

CURRENT STATUS OF CYSTICERCOSIS IN VIETNAM

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Abstract. This English review concerning the current status of cysticercosis in Vietnam has been compiled from various reports of studies conducted over the past 15 years, which have appeared in national publications in Vietnamese, in order to make the information available to the international community. Hospital surveys indicate that cysticercosis is emerging as a serious health problem in the country though most of the information comes from the Hanoi area. Many more men than women are being treated for cysticercosis with most patients being young to middle-aged adults though several juvenile cases have been seen in the south. Clinical manifestations of the disease in humans include subcutaneous nodules, epileptic seizures, severe headache, impaired vision and memory loss. Albendazole has been found to be the best drug for treating cysticercosis though it does not appear to be totally effective for curing cerebral cysts. Information concerning porcine and bovine cysticercosis is very limited and based mostly on passive surveillance at Hanoi slaughterhouses. Surveys for human taeniasis in central and northern provinces indicate a prevalence of 0.2 - 7.2%. However, techniques of low sensitivity were used and the results are inconclusive since it is unknown with which species of tapeworm the people were infected. In addition to *Taenia solium* which causes human cysticercosis, *T. saginata* and *T. asiatica* are also known to be present in Vietnam. Risk factors investigated thus far with regard to transmission of *T. solium* suggest that consumption of raw pork, inadequate or absent meat inspection and control, poor sanitation in some areas, and the use of untreated human waste as fertilizer for crops may play important roles in Vietnam but this remains to be validated. The evidence thus far collected suggests that a national surveillance program for cysticercosis is a great need for Vietnam. The authors recommend further research on the epidemiology and impact of cysticercosis in both human and pig hosts in order to determine whether a prevention and control program in Vietnam would be merited and cost effective.

INTRODUCTION

Cysticercosis caused by the larval form of the zoonotic pork tapeworm, *Taenia solium*, is

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considered to be widespread in developing countries of Latin America, Africa and Asia, particularly prevalent in rural areas in association with poverty and poor sanitation where raw or undercooked pork is consumed and pigs have access to human feces (Sarti *et al.*, 1992; reviewed by Pawlowski and Murrell, 2001). The burden of cysticercosis remains to be understood in many endemic countries often resulting in the disease being neglected at the national level since policies on infectious diseases and their control are primarily evidence based. However, in those countries where

the presence of the disease and its effect on public health and agriculture have been documented the collective impact of cysticercosis has been determined to be substantial (Acevedo-Hernandez, 1982).

People can become infected with the larval form of the parasite by ingesting *T. solium* eggs either from direct contact with a human tapeworm carrier (eg food handlers) or from contaminated food or water, thus one does not have to raise pigs nor consume pork to become infected with cysticercosis (Sarti *et al*, 1992; Schantz *et al*, 1992). The contamination of streams with sewage effluent and use of human sewage or "nightsoil" for fertilizing crops have also been indicated as sources of *Taenia* eggs (Collier and Reilly, 1984; Nansen and Henriksen, 1986; Kyvsgaard *et al*, 1991). In addition, *Taenia* eggs can remain infective in soil samples for over six months supporting the significance of cysticercosis as an environmental health risk (Ilsøe *et al*, 1990).

In Asia, cysticercosis has been reported to be a problem in pork consuming communities in India (Pathak and Gaur, 1989), Nepal (Amatya and Kimula, 1999; Heap, 1990), China (Cao *et al*, 1996) and Indonesia (Bali and Irian Jaya) (Suweta, 1991; Simanjuntak *et al*, 1997; Wandra *et al*, 2000). Coker-Vann and colleagues (1981) reported between 3 to 13% of sera from populations in Micronesia, Myanmar, Vietnam and the Philippines were found to have antibodies to *T. solium*. In Vietnam, the infection has been associated with eating raw pork ("nem chua") which is a common habit among older men especially in rural areas. The prevalence of cysticercosis in Vietnamese pigs was first reported in 1924 (Bernard *et al*, 1924) while Hy and colleagues in 1960 reported on clinical cases of human cysticercosis detected by biopsy of subcutaneous nodules (Hy *et al*, 1960). In recent years, hundreds of cases of neurocysticercosis have been diagnosed and treated at referral hospitals around the country (discussed below) facilitated by the availability of neuroimaging technology.

The emergence of cysticercosis as a health problem in Vietnam has instigated many epi-

demiological investigations during the past decade on *T. solium* and other zoonotic *Taenia* infections (ie *T. saginata* and *T. asiatica*) in both intermediate and definitive hosts by the National Institute of Malariology, Parasitology and Entomology, the National Institute of Veterinary Research and other research institutes. The results of these studies have been published in national journals and reports invariably in Vietnamese. The purpose of this review is to report on the results of these studies and future research needs in English, bringing the evidence together collectively not only for national authorities and scientists but also to make the international community aware of the emerging situation with regard to zoonotic *Taenia* infections in Vietnam, hopefully instigating future collaborations and initiatives.

MATERIALS AND METHODS

Porcine and bovine cysticercosis surveys

Post-mortem assessments of cattle and pig carcasses were conducted by cutting specific muscles and visually inspecting for the presence of cysts. The hip and shoulder muscles as well as the diaphragm and heart were inspected for cysts. In some cases, cysts were examined microscopically and stained using standard methods (details on these and other methods can be obtained from the Department of Parasitology, National Institute of Malariology, Parasitology and Entomology NIMPE, Hanoi). For ante-mortem surveys, pigs were examined by lingual examination whereby the ventral surface of the tongue was inspected for the presence of cysts. In one instance, sera were collected from pigs and tested by a monoclonal based sandwich ELISA for the detection of circulating parasite antigen (Doanh *et al*, 2002).

Human taeniasis surveys

Surveys for taeniasis were conducted utilizing standard fecal examination and detection of proglottids. Stool samples were analyzed by concentration methods (ie formalin-

ether, Kato and Kato-Katz techniques). Details on these methods can be obtained from the Department of Parasitology, NIMPE, Hanoi. In many instances, persons were also recorded as infected even if their fecal examination was negative if they reported having seen or were found to have *Taenia* proglottids on their stools or coming out of their anus. In one case, molecular techniques using amplification through polymerase chain reaction (PCR) of mitochondrial genetic information was used to identify proglottids of a juvenile case of taeniasis (De *et al*, 2001b). For some surveys, data on age, sex and occupation were collected and reported. One study also entailed examining 100 soil samples from the surveyed community for the presence of helminth eggs using the Romanenko method (De *et al*, 2001d).

Human cysticercosis surveys

Surveys for human cysticercosis were based on detection of cases using neuroimaging, biopsies and/or serology. Computerized tomography (CT scanning) was used to detect the presence of cerebral cysts. Detection and biopsy of subcutaneous nodules gave a diagnosis in many cases. In more recent surveys, immunodiagnosics using either an antibody detection ELISA test based on cyst antigen (De *et al*, 1998b) or an antigen detection ELISA test based on monoclonal antibody (De *et al*, 2001d; Erhart *et al*, 2002) have been utilized. For some surveys, data on age, sex and occupation were collected and reported.

Risk factor assessment

Information concerning meat consumption and procurement habits, pig husbandry practices, sanitation (*ie* presence, type, use and location of latrines), hygienic practices, knowledge of the presence and transmission of cysticercosis/taeniasis and use of "nightsoil" for fertilizer was obtained during some taeniasis surveys. In one instance, a randomized KAP study on knowledge, attitudes and practices (KAP) was conducted in a community utilizing a questionnaire (De *et al*, 2001d). The results are summarized, but details on the interview form can be obtained from NIMPE, Hanoi.

Chemotherapeutic trials

Taeniasis patients were treated with niclosamide, quinacrin or praziquantel while cysticercosis patients were treated with praziquantel, albendazole or diethylcarbamazine. Drug dosages and treatment schedules varied. The cure rate of taeniasis was based on expulsion of entire worms including the scolex, which allowed for differentiation. Cure rate of cysticercosis patients was determined at different time periods post-treatment based on clearance of subcutaneous nodules, disappearance of clinical symptoms (*ie* epileptic seizures), clearing of live cysts in the brain and/or elimination of parasite antigens in the blood. Physical examination, patient reporting, CT scanning and serology using antigen-ELISA testing were used to make these determinations.

RESULTS

Pig surveys

A distribution map of porcine cysticercosis is presented in Fig 1. Surveys on porcine cysticercosis have been conducted primarily in northern Vietnam, mostly at slaughterhouses. In a 1989 - 1993 study at slaughterhouses in Hanoi (see Table 1) 2,091,000 pigs were examined for cysticercosis (both *Cysticercus cellulosae*, the larval form of *T. solium*, and *C. tenuicollis*, the larval form of *Taenia hydatigenata*). Overall 799 were found to be infected with *C. cellulosae* (0.038%) and 959 infected with *C. tenuicollis* (0.047%). There was a trend of decreasing incidence of both infections during the time period (0.064%-0.018% for *C. cellulosae*; 0.067% - 0.030% for *C. tenuicollis*). Sites of larvae of *T. solium* in the 799 pig carcasses: 52% of pig had cysts in jaw, head and shoulder muscles, 52% in heart, 36% in tongue, 28% in back muscles, 16% in chest muscles and 4% in abdominal muscles (Thuat and Lang, 1996). During 1989 - 1993 at the Hai Ba Trung district slaughterhouse, which provides 40-50% of the meat consumed in Hanoi, 0.052% pigs (386/737,300) were recorded as positive for *C. cellulosae*

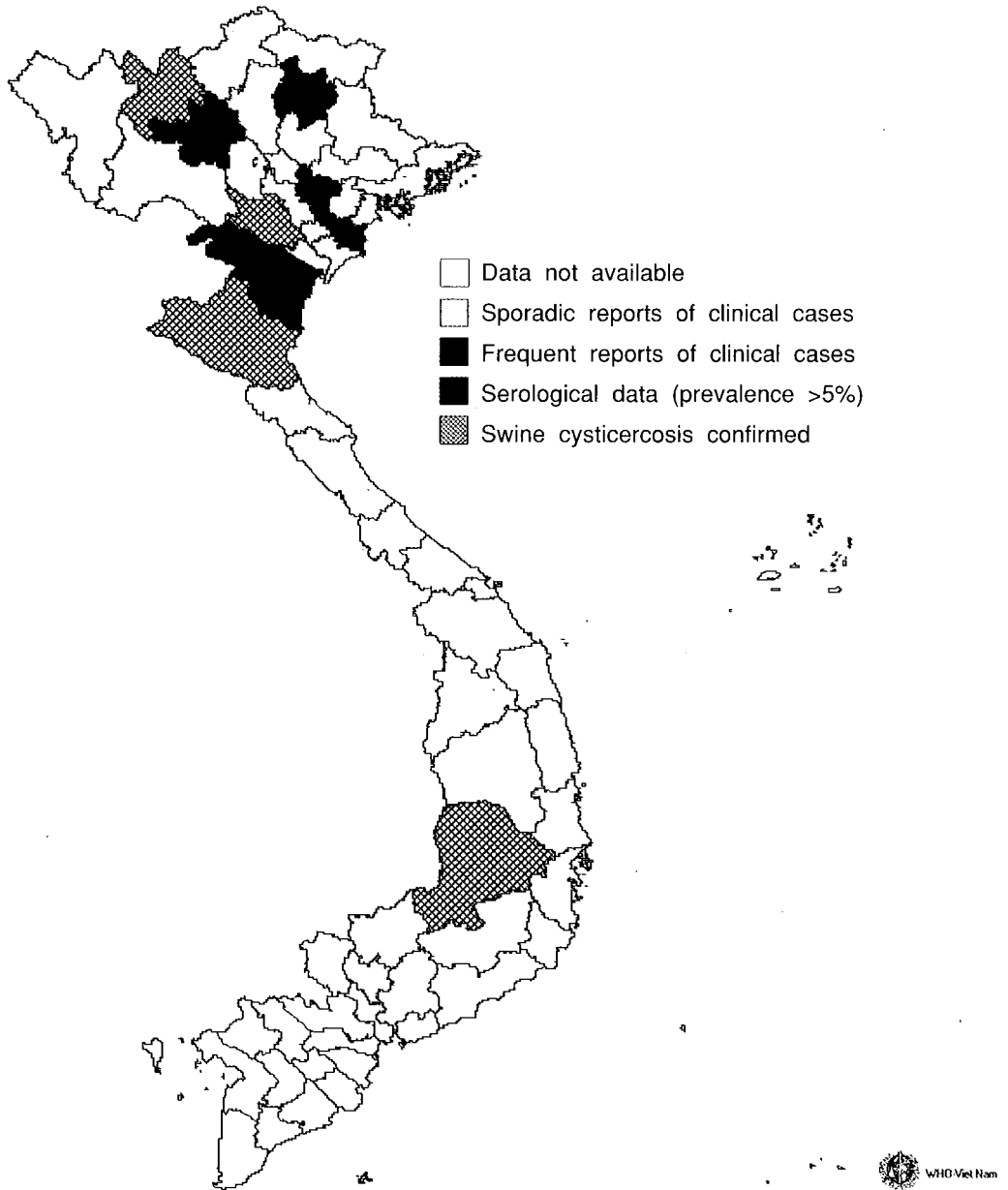


Fig 1—Map of Vietnam showing known endemic sites of *Taenia solium*.

Table 1

Infection of cattle and pigs with cysticercosis recorded at Hanoi slaughterhouses between 1989 - 1993. (Thuat and Lang, 1995; 1996).

Year	Cattle inspected	<i>Cysticercus bovis</i>		Pigs inspected	<i>Cysticercus cellulosae</i>		<i>Cysticercus tenuicollis</i>	
		No. positive	%		No. positive	%	No. positive	%
1989	13,930	7	0.050	379,000	243	0.064	255	0.067
1990	14,190	15	0.105	420,000	245	0.058	157	0.037
1991	24,170	13	0.054	412,000	124	0.030	252	0.061
1992	39,980	2	0.005	348,000	95	0.027	147	0.042
1993	52,120	2	0.004	498,000	92	0.018	148	0.030
Total	144,390	39	0.027	2,057,000	799	0.038	959	0.047

with a decreasing trend in prevalence during the period from 0.085% in 1989 to 0.021% in 1993 (Thuat and Lang, 1995). A survey in Luong Yen slaughterhouse in Hanoi indicated 0.02% (36/180,000) of pigs infected with cysticercosis (De *et al*, 1998a). Between 1999 - 2000 a community-based serological survey on porcine cysticercosis in Bac Ninh and Bac Kan provinces using antigen-ELISA indicated 9.91% of 323 pigs sampled were positive, however 26 of the sampled pigs were necropsied with 10 found positive for *C. tenuicollis* while none were found to be infected with *C. cellulosae* (Doanh *et al*, 2002). In the one reported study on porcine cysticercosis conducted in south Vietnam, a post-mortem survey of 891 pigs from 12 southern provinces in 1998 indicated that 0.9% were positive (8/891) (Huan, 1998).

Cattle surveys

There is very little information concerning bovine cysticercosis in Vietnam. A 1989 - 1993 survey of cattle slaughtered at Hanoi slaughterhouses indicated that 0.027% (39/144,390) of cattle were infected with larvae of *T. saginata* (Thuat and Lang, 1995). A trend of decreasing prevalence during that time period was noted with a high of 0.105% in 1990 decreasing to 0.003% in 1993 (Table 1).

Human surveys

Taeniasis: Three species of *Taenia* infecting

humans have been detected in Vietnam - *T. solium*, *T. saginata* and *T. asiatica*. Several surveys for taeniasis based on microscopy and/or individual reporting of proglottids have been conducted in northern and central Vietnam during the past decade. The results of these surveys (see Table 2) indicate a prevalence range of 0.1 - 7.2% for the provinces surveyed. Bac Ninh Province located east of Hanoi reported the highest prevalence of taeniasis (7.2%).

Individual reporting of proglottids was found to indicate many more cases of taeniasis compared to detection of *Taenia* eggs in stools. An in-depth investigation in Phu Hoa Community of Luong Tai district, Bac Ninh Province indicated that while none of the 288 persons who submitted fecal samples were detected to have *Taenia* eggs in their stools, 12.6% of 230 respondents interviewed indicated that they had seen tapeworm proglottids (De *et al*, 2001d). A study conducted in Hoa Binh Province indicated 0.6% prevalence based on history of proglottid observation while only 0.1% of those surveyed were positive by stool microscopy (De *et al*, 2001c).

An epidemiological study conducted by De *et al* (1998a) in northern provinces of Vietnam indicated a trend of higher prevalence of taeniasis in midland and mountainous regions (2.0 - 6.0%) compared to the plains regions (0.5 - 2.0%). In that study people were

Table 2
Prevalence of taeniasis from different provinces of Vietnam.

Province	Geographical characteristics ^a	No. examined	% infected	Reference
Lao Cai	NH	400	2.8	De <i>et al</i> , 1999
Cao Bang	NH	403	1.2	De <i>et al</i> , 2001a
Hoa Binh	NH	2,686	0.6	De <i>et al</i> , 2001c
Lang Son	NH	364	1.6	De <i>et al</i> , 2001a
Ninh Binh	NC	1,101	0.4	Hung <i>et al</i> , 1999
Ha Noi	NP	6,871	0.7-2.0	Thuat and Lang, 1996
Bac Ninh	NP	597	7.2	De <i>et al</i> , 2001d
Khanh Hoa	CC	3,696	0.2	Chuong <i>et al</i> , 1998
Phu Yen	CC	2,188	2.8	Chuong <i>et al</i> , 1998
Binh Dinh	CC	4,799	0.4	Chuong <i>et al</i> , 1998
Quang Nam	CC	5,068	0.6	Chuong <i>et al</i> , 1998
Dak Lak	CH	1,494	5.3	De <i>et al</i> , 1998b
Dak Lak	CH	1,166	1.1	De <i>et al</i> , 1997

^aNH = Northern Highlands, NC = Northern Coastal, NP = Northern Plain, CC = Central Coastal, CH = Central Highlands.

Table 3
Number and sex of infected persons in Vietnamese hospital and community-based surveys for cysticercosis.

Site	Time Period	Diagnostic criteria ^a	No. infected	% Male	% Female	% < 15 years old ^d	Reference
Hanoi hospitals	1989-1990	B, N	484	65.1	34.9	0.2	Lam and Tan, 1992
Thanh Nhan Hospital, Hanoi	1993	B, N	60 ^b	75.0	25.0	n.d.	De <i>et al</i> , 1998a
Hanoi hospitals	1996	B, N	111	72.1	27.9	0	Nguyen, 1996
Bach Mai Hospital, Hanoi	1996	N	20	80.0	20.0	0	Chap <i>et al</i> , 1999
Ho Chi Minh hospitals	1992-2000	S	163 ^c	56.4	43.6	15.5	Tuan <i>et al</i> , 2001
Bac Ninh Province	1999-2000	B, N, S	26	69.2	30.8	n.d.	De <i>et al</i> , 2001d

^aB = biopsy of subcutaneous nodules, N = neuroimaging (CT scanning), S = serology (antigen detection ELISA).

^b50% were from Bac Ninh Province.

^cincludes patients from Cambodia.

^dn.d. = no data available.

treated for *Taenia* spp and the worms collected and identified indicating that most people with tapeworms (78 - 80%) were infected with the beef tapeworm, *T. saginata*, while only about 20 - 22% were infected with *T. solium*. Of the people found to harbor tapeworms only 22.5% had been found positive for *Taenia* eggs by stool detection.

An interesting case was reported in 2001 (De *et al*, 2001b) when *Taenia* proglottids

collected from a 14 year old boy in Hanoi were determined by molecular studies to have come from a *T. asiatica* tapeworm (De *et al*, 2001b).

Thus far no studies have been conducted aimed at detecting *Taenia* eggs in water or on foodstuffs, however in a recent study on environmental contamination in Bac Ninh Province 2 out of 100 soil samples examined contained *Taenia* eggs (De *et al*, 2001d).

Cysticercosis: A distribution map for human

Table 4

Age and sex distribution of cysticercosis patients treated in Hanoi Hospital in 1989 - 1990 (Lam and Tan, 1992).

Age group	Male		Female		Total	
	Number	%	Number	%	Number	%
0 - 4	0	0	0	0	0	0
5 - 9	0	0	0	0	0	0
10 - 14	1	0.2	0	0	1	0.2
15 - 19	8	1.7	3	0.6	11	2.3
20 - 24	24	5.0	14	2.9	38	7.8
25 - 29	27	5.6	18	3.7	45	9.3
30 - 39	90	18.5	43	8.9	133	27.5
40 - 49	87	18.0	49	10.2	136	28.1
50 - 59	54	11.1	37	7.6	91	18.8
>60	24	5.0	5	1.0	29	6.0
Total	315	65.1	169	34.9	484	100

Table 5

Age distribution of patients seropositive for cysticercosis at Ho Chi Minh Hospital from 1992 - 2000 (Tuan *et al*, 2001).

Age group	Number positive	% of positive cases
0 - 5	6	3.7
6 - 10	7	4.3
11 - 15	9	5.5
16 - 20	11	6.7
21 - 25	12	7.4
26 - 30	24	14.7
31 - 35	15	9.2
36 - 40	26	16.0
41 - 45	12	7.4
46 - 50	10	6.1
51 - 55	9	5.5
56 - 60	9	5.5
61 - 65	6	3.7
66 - 70	5	3.1
>70	2	1.2
Total	163	100

cysticercosis in Vietnam is presented in Fig 1. Most of the information concerning human cysticercosis in Vietnam comes from hospital studies (see Table 3). The results of these studies indicated that the majority of the

cysticercosis patients seen at referral hospitals were male (70% of a total of 727 patients) and over the age of 15 (96.7% in studies where age recorded). An age distribution of cysticercosis patients seen at Hanoi hospitals between 1989 - 1990 indicated that over 50% were between the age of 30 - 50 years of age (Table 4) while a similar distribution was seen in 1996 with 57.6 % of cysticercosis patients being between the ages of 26 - 45 and no cases recorded in the under 15 age group (Nguyen, 1996).

Only one hospital study appears to have been conducted in southern Vietnam (Ho Chi Minh City) indicating a more equitable sex distribution with several juvenile cases compared to data from the referral hospitals in the north (see Table 5). The mean age of patients was 33.6 with a range of 1 - 79 years. The highest number of infected persons was between the ages of 26 - 40. Patients came from many different localities including northern provinces and Cambodia. The incidence of cysticercosis was noted to be high in those coming from Ho Chi Minh City (19.7%), and the southern provinces of An Giang (14.1%), Tay Ninh (8.5%) and Dong Nai (7%) (Tuan *et al*, 2001).

A few community-based surveys for cysticercosis have recently been conducted in endemic northern Bac Ninh Province. A 1999-2000 survey of 597 people indicated that 5.0% were infected with cysticercosis (Doanh *et al*, 2002) while a KAP interview-based survey in Ty Dien village of Bac Ninh Province indicated that out of 230 people randomly selected 7.2% reported having subcutaneous nodules, 4.3% reported having epileptic seizures, 12.6% reported having memory loss and 4.4% indicated having been treated previously for cysticercosis. Of these, 210 people were tested for cysticercosis using antigen-ELISA testing resulting in 12 positive persons (5.7%). Nine of these 12 positive persons agreed to have their infection status confirmed with 7 found to have cerebral cysts by CT scanning while the other 2 were found to be positive by biopsy of subcutaneous nodules (Erhart *et al*, 2002). In total 26 people from Ty Dien village, 18 males (69.2%) and 8 females (30.8%), having subcutaneous nodules or found to be serologically positive were confirmed to be infected by biopsy of subcutaneous nodules and/or CT scanning (De *et al*, 2001d).

The most common clinical signs suggestive of cysticercosis infection were the presence of subcutaneous nodules and neurological symptoms such as epileptic seizures, severe headache, and impaired vision. Deaths have also been attributed to neurocysticercosis in Vietnam (Hau, 1999). Forty of 78 cysticercosis patients detected by biopsy of subcutaneous nodules at Bach Mai and Thanh Nhan Hospitals in Hanoi reported having epilepsy. Of these, 45% were found to have other neurological symptoms (Thuc, 1997). Neurological symptoms observed in cysticercosis patients in Vietnam are presented in Table 6.

Taeniasis was also common among cysticercosis patients with 18.4% of 141 cysticercosis patients diagnosed by biopsy of subcutaneous nodules at Hanoi hospitals in 1989 - 1990 detected to also have taeniasis (Lam and Tan, 1992). A 1993 survey at Thanh Nhan Hospital in Hanoi indicated that 30% of cysticercosis patients also had taeniasis (De *et al*,

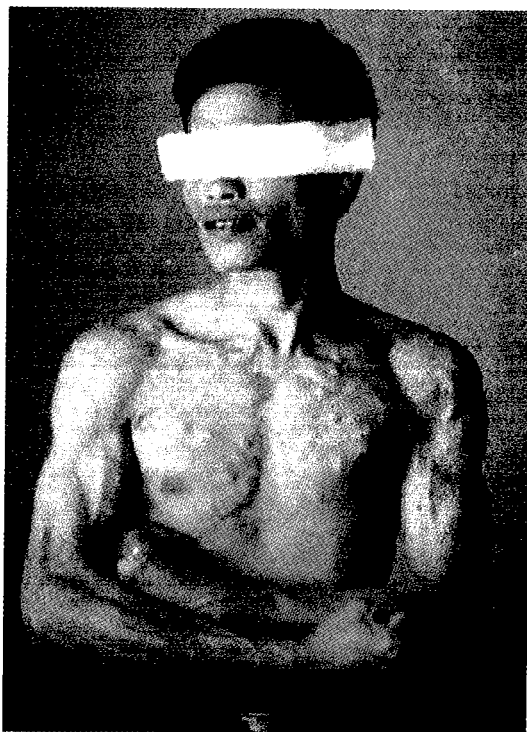


Fig 2—Cysticercosis patient with subcutaneous nodules.

1998b) while a survey of 111 cysticercosis patients at Hanoi Medical School indicated that 27.9% were passing *Taenia proglottidis* (Nguyen, 1996).

Subcutaneous nodules are a very common and distinctive sign of infection prompting referral for treatment (Fig 2). Of 60 cysticercosis patients referred in 1993 to Thanh Nhan Hospital in Hanoi, 100% had subcutaneous nodules and 98% had both subcutaneous nodules and cerebral cysts (De *et al*, 1998b). The presence of subcutaneous nodules is not always associated with occurrence of neurological symptoms as 35.1% of 111 cysticercosis cases seen at Hanoi hospitals did not exhibit neurological symptoms (Nguyen, 1996). Studies indicate the chest, back and arms to be the most common predilection sites for subcutaneous nodules (see Table 7). A study of the distribution of subcutaneous nodules detected on 60 cysticercosis patients seen at Thanh Nhan Hospital in Hanoi in 1993 indicated that

Table 6

Percentage of cysticercosis cases with various neurological symptoms reported in Vietnam.

No. of patients	Epilepsy	Headache	Memory loss	Lisping	Impaired hearing	Impaired vision	Dizziness	Reference
111	34.2	69.4	18.0	n.d.	n.d.	n.d.	8.1	Nguyen, 1996
141	11.0	36.0	n.d.	15.0	19.0	30.0	n.d.	Lam and Tan, 1992
50	n.d.	100.0	80.0	n.d.	n.d.	70.0	n.d.	Thuc, 1998

n.d. = no data available

Table 7

Distribution of subcutaneous nodules in the bodies of 141 cysticercosis cases treated at Hanoi Hospital in 1989 - 1990 (Lam and Tan, 1992).

Number of Cysts	Head and Face		Neck		Chest and Back		Arms and Legs	
	Number	%	Number	%	Number	%	Number	%
1 - 5	69	48.9	49	30.1	56	39.7	39	27.7
6 - 10	6	4.3	12	7.4	30	21.3	39	27.7
11 - 20	14	9.9	0	0	21	14.9	27	19.1
21 - 30	0	0	0	0	1	0.7	8	5.7
31 - 40	0	0	0	0	1	0.7	1	0.7
41 - 50	0	0	0	0	0	0	3	2.1
Total	89	63.1	61	37.5	109	77.3	117	83.0

36.6% of the total number of nodules were located on the back and chest, while 28.7% were found on the arms, 18.2% on the head and neck and 17.4% on the legs (De *et al*, 1998a). People may have substantial numbers of subcutaneous nodules with cases having over 300 recorded (Lam and Tan, 1992).

There have also been reports of high intensities of cerebral cysts with one case having 102 (De *et al*, 1998b). Thuc (1998) has classified cerebral lesions into different categories based on their appearance on CT scanning. The three groups include a vesicular and colloidal form, a granular nodular and nodular calcified form, and a single nodular calcified form. A study on one cohort of 50 cysticercosis patients with cerebral lesions identified by CT scanning indicated the vesicular and colloidal vesicular form to be the most common form of cerebral lesion (80%) with only 20% having the granular nodular/nodular calcified while none had the single nodular calcified form

(Thuc, 1998).

Risk factors

Several studies investigating risk factors for taeniasis and cysticercosis in Vietnam have indicated that important factors include consuming raw pork and unwashed vegetables, allowing pigs to roam and in some cases enter homes, poor sanitation due to absence or lack of hygienic latrines, use of human feces ("nightsoil") for fertilizer, nonexistent or inadequate meat inspection and control, and poor hygiene (*ie* not washing hands after defecating) (Lam and Tan, 1992; De *et al*, 1997; 1998b; 1999; 2001c,d; Chap *et al*, 1999; Tuan *et al*, 2001). These factors are considered to be much more common in the poorer, rural areas of the country, especially in the mountainous region of the north.

De and colleagues (1999; 2001c) have found that the habit of eating raw meat is very common in the northern highlands where the

Table 8

Results of household and hospital interviews concerning potential risk factors for cysticercosis/taeniasis in different areas of Vietnam (De *et al*, 2001c,d; Tuan *et al*, 2001).

Risk factors	% of households ^a		
	Hoa Binh Province ^b	Bac Ninh Province ^c	Ho Chi Minh City ^d
Rural origin	n.d.	n.d.	68.3
Awareness of taeniasis	n.d.	n.d.	74.6
Awareness of cysticercosis	n.d.	0	0
Latrine present ^e	72.8	96.0	n.d.
Use latrine for defecation	n.d.	99.1	n.d.
Defecate outdoors	n.d.	n.d.	17.6
Nightsoil used as fertilizer	18.4	5.0	6.3
Pigs allowed to roam	8.5	6.0	n.d.
Purchase noninspected pork	n.d.	100	n.d.
Consume raw pork	4.5	74.3	22.5
Consume raw vegetables	n.d.	n.d.	88.7
Drink unboiled water	n.d.	n.d.	79.6
Wash hands before eating	n.d.	n.d.	24.6
Wash hands after defecation	n.d.	46.5	n.d.

^an.d. = no data available.

^bKAP interview survey of 2,686 persons from 526 households from 10 districts.

^cKAP interview survey of 230 persons conducted at 100 randomly selected households in cysticercosis-endemic Ty Dien Village.

^dInterview survey of 142 cysticercosis patients at Ho Chi Minh Hospital.

^ehygienic standard variable.

presence of latrines is limited ranging from 0 - 50%. Chap and colleagues (1999) also found that consumption of raw pork is very common in the northern provinces such as Ha Bac, Hai Duong and Thanh Hoa Provinces, particularly among middle-aged men. Risk factor assessment for taeniasis in endemic rural Hoa Binh province indicates that the use of night soil for fertilizing vegetable crops is fairly common in that province (see Table 8). Results of a KAP interview survey of 230 persons concerning risk factors conducted in cysticercosis endemic Bac Ninh Province are presented in Table 8, which indicate that consumption of raw, un-inspected pork and poor hygiene may be important factors with regard to the presence of *T. solium* in that community (De *et al*, 2001d). A questionnaire survey of cysticercosis patients seen at Ho Chi Minh Hospital (Tuan *et al*, 2001) provided some insight into the situation in the south indicating that people

are very aware of tapeworms though ignorant of cysticercosis with a high percentage of people consuming raw vegetables (Table 8).

As mentioned previously, a recent case of taeniasis caused by *T. asiatica* was diagnosed in an individual who habitually consumed raw pork and in particular raw pig livers which are the usual source of infection with that species of tapeworm (De *et al*, 2001b).

Treatment studies

Taeniasis: Lam and Tan (1992) reviewed studies involving taeniasis treatment during the period 1962 - 1992, the results of which are presented in Table 9. During that time 90 persons, mostly farmers and almost exclusively adults, were treated for taeniasis and the worms collected and identified. The proportion of *T. solium* tapeworms collected from study participants was noted to increase during the time period

Table 9
Treatment of taeniasis patients between 1962 - 1989 and tapeworm species collected (Lam and Tan, 1992).

Year	Drug	Dose	No. people treated	No. tapeworms passed	<i>T. saginata</i> %	<i>T. solium</i> %
1962	Quinacrin	1.2 g/person	27	22	95.5	4.5
1974 - 75	Niclosamide	2 g/person	33	33	87.9	12.1
1989	Praziquantel ^a	10 mg/kg	30	30	60.0	40.0

^aTrade name Biltricide

Table 10
Cure rate after 6 months and side effects following random treatment of cysticercosis patients with albendazole or praziquantel (Nguyen, 1996).

Drug		Praziquantel	Albendazole
Dose		30mg/kg/day x 10 days	15mg/kg/day x 20 days
Number patients treated		30	81
Cure rate ^a	Subcutaneous nodules	90.0	96.3
%	Cerebral cysts	23.5	50.0
	Epileptic seizures	77.7	96.6
	Headache	92.3	97.6
Side effects	Fever	33.3	18.5
%	Increased headache	43.3	33.3
	Urticaria	3.3	11.1
	Nausea	16.8	9.9
	Epileptic seizures	0	1.2
	SPSCN ^b	30.0	27.2

^a6 months post-treatment.

^bSPSCN = Swollen/Painful subcutaneous nodules.

while that of *T. saginata* decreased. De and colleagues (1998b) have reported that praziquantel (18 mg/kg) is more effective at curing taeniasis compared to niclosamide (2g/person) giving cure rates of 100% vs 70-90%, respectively. The vast majority of taeniasis patients are apparently infected with only one tapeworm as only one person has passed multiple tapeworms (two immature *T. saginata*) in these treatment studies.

Cysticercosis: Several drugs, including diethylcarbamazine (DEC), praziquantel and albendazole, have been investigated with regard to their efficacy for treating cysticercosis and their side effects.

Lam and Tan (1992) treated 141 cysticercosis patients, who were positive by biopsy of subcutaneous nodules with DEC 6mg/kg for 10 days for 3 courses. Also on the first day they were given praziquantel 10mg/kg single dose for treating *T. solium* adults. Cysts disappeared in 34 patients and became smaller and softer in another 24 patients while in one patient the number of cysts increased. Seizures ceased in 11 out of 15 patients suffering from epilepsy. DEC could apparently stop the development of the cysticerci so those patients with young cysts could be effectively treated. Following treatment with DEC, cysts were found to become calcified in legs and brains as

Table 11

Clinical and serological assessment of 26 cysticercosis patients in Ty Dien village in Bac Ninh Province at different time points post-treatment with albendazole 15 mg/kg/day for 30 days (De *et al*, 2001d).

Months post-treatment	Ag-ELISA positive	Subcutaneous nodules	Epileptic seizures	Live cysts on CT scan
0	92.3% (24/26)	80.8% (21/26)	42.3% (11/26)	80.8% (21/26)
1	76.9% (20/26)	61.5% (16/26)	0% (0/26)	—
2	72.7% (16/22)	33.3% (7/21)	4.8% (1/21)	—
3	59.1% (13/22)	25.0% (5/20)	5.0% (1/20)	—
6	36.4% (8/22)	5.3% (1/19)	10.5% (2/19)	0% (0/16)
12	17.4% (4/23)	12.5% (3/24)	16.7% (4/24)	0% (0/9)

indicated by CT scanning and radiography (Lam and Tan, 1992).

De and colleagues (1998b) conducted a comparative study of DEC, praziquantel and albendazole with regard to their cure rate of cerebral cysts. DEC at 6mg/kg/day for 10 days for 3 different courses gave very poor results, praziquantel at 30mg/kg/day for 2-3 courses cleared 96.7% of subcutaneous nodules but only 18.8% cerebral cysts after six months of treatment, while albendazole at 15mg/kg/day for 20 days for 2 - 3 courses cleared 83.3% of subcutaneous nodules and 43.8% of cerebral cysts after six months of treatment.

Forty patients with cysticercosis and epilepsy were treated with praziquantel 30mg/kg/day for 10 days for 3 courses along with an antiepileptic drug (Gardenal) resulting in 34 cases (85%) being cured of their seizures while the other 6 required the additive treatment of a neurological drug (Tegretol) to be cured (Thuc, 1997). Thuc (1998) also treated 50 cysticercosis patients, having increased cerebral ventricular pressure with praziquantel resulting in 48 of the patients responding fully to treatment, *ie* intracranial pressure returning to normal and disappearance of live cerebral cysts.

A study at Hanoi Medical School from 1995-1996 (Nguyen, 1996) compared the efficacy and side effects of albendazole and praziquantel for treating cysticercosis. The cure rate of patients randomly placed in treatment

groups was assessed after 6 months based on clearance of subcutaneous nodules, disappearance of clinical symptoms and/or no live cerebral cysts detected by CT scanning (see Table 10). Results indicated that both drugs are effective at clearing subcutaneous cysts, albendazole is better at killing cerebral cysts though at the dose used the effect was limited, albendazole was more effective at curing epilepsy while both drugs resulted in effective cure of headache. Side effects including fever, increased headache, nausea, itching, and swollen, painful subcutaneous nodules were fairly common immediately following treatment with both drugs though more so with praziquantel except for urticaria.

De and colleagues (2001d) treated 26 people in Ty Dien village in Bac Ninh Province, found positive for cysticercosis by CT scanning and/or subcutaneous nodule biopsy, with albendazole 15 mg/kg/day for 30 days and then reassessed them clinically and serologically with an antigen-ELISA at various time points post-treatment as shown in Table 11. The results indicated that albendazole is effective at killing cerebral cysts and alleviating seizure activity though parasite antigens and subcutaneous nodules persist for several months indicating that the drug's efficacy against cysticercosis needs to be validated.

Nguyen and colleagues (2001) investigated whether prednisolone given along with albendazole would avert the allergic reactions

observed in some cysticercosis patients treated with albendazole. A cohort of 126 cysticercosis patients seen at NIMPE during the period of 1998 - 2000 were divided into three treatment groups as follows: 1) albendazole 15mg/kg/day + prednisolone 20mg/day for 30 days; 2) albendazole 20mg/kg/day + prednisolone 20 mg/day; and 3) albendazole 15 mg/kg/days for 30 days without prednisolone. Results of the three treatment regimens was the same with regard to reactions thus it was not proven that prednisolone could prevent allergic reactions to the albendazole treatment.

DISCUSSION

The results indicate that cysticercosis caused by *T. solium* is a serious problem in Vietnam based on the number of patients seen at referral hospitals. However, it is difficult to estimate the true burden of cysticercosis in the country since the information available is based on passive surveillance, mostly reports from referral hospitals in Hanoi which indicate that the disease is primarily infecting young to middle-aged adult males. The one community-based survey for cysticercosis in a northern province (Bac Ninh) supported these findings (De *et al*, 2001d). Limited information on cysticercosis from southern Vietnam suggests a different epidemiological picture with a more equal sex distribution and a considerable number of children infected. Surveys for adult *Taenia* infections have been more active though based on techniques of questionable sensitivity and specificity, *ie* microscopy and personal observation of proglottids. Since evidence suggests that *T. saginata* and *T. asiatica* are also present in the country it is difficult to assess the relationship between cysticercosis caused by *T. solium* and taeniasis based on the surveillance techniques that have been used thus far. The very limited information concerning porcine cysticercosis is also based on passive surveillance, relying on routine post-mortem inspection in a few Hanoi slaughterhouses. The very low prevalence of porcine cysticercosis being reported (0.038 - 0.05%) is suspect in consid-

eration of the number of human cysticercosis cases being seen in the country.

Based on the evidence now available, consideration should be given to implementing a national surveillance program for both taeniasis and cysticercosis (human and porcine) in Vietnam. Countrywide community-based surveys where people and pigs are both examined in the same environment will be necessary for such a program to be effective and valid. Antemortem examination of pigs has been aided by the development of serological tests to detect antibodies against or antigens of *T. solium* (Tsang *et al*, 1989; 1991; Ito *et al*, 1998; Erhart *et al*, 2002) which would eliminate the bias inherent in slaughterhouse surveys in that all pigs in the community have an equal chance of being surveyed, not just those that make it to the slaughterhouse. The test to be used will need to be species-specific since infection with the metacystode stage of *Taenia hydatigena* (*C. tenuicollis*) has been shown to be common in Vietnamese pigs. The ability to use these same serological tests for surveying the human population for cysticercosis will greatly simplify the surveillance program. Assessment of the presence of lingual cysts in pigs and subcutaneous nodules in humans could be considered as a simple, inexpensive and fairly rapid way of initially detecting *T. solium* in Vietnamese communities, providing the basis for more in depth assessment involving serology and neuroimaging techniques. In addition, surveillance for taeniasis has been aided by the development of a test for *Taenia* antigens in feces (Allan *et al*, 1996) however species determination requires treatment of the host and recovery and identification of the tapeworm. A new species-specific serological test for taeniasis caused by *T. solium* currently being refined and validated, may be available soon which will avoid the need for handling feces (Wilkins *et al*, 1999).

In addition to infection surveys much more epidemiological information is needed on the transmission of *T. solium* in Vietnam and risk factors involved with regard to both human and pig hosts. In the KAP studies that have

been conducted many respondents indicated that the pork they consume is not subject to inspection or government control indicating a possible area for intervention. The potential role of contaminated "nightsoil" and wastewater for fertilizing crops in transmission of cysticercosis to humans and pigs also merits serious investigation whereas in some of the poorer, lesser-developed provinces the simple lack of latrines may be the most important factor. Complimenting the epidemiological aspects of cysticercosis would be an assessment of the impact of the disease on pig production as well as human health and production in the country. While porcine cysticercosis has not been noted as a serious problem in urban slaughterhouses it could be having substantial impact on pig production in rural smallholder communities. Costs related to diagnosis and treatment of human cysticercosis cases may be apparent whereas costs related to decreased human productivity due to incapacitation, stigmatization and death related to infection may be substantial, albeit obscure, requiring in depth analysis. By collecting the baseline information on the epidemiology and impact of cysticercosis suggested, the provincial and national governments of the country will have the evidence needed on which to base the ranking of cysticercosis in the list of health and agricultural constraints they face as well as information to determine the cost-benefit analysis of different interventions to decide whether and what interventions might prove helpful. Considering that the International Task Force for Disease Eradication has targeted cysticercosis caused by *T. solium* as one of only six diseases deemed potentially eradicable (Centers for Disease Control and Prevention, 1993) possibilities exist for potential elimination of cysticercosis from Vietnam if the necessary political will and resources are forthcoming.

ACKNOWLEDGEMENTS

The review was conducted as part of the project "Wastewater reuse in agriculture in

Vietnam: Water management, environment, and human health aspects" which is funded by the Danish International Development Agency (DANIDA). The World Health Organization Vietnam country office in Hanoi is thanked for provision of the map indicating known endemic sites for *T. solium*, as well as other helpful contributions.

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