999) A population based case-control study of *Taenia solium* taeniasis and cysticercosis. *Annals of Tropical Medicine and Parasitology* 93, 247–258.
- Sarti E, Schantz PM, Plancarte A *et al.* (1992) Prevalence and risk factors for *Taenia solium* taeniasis and cysticercosis in humans and pigs in a village in Morelos, Mexico. *American Journal of Tropical Medicine and Hygiene* 46, 677–685.
- Schantz PM, Cruz M, Sarti E & Pawlowski ZS (1993) Potential eradicability of taeniasis and cysticercosis. *Bulletin of PAHO* 27, 397–403.
- Schantz PM (2002) *Taenia solium* cysticercosis: an overview of the global distribution and transmission. In *Taenia solium Cysticercosis: from Basic to Clinical Science* (eds G Singh & S Prabhakar) CAB International, Wallingford, pp. 63–73.
- Sokal RR & Rohlf JF (1981) *Biometry: the Principles and Practice of Statistics in Biological Research*. WH Freeman Company, New York, p. 859.
- Thienpont D, Rochette F & Vanparijs OFJ (1986) *Diagnosing Helminthiasis by Coprological Examination*, 2nd Edn. Janssens Research Foundation, Beerse, Belgium, pp. 205.
- Verle P, Kongs A, De NV *et al.* (2003) Prevalence of intestinal parasitic infections in northern Vietnam. *Tropical Medicine and International Health* 8, 961–964.
- Vietnam Administrative Atlas, Cartographic Publishing House, Hanoi, Vietnam (2003).
- Willingham AL, De NV, Doanh NQ *et al.* (2003) Current status of cysticercosis in Vietnam. *Southeast Asian Journal of Tropical Medicine and Public Health* 34 (Suppl. 1), 35–50.

Corresponding Author

P. Dorny, Department of Animal Health, Institute of Tropical Medicine Antwerp, Nationalestraat 155 2000 Antwerp, Belgium.
Tel.: +32 3247 6394; Fax: +32 3247 6268; E-mail: pdorny@itg.be

R. Somers *et al.* **Taeniasis and cysticercosis in Vietnam****Taeniasis à *Taenia solium* et cysticercose dans trois communautés du Nord Vietnam**

OBJECTIFS (1) Investiguer la performance d'un test ELISA basé sur des antigènes de cysticercose et un test copro-antigène sur des selles pour la détection de taeniasis dans deux communautés rurales (montagnarde et côtière) et un groupe de travailleurs d'usine péri-urbain, (2) examiner les caractéristiques cliniques de la cysticercose humaine dans le nord du Vietnam.

MÉTHODE Les villageois et travailleurs d'usine ainsi que leurs familles ont été informés et invités à participer à l'étude. Des échantillons de sang et de selles des participants ont été prélevés et un questionnaire simple sur la taeniasis et la cysticercose a été rempli. Les sera ont été examinés pour la présence d'antigènes circulants de cysticercose en utilisant un test ELISA monoclonal en sandwich. Les participants positifs pour l'ELISA ont subi une examination clinique et une tomographie assistée par ordinateur. Les échantillons de selles ont été examinés par microscopie pour la présence d'œufs de taenia et pour la présence de copro-antigènes. Les vers plats ont été identifiés morphologiquement après excrétion suite au traitement et par PCR-RFLP.

RÉSULTATS La présence d'antigènes circulants suggestifs d'infection active, a été détectée respectivement dans 5.3% (16/303), 0.6% (1/175) et 0.0% (0/229) des individus des régions montagneuses, côtières et urbaines. L'examination clinique et la tomographie des individus positifs pour l'antigène de cysticercose ont montré que la cysticercose active, dans la plupart des cas, ne causait pas de maladie sévère. Les copro-antigènes de taenia ont été trouvés respectivement dans 0.3% (1/297), 1.8% (3/166) et 0.0% (0/228) des échantillons de selles des communautés montagnardes, côtières et urbaines. Trois vers plats dont deux *Taenia solium* et un *Taenia saginata* ont été excrétés suite au traitement.

CONCLUSION Cette étude met l'accent sur l'aspect focalisé de la distribution de la taeniasis/cysticercose et suggère que la cysticercose humaine est acquise suite à un contact direct avec un porteur de *T. solium* ou par auto-infection plutôt que par une infection à partir de l'environnement.

Mots clés cysticercose, taeniasis, épidémiologie, le nord du Vietnam

Teniasis por *Taenia solium* y cisticercosis en tres comunidades de Vietnam del Norte

OBJETIVOS (1) Investigar la respuesta a un ELISA detector de antígeno para cisticercosis en suero y una prueba de copro-antígeno en heces para teniasis, en dos comunidades rurales (áreas montañosa y costera) y un grupo de trabajadores en una fábrica (peri-)urbana. (2) Examinar las características clínicas de la cisticercosis humana en Vietnam del norte.

MÉTODOS Aldeanos y trabajadores de la fábrica y sus familiares fueron informados e invitados a participar en este estudio. Se recolectaron muestras de sangre y heces de los participantes y se completó un cuestionario simple sobre teniasis/cisticercosis. El suero se examinó para la presencia de antígeno circulante de cisticercosis utilizando un ELISA sandwich basado en anticuerpos monoclonales. Las personas que dieron positivas para el Ag-ELISA fueron examinadas clínicamente y se tomó una tomografía axial computarizada (TAC). Las muestras de heces se examinaron microscópicamente para la presencia de huevos de *Taenia* y copro-antígenos. Las tenias fueron identificadas morfológicamente y por PCR-RFLP tras expulsión terapéutica.

RESULTADOS Se detectaron antígenos circulares de cisticercosis, sugerentes de infección activa, en 5.3% (16/303), 0.6% (1/175) y 0% (0/229) de los individuos muestreados en las montañas, costa y regiones urbanas respectivamente. Los exámenes clínicos y el TAC de las personas positivas para antígeno de cisticercosis mostraron que la cisticercosis activa no causó enfermedad severa en la mayoría de los casos. Se encontraron copro-antígenos de *Taenia* en 0.3 (1/297), 1.8% (3/166) y 0 (0/228) de las muestras fecales provenientes de las comunidades montañosa, costal y urbana, respectivamente. Tres tenias fueron expulsadas después del tratamiento: dos *Taenia solium* y una *Taenia saginata*.

CONCLUSIÓN Este estudio destaca la distribución focal de las teniasis/cisticercosis, y sugiere que la cisticercosis se adquiere más bien por el contacto cercano de un portador de *T. solium* e infección propia, que a través de infecciones provenientes del ambiente.

Palabras clave cisticercosis, teniasis, epidemiología, Vietnam del norte