

Review

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Current Situation of Taeniasis and Cysticercosis in Indonesia

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Abstract: Three human taeniid species, *Taenia solium*, *Taenia saginata* and *Taenia asiatica* are distributed in Indonesia. A field survey conducted in Bali from 2002 to 2006 showed that the prevalence of taeniasis was highly variable among four districts (1.1-27.5%), and only two cysticercosis cases due to *T. solium* infection were detected. All tapeworms (n = 66) expelled from 66 tapeworm carriers were confirmed to be *T. saginata* by mitochondrial DNA analysis. A total prevalence of 13.0% (19/146) for *T. solium* taeniasis was found in Jayawijaya District, Papua (Irian Jaya). It included 14 of 88 (15.9%) in 1999 and 5 of 58 (8.6%) in 2001, while the seroprevalence of cysticercosis in humans by sub-district in Papua ranged from 0.0% in a non-endemic area to 48.5% in an endemic area from 1996 to 2005. The seroprevalence of cysticercosis in pigs and dogs in Jayawijaya ranged from 8.5% to 70.4% (1998-1999) and 4.9% to 33.3% (2000-2002), respectively. A 2003-2006 survey of 371 local people in Samosir island, north Sumatra revealed 6 of 240 (2.5%) to be infected with *T. asiatica*; 2 of 58 (3.4%) and 4 of 182 (2.2%) cases were detected in 2003 and 2005, respectively. This brief review summarizes the present situation of taeniasis and cysticercosis, the distribution of three human taeniid species, and the risk factors/transmission aspects of these tapeworm infections in Bali, Papua, and north Sumatra regions of Indonesia.

Key words: *Taenia solium*, *Taenia saginata*, *Taenia asiatica*, cysticercosis, taeniasis, Indonesia.

1. INTRODUCTION

Taenia solium is a human tapeworm that causes two distinct clinical manifestations: taeniasis by the presence of adult tapeworm(s) in the small intestine, and cysticercosis by the presence of larval stages in the parenteral tissues. Humans acquire the metacestodes (=cysticercus/cysticerci) of *T. solium*, which become adult tapeworms in the small intestine within a few months, by consumption of contaminated uncooked or undercooked pork.

The pig intermediate host becomes infected by inges-

tion of eggs or gravid segments of *T. solium* released from tapeworm carriers. In humans, the ingestion of eggs of *T. solium* occurs through contaminated food, water, etc. It is also speculated that auto-infection occurs directly by anal-oral contamination or, less likely, by internal auto-infection through the reflux of proglottids or eggs from the intestine into the stomach [1-3]. Cysticercosis can affect many anatomical organs, but it becomes particularly prominent and symptomatic in the central nervous system (CNS), causing neurocysticercosis (NCC). NCC is the most common parasitic disease of the CNS and one of the most important

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Fig. 1. Geographic map of Indonesia showing the taeniasis and cysticercosis endemic areas in Bali province/island (all 9 districts=1-9), Papua/west Irian Jaya province (Manokwari=10, Nabire=11, Paniai=12, Jayawijaya=13), and north Sumatra Province (Samosir district/island=14).

causes of acquired epilepsy [3,4].

Cysticercosis caused by *T. solium* infection is a public health problem in rather limited areas of Indonesia, whereas taeniasis caused by the three taeniid cestodes, *T. solium*, *Taenia saginata* and *Taenia asiatica* is a national problem with a lower priority but recognized widely in Indonesia [5,6]. These cestodes were reported from three known taeniasis and cysticercosis endemic provinces in Indonesia: i.e. Bali (*T. solium* and *T. saginata*), Papua (*T. solium*) and north Sumatra (*T. asiatica*) [7].

Historically, *T. saginata* taeniasis was reported among Dutch residents of East Java in 1867 [8], and *T. solium* taeniasis among Chinese residents of East Kalimantan in 1940 [9]. Cases of taeniasis and/or cysticercosis have also been reported sporadically in east Nusa Tenggara, southeast Sulawesi, Lampung, north Sulawesi, Jakarta and west Kalimantan [10-12].

2. TAENIASIS AND CYSTICERCOSIS IN BALI

a. Prevalence and distribution

Taeniasis cases have been observed in all nine districts of Bali Province. Among 596 people living in five villages in four districts of Bali (Gianyar, Badung, Denpasar, and Karang Asem) in the 2002-2006 period, the prevalence of *T. saginata* taeniasis ranged from 1.1 to 27.5% (Table 3). The number of *T. saginata* cases was significantly higher in males than in females ($P < 0.01$). Most *T. saginata* carriers were in the 30-44 year age group. These findings are probably due to differences in life styles, namely the fact that

adult male groups often enjoy raw beef (*lawar*) with spirit/toddy (*tuak*) in the traditional village community [6] There are two reports on the prevalence of cysticercosis in Bali in early 1990 [13,14].

During the 2002-2006 period, there were only 2 seropositives against both *T. solium* purified glycoproteins and chimeric recombinant antigen among 415 serum samples examined after mass screening in the four districts, i.e. Ketewel village (Gianyar) in 2002 (1/125, 0.8%) and Subagan village (Karang Asem) in 2006 (1/36, 2.8%) [6, 7] (Wandra *et al.*, unpublished data).

In June 2003, a case of disseminated cysticercosis was reported in Sanglah Hospital, Denpasar, Bali: a 36-year-old Balinese man presented with neuro-, subcutaneous- and oral-cysticercosis. Serological examinations (ELISA and immunoblot) were strongly positive and CT scan revealed multiple active lesions in the brain [15]. Two cases of NCC and one case of NCC with multiple subcutaneous nodules were also reported from Sanglah Hospital, Denpasar, Bali in 2004. The patients were two Balinese women (both 31 years old) and a Balinese man (60 years old) [15].

b. Species of *Taenia*

During the 2002-2006 period, a total of 66 proglottid samples from 66 tapeworm carriers were analyzed by multiplex PCR [16,17] with modifications for differentiation of *T. saginata*, *T. solium* and *T. asiatica* (Wandra, unpublished data). Mitochondrial DNA (mtDNA) samples from the parasites were prepared using DNeasy Tissue kit (Qiagen). Cytochrome *c* oxidase subunit 1 (*cox1*) gene was amplified

according to Yamasaki et al. [16,17], except for the primer (5'-TTATTTATTTACGTC AATCTTATTG-3') for *T. asiatica* (Wandra *et al.*, unpublished data). For further confirmation of the taeniid cestode parasite, DNA sequencing was carried out in 32 of 66 proglottid samples [16,17]. All were re-confirmed to be *T. saginata*, and no *T. asiatica* were identified.

MtDNA analysis using the *cox1* fragment of the 1181-bp of *T. solium* cysticercus resected from a 36-year-old Balinese man, with both NCC and subcutaneous nodules, revealed that the nucleotide sequences of *T. solium* at positions 508, 650, 927, and 1483 were C, T, A and A (C=cytosine, T=thymine, A=adenine, and A) and differed from those showing T, C, T, and G (G=Guanine) from Papua, respectively [15] (Wandra *et al.*, unpublished data). The nucleotide sequences of *T. solium* from Bali and Papua were archived as AB271234, AB066488.

c. Risk factors and transmission

Human *T. saginata* infection is related to consumption of a local raw beef dish (beef *lawar*). Quality control of beef and pork, particularly in unlicensed slaughterhouses and even in markets, is rendered difficult by the limited number of meat inspectors [6].

It was confirmed that all of the taeniasis patients had consumed raw pork and/or beef (*lawar*). In Ketewel village (Gianyar), the number of families consuming raw beef increased in 2004 compared with 2002. Bivariate analysis of 106 family heads from the endemic areas (Banjar Saba, Banjar Pamesan and its surroundings, Sukawati Sub-

District, Gianyar) and non-endemic areas (Banjar Paang Kelod, East Denpasar Sub-District, Denpasar) in 2004 showed significant association between *T. saginata* taeniasis and a low level of education and active consumption of beef *lawar* bought at local markets. By contrast, infection of *T. solium* in Bali is now rather rare and sporadic compared with the situation 10-20 years ago. This is probably due to an improvement in sanitation and improved pig husbandry, although not to reduced consumption of pork, since pork is still the favorite food of Balinese [6].

3. TAENIASIS AND CYSTICERCOSIS IN PAPUA

An epidemiological study on taeniasis and cysticercosis was carried out in 11 sub-districts in 5 districts (Jayawijaya, Merauke, Manokwari, Paniai, Nabire) of Papua during the 1996-2005 period. A total of 1,474 persons were surveyed using both questionnaires and physical examinations. Serology of people (1,444) and also pigs (272) and dogs (125) was carried out for the detection of antibodies against *T. solium* cysticercosis. Detection of taeniasis was also carried out by copro-ELISA [18].

A total prevalence of 13.0% (19/146) was confirmed for taeniasis in Jayawijaya, which included 14 of 88 (15.9%) cases in 1999 and 5 of 58 (8.6%) cases in 2001 [19,20]. The seroprevalence of cysticercosis in humans by sub-district in Papua ranged from 0.0% (0/60) in a non-endemic area, Merauke of Merauke Sub-District in 1998, to 45.8% (44/96) in a highly endemic area, Jayawijaya of Asologaiama Sub-District in 1996 (Table 1).

Table 1. Summarized data of seroprevalence of cysticercosis in Papua by district and sub-district, 1996-2005

District	Sub-district (year)	Population sampled	A/B/C (%)	D/B/C (%)	E/B/C (%)	Total (%)	F/B/C (%)
Jayawijaya	Assologaima (1996)	100	17/17/12 (70.6)	34/32/20 (62.5)	49/47/12 (25.5)	100/96/44 (45.8)	12/12/10 (83.3)
	Wamena City (1998-2002)	634	34/34/15 (47.1)	24/24/12 (50.0)	576/574/71 (12.4)	634/632/99 (15.7)	11/11/11 (100)
	Kurulu (1998)	134	52/52/26 (50.0)	12/12/8 (66.7)	69/67/18 (26.9)	134/131/52 (39.7)	13/13/11 (84.6)
	Hubikosi (1998-2001)	64	25/11/3 (27.3)	7/1/0 (0.0)	32/31/5 (16.1)	64/43/8 (18.6)	1/-/-
	Sub-total	932	128/114/57 (50.0)	77/69/40 (58.0)	726/719/106 (14.7)	932/902/203 (22.5)	
Merauke	Merauke (1997)	30	-	-	30/30/1 (3.3)	30/30/1 (3.3)	-
	Merauke (1998)	60	-	-	60/60/0 (0.0)	60/60/0 (0.0)	-
	Sub-total	90	-	-	90/90/1 (1.1)	90/90/1 (1.1)	-
Manokwari	Minyambow (2003)	97	-	-	97/97/4 (4.1)	97/97/4 (4.1)	-
	Anggi (2003-4)	177	-	-	177/177/4 (2.3)	177/177/4 (2.3)	-
	Sub-total	274	-	-	274/274/8 (2.9)	274/274/8 (2.9)	-
Paniai	Paniai (2004)	61	-	-	61/61/1 (1.6)	61/61/1 (1.6)	-
Nabire	Nabire (2004)	37	-	-	37/37/0 (0.0)	37/37/0 (0.0)	-
	Idakebo (2004)	14	11/11/4 (36.7)	-	3/3/1 (33.3)	14/14/5 (33.3)	-
	Monamani (2004-5)	66	47/47/5 (10.6)	-	19/7/0 (0.0)	66/54/5 (9.3)	-
	Sub-total	117	58/58/9 (15.5)	-	59/47/1 (2.1)	117/105/10 (9.5)	-
Total		1474	186/172/66 (25.0)	77/67/36 (53.7)	1040/1033/122 (11.8)	1474/1444/166 (11.4)	37/36/32 (88.9)

A: No. of suspected neurocysticercosis (NCC), B: No. of examined samples, C: No. of positive samples, D: No. of suspected cysticercosis (SCC), E: No. of population at risk (PAR), F: No. of suspected NCC and SCC, %: Percentage of serum sample positive (C/B x 100%).

The seroprevalence of cysticercosis in pigs and dogs in Jayawijaya ranged from 8.5-70.4% in the 1998-1999 period and 4.9-33.3% in the 2000-2002 period. Necropsy of 4 seropositive dogs revealed cysticerci of *T. solium* in the brain, heart and muscle (2 dogs). MtDNA analysis of proglottids and cysts obtained from humans, and cysts from pigs, dogs, and non-obese diabetes/shi-*scid* mice experimentally infected with *in vitro* hatched oncospheres of locally collected *Taenia* spp. revealed these all to be an Asian genotype of *T. solium* [21-23].

Neither *T. saginata* nor *T. asiatica* have been identified in Papua. Bivariate analysis from available demographic knowledge and behavior data in a group seropositive for cysticercosis (n=102-158) versus a control group seronegative for cysticercosis (n=355-576) in Jayawijaya revealed that the factors associated with cysticercosis for local people were age range (p<0.01), level of education (p<0.01), and washing of hands before eating (p<0.05). There was no significant difference with regard to gender (P>0.05) (Table 2). The findings suggest that an age of 18 years or older, a low level of education, and the habit of not washing hands before eating were the most important factors associated with cysticercosis (Wandra *et al.* unpublished data).

In Jayawijaya, Assologaima Sub-District, questionnaires distributed to 31 respondents revealed that 83.9% were illiterate, 93.6% were farmers, all were Christians, and all had a history of eating pork roasted on *batu panas* (hot stones). With regard to behavior and environmental hygiene, 90.3% obtained water from the river and consumed it without boiling, 64.5% did not wash their hands before eating, 58.1% did not wash their hands after defecating, and 64.5% defecated in the forest. There were no sanitation facilities (Wandra *et al.*, unpublished data).

Among 506 families in four sub-districts (Assologaima, Wamena Kota, Kurulu and Hubikosi) in Jayawijaya District surveyed in the 1996-2005 period, it was reported that 17% (86/506) defecated in a toilet, 6.3% (32/506) in the backyard, 1.8% (9/506) in the river, 64.6% (327/506) in the garden, and 10.3% (52/506) in the forest (Wandra *et al.*, unpublished data).

The number of *T. solium* endemic districts in Papua has increased from one district (Paniai) first identified in the 1970s to 4 districts (Paniai, Jayawijaya, Manokwari and Nabire) identified in the past 10 years. Movement of people from one district to another, sometimes with pigs appears to have spread the parasite from endemic to non-endemic areas, especially where the ethnic groups Akari, Dani, Lani, and Yale are predominant, because of their traditional life style and socio-cultural background [5,24].

There is no evidence that *T. solium* transmission occurs in Merauke. One woman showing a high antibody titer in 1997 was a transmigrant from another province (Table 1). There is no data available on taeniasis/cysticercosis from other districts in Papua [22,23,25,26].

4. TAENIASIS IN NORTH SUMATRA

On Samosir island in Lake Toba, north Sumatra, the prevalence of taeniasis during the 1972-1990 period was reported to range from 1.9 to 20.7% [27-30]. Epidemiological surveys of taeniasis and cysticercosis in 2003-2006 on a total of 371 people from 285 families revealed that 6 of 240 (2.5%) were infected with *T. asiatica* 2: of 58 (3.4%) in 2003 and 4 of 182 (2.2%) in 2005 [7] (Table 3).

In these surveys, we applied questionnaire, copro-microscopy (Kato-Katz method), copro ELISA, copro DNA

Table 2. Risk factors associated with cysticercosis in Jayawijaya District, Papua, 1996-2002

Variables	Serological examination		P	OR ^a	CI ^b
	No. of positive (%)	No. of negative (%)			
Age (year)					
≥18 (n=404)	113 (28.0)	291 (72.0)			
<18 (n=284)	41 (14.4)	243 (85.6)	<0.01	2.3	1.5-3.5
Gender					
Male (n=453)	106 (23.4)	347 (76.4)			
Female (n=281)	52 (18.5)	229 (81.5)	0.140	1.4	0.9-1.9
Level of education					
Low ^c (n=295)	80 (27.1)	215 (72.9)			
Middle and High ^d (n=288)	48 (16.7)	240 (83.3)	<0.01	1.9	1.2-2.8
Washing of hands before eating					
No/sometime (n=218)	59 (27.1)	159 (72.9)			
Yes (n=239)	43 (18.0)	196 (82.0)	<0.05	1.7	1.1-2.7

^a Odd ratio

^b 95% Confidence interval

^c No formal school education or only primary school

^d Junior/senior high school (middle), Academy/university (high)

Table 3. Summarized data of taeniasis and seroprevalence of cysticercosis by district in endemic provinces in Indonesia, 1999-2006

Province	District (year)	Taeniasis		Cysticercosis	
		Prevalence (%)	Reference	Seroprevalence (%)	Reference
Bali	Gianyar (2002)	25.6 (32/125)	[6,7]	0.8 (1/125)	[6,7]
	Gianyar (2004)	27.5 (14/51)	[6,7]	0.0 (0/46)	[6,7]
	Gianyar (2005)	23.8 (5/21)	Wandra <i>et al.</i> , unpublished	0.0 (0/13)	Wandra <i>et al.</i> , unpublished
	Gianyar (2006)	3.6 (2/56)	Wandra <i>et al.</i> , unpublished	0.0 (0/39)	Wandra <i>et al.</i> , unpublished
	Badung (2004)	1.1 (1/94)	[6,7]	0.0 (0/91)	[6,7]
	Denpasar (2004)	7.0 (9/128)	[6,7]	0.0 (0/49)	[6,7]
	Denpasar (2005)	6.5 (2/31)	Wandra <i>et al.</i> , unpublished	0.0 (0/16)	Wandra <i>et al.</i> , unpublished
	Karang Asem (2006)	1.1 (1/90)	Wandra <i>et al.</i> , unpublished	2.8 (1/36)	Wandra <i>et al.</i> , unpublished
Papua	Jayawijaya (1999)	15.9 (14/88)	[19]	Table 1	
	Jayawijaya (2001)	8.6 (5/58)	[20]		
North Sumatra	Samosir (2003)	3.4 (2/58)	[7]	0.0 (0/58)	[7]
	Samosir (2005)	2.2 (4/182)	[7]	0.0 (0/105)	[7]

tests, morphology, mtDNA analysis for isolated specimens, and serology for cysticercosis. There was no evidence of the occurrence of *T. solium* or *T. saginata* in the Samosir island communities.

MtDNA analysis of proglottid samples isolated from taeniasis carriers revealed that all the expelled tapeworms were *T. asiatica* [17] (Wandra *et al.*, unpublished data).

The residents of Samosir island eat a traditional dish with minced pork, viscera and blood (*sang-sang*), which may be a risk factor for taeniasis. When they cut pork into small pieces, they sometimes eat uncooked viscera (liver) which contains the cysts of *T. asiatica* [7]. A survey on the characteristics of 285 respondents on Samosir island showed that all (100%) were Christians, 60.7% (173/285) had no formal school education or only primary school, 84.9% (242/285) were farmers or merchants, and 51.2% (146/285) of families had no sanitary facilities (Wandra *et al.*, unpublished data).

5. CONCLUSIONS

T. solium and *T. saginata* are known to be endemic on Bali Island. Recent field surveys in Bali during the 2002-2006 period showed that *T. saginata* taeniasis prevalence was highly variable among four districts and only two cysticercosis cases due to *T. solium* infection were detected. However, several hospital cases of cysticercosis were reported during the 2003-2004 period. All expelled tapeworms were confirmed to be *T. saginata* by mtDNA analysis. There were no *T. asiatica* human cases identified in Bali. *T. solium* is now widely distributed in Papua, where the number of contaminated districts has increased during the 1996-2005 period. To date no cases of *T. saginata* or *T. asiatica* have been found in Papua. In Samosir island,

north Sumatra, *T. asiatica* taeniasis is related to consumption of uncooked viscera of local pigs. Our results indicate that taeniasis and cysticercosis control programs should be adopted with consideration toward differences in culture, religion, socio-economic status and level of education.

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