



Regional status, epidemiology and impact of *Taenia solium* cysticercosis in Western and Central Africa

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Abstract

In West Africa, *Taenia solium* cysticercosis in both pigs and man has been reported in Benin, Burkina-Faso, Ghana, Ivory Coast, Senegal and Togo, and although official data are lacking, *T. solium* is anticipated to be present in most of the pig-raising regions of other West African countries as well. In some regions of Nigeria, the prevalence of porcine cysticercosis and human taeniosis is quite high (20.5 and 8.6%, respectively). Surprisingly, however, no cases of human cysticercosis have been reported, although epilepsy is very common. Large epidemiological surveys have only been carried out in Togo and Benin, where the prevalence of human cysticercosis was 2.4 and 1.3%, respectively. In Central Africa, porcine and human cysticercosis are (hyper)-endemic in Rwanda, Burundi, the Democratic Republic of Congo and Cameroon. The parasite also has been reported in pigs in Chad and Angola. Cysticercosis has been shown to be one of the major causes of epilepsy in Cameroon with figures as high as 44.6%. Cameroon is one of the few countries where the taeniosis–cysticercosis complex has been examined more in detail. In the Western province of Cameroon large scale surveys have shown that active cysticercosis is present in 0.4–3% of the local population and in 11% of the village pigs. However, the prevalence of adult *T. solium* was only 0.1%, which underscores the frequency of the *T. solium* paradox. Based on the available information, a very conservative economic estimate indicates that the annual losses due to porcine cysticercosis in 10 West and Central African countries amount to about 25 million Euro. The financial losses due to human cysticercosis are very difficult to estimate, but are certainly exceeded by the social impact of the disease, especially because of the particular perception of epilepsy in many African communities. It is concluded that the true prevalence of *T. solium* cysticercosis in pigs and humans in Central and West Africa remains underestimated because of unreliable slaughterhouse data and the lack of awareness and diagnostic facilities in the public health sector.

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1. Introduction

According to Tsang and Wilson (1995) *Taenia solium* cysticercosis is largely under-recognised in many developing countries. This is certainly true for Africa and especially for Central and Western

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Africa where, until recently, very few epidemiological data were available (Geerts, 1993, 1995). However, during the past decade many surveys have been carried out in several of these countries. Comprehensive studies on the taeniosis–cysticercosis complex have been done only in Benin, Togo and Cameroon.

Except for the Muslim regions, where pork is not eaten for religious reasons, *T. solium* cysticercosis affects virtually all countries in Western and Central Africa. Although official data are often lacking, in most of the countries all the necessary conditions for transmission of the parasite from pigs to man and vice versa are present: open air defecation or deliberate defecation in pig sties, clandestine slaughtering of pigs, lack of trained and qualified meat inspectors, lack of detection and treatment of *T. solium* carriers and consumption of raw or insufficiently cooked pork (Preux et al., 1996; Zoli et al., 1998; Geerts et al., 2002).

Based on the available literature and on unpublished information, this review presents an overview of the regional status, the epidemiology and the impact of *T. solium* cysticercosis in Western and Central Africa. It must be emphasized that many data on porcine cysticercosis provided by meat inspection services should be interpreted with caution. It is well known that such data are not representative of the real situation, since a large proportion of pigs, and certainly cysticercotic pigs, are slaughtered outside the abattoirs. Furthermore, meat inspection often underestimates the true prevalence of porcine cysticercosis as was clearly demonstrated by Onah and Chiejina (1995), who found 20.5% of pigs with cysticercosis after detailed inspection of the carcass, whereas the official meat inspection reported only 3%.

2. Regional status and epidemiology

2.1. Western Africa

The available data on porcine and human cysticercosis in West Africa are summarised in Table 1. Due to political instability over a long period it is very difficult to collect information in Guinea-Bissau, Liberia, Sierra Leone, but it can be

assumed that *T. solium* is also well-established in the pig-raising regions of these countries. In Nigeria, the prevalence rate of cysticercosis in pigs has been reported to reach up to 20.5% in some regions (Onah and Chiejina, 1995). Taking into account the high numbers of *Taenia* spp. carriers (8.6%) (Onah and Chiejina, 1995) and the high prevalence of epileptics in Nigeria (37 per 1000), it is anticipated that human cysticercosis is present, although no reports have been published.

In West Africa, *T. solium* cysticercosis in man was first recorded in Ivory Coast (Bowesman, 1952). Later, Proctor et al. (1965) identified spinal cysticercosis as a major cause of paraplegia in Ghana. More recently, extensive studies were carried out in Togo and Benin in order to study the prevalence of the disease. Dumas et al. (1989) reported 2.4 and 29.5% seropositives for cysticercosis in the adult population and in epileptics of northern Togo, respectively. A prevalence of 10.8% was reported in hospitalized epileptic patients in the capital Lome (Grunitzky et al., 1995). In Benin, nation-wide surveys revealed that the overall seroprevalence of cysticercosis in the general population was 1.3% with a significantly higher prevalence in men (1.9%) than in women (0.8%), and that the prevalence increased with increasing age (Houinato et al., 1998). Obviously, higher seroprevalence rates were found in non-muslim regions (up to 3.3%) than in muslim regions (up to 0.8%). The prevalence rate of epilepsy in Benin was 15.2 per thousand which is comparable to the rate in Togo (16.7 per 1000) (Avodé et al., 1998; Dumas et al., 1989).

2.2. Central Africa

Nelson et al. (1965) reported that *T. solium* was common in Cameroon and parts of East Congo (DRC, ex-Zaire). Pandey and Mbemba (1976) confirmed that 0.1–8.1% of pigs in different regions (Shaba, Ituri, Kinshasa and Kivu) of the Democratic Republic of Congo were infested with *C. cellulosae*. In 1990, up to 30% of pigs were found infected with *T. solium* cysticercosis in some regions of the DRC (Chartier et al., 1990). Fain (1997) observed a high frequency of epilepsy during colonial times (before 1960) in eastern

Table 1
Prevalence of porcine and human cysticercosis in West Africa

Country	Prevalence in pigs ^a		Seroprevalence in man ^b	
	%	References	%	References
Benin	ND		1.3 ^c	Houinato et al. (1998)
Burkina Faso	0.6	Coulibaly and Yameogo (2000)	CR	Preux et al. (1996)
Ghana	11.7	Permin et al. (1999)	CR	Odamtten and Laing (1967)
Ivory coast	2.5	Mishra and N'Depo (1978)	CR	Heroin et al. (1972)
Nigeria	1.8–18.4	Dada (1980)	ND	Onah and Chiejina (1995)
	20.5	Onah and Chiejina (1995)		
Senegal	1.2	Deme, personal communication	CR	Collomb et al. (1964)
Togo	17	Dumas et al. (1990)	2.4 ^c	Dumas et al. (1989)

CR, case report; ND, no data available.

^a Meat inspection.

^b Antibody detection ELISA.

^c % of the general population.

upper Congo with the presence of cysticerci in about 3% of the population.

In Chad, Graber and Chailloux (1970) reported a prevalence rate of 6.8% in Djamena's slaughterhouse based on routine meat inspection. Recent studies carried out by Assana et al. (2001) showed that 26.0 and 40.8% of pigs in Mayo Kebbi (South-West of Chad) were positive by tongue examination and by an antigen detection ELISA (Ag-ELISA), respectively.

Rwanda has for a long time been considered hyperendemic for taeniosis–cysticercosis (Brandt, 1997). The prevalence of *T. solium* cysticercosis in the human population is even higher than in some hyperendemic regions in Latin America. Cysticercosis was present in 7% of 300 autopsies carried out in a region of Butare (Vanderick and Mbor-yingabo, 1972); this contrasts with 2.4% in a similar study in Mexico (Sarti et al., 1992). Unfortunately, no recent figures are available for Rwanda, except the high percentage (21%) of seropositives for cysticercosis among epileptics (Tsang and Wilson, 1995). In Burundi the prevalence of porcine cysticercosis seems to differ from one region to another (2–39%) (Newell et al., 1997). The latter authors reported a seroprevalence of 2.8% in the general population and 11.7% in epileptics (Table 2).

Cameroon is the only Central African country in which the taeniosis/cysticercosis complex has been studied in great detail in both pigs and man.

Since the report of Nelson et al. (1965) that cysticercosis was common in the Cameroons, many surveys have been carried out on village pigs, on markets and at slaughterhouses. The results are summarised in Table 3 and show that up to 24.6% of the pigs (Menoua) were positive by tongue inspection. The risk factors for cysticercosis in village pigs in Cameroon were determined by Pouedet et al. (2002) (Fig. 1). As expected, animals that were usually confined were significantly less infected than free roaming pigs and infection rates were significantly higher in pigs that had access to human faeces than in those without access. Adult pigs were more frequently infected than young ones. Recent surveys in the western and north-western parts of Cameroon showed that 81.6% of the village pigs are usually kept in confinement, but 18.4% are free roaming, 53.1% of which had access to human faeces due to the local habit of defecation in the pigsties (Pouedet et al., 2002; Shey-Njila et al., in press). In contrast, in the Far North of Cameroon this practice does not exist; instead people defecate near the farms in the open air so that only scavenging pigs have access to the feces (Assana et al., 2001). In the West Province of Cameroon the prevalence of human cysticercosis has been reported to range between 0.7 and 2.4% (Zoli et al., 1987; Nguekam et al., 2003). A recent survey amongst Cameroonian epileptic patients revealed a very high cysticercosis prevalence rate (44.6%) using antibody detection ELISA (Zoli et

Table 2
Prevalence of porcine and human cysticercosis in Central Africa

Country	Prevalence in pigs ^a		Seroprevalence in man ^b	
	%	References	%	References
Angola	0–6.8 ^a	Kama (1998)	ND	
Burundi	2–39 ^a	Newell et al. (1997)	2.8 ^c	Newell et al. (1997)
Chad	6.8 ^a	Graber and Chailloux (1970)	ND	
	25.7 ^b	Assana et al. (2001)		
Congo	0.1–8.1	Pandey and Mbemba (1976)	3 ^d	Fain (1997)
	10–30 ^a	Chartier et al. (1990)		
Rwanda	20 ^a	Thienpont et al. (1959)	7 ^e	Vanderick and Mboyingabo (1972)

ND, no data available.

^a Classical meat inspection.

^b Tongue examination.

^c Serology.

^d Based on presence of cysticerci.

^e Based on autopsies.

al., unpublished results). It was also shown that the risk for taeniosis and cysticercosis in butchers and tongue inspectors of the Menoua District was not significantly higher than in people who did not occupationally come into contact with pigs or pork (Vondou et al., 2002). Of 3109 stool samples examined microscopically, only four *Taenia* spp. carriers were found, of which 3 (0.1%) were identified to have *T. solium* (Vondou et al., 2002). Similar low prevalences have been reported in the few other surveys on human taeniosis (Table 4). However, in Guinée (Conakry) and Nigeria

higher prevalence figures have been observed, although no distinction was made between *T. solium* and *T. saginata* in these investigations.

3. Impact

3.1. Impact on pig production

Porcine cysticercosis is an economically important parasitic disease because it affects a large number of pigs, making their meat unfit for

Table 3
Prevalence of porcine cysticercosis in Cameroon based on different detection methods

Locality	Prevalence (%)			Reference	
	Tongue inspection	Carcass inspection	Serology		
			Ag-ELISA	Ab-ELISA	
Garoua ^a	–	12	–	–	Awa et al. (1999)
Menoua ^b	24.6	19.9	–	38	Zoli et al. (1987)
	6.3	–	11.0	21.8	Pouedet et al. (2002)
Mifi ^b and Bamboutos ^b	–	2.3	11.2	21.8	Nguekam (1998)
Extreme North ^c	20.5	15.7	39.8	–	Assana et al. (2001)
North-West ^c	4.4	–	27	–	Shey-Njila et al. (in press)
Ngaoundere ^a	7.8	–	22.4	–	Zoli et al. (unpublished results)

^a Town.

^b Department.

^c Province.

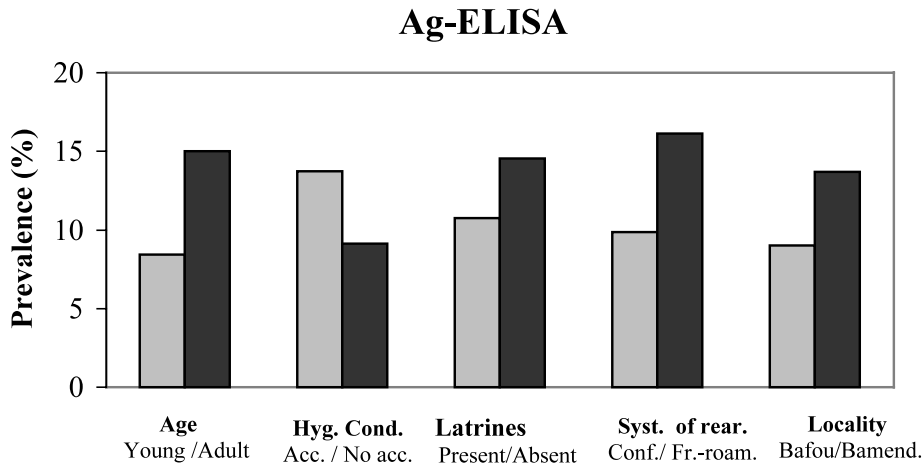


Fig. 1. Risk factors associated with porcine cysticercosis in West Cameroon: relationship between prevalence (Ag-ELISA) and pig age, pig rearing system, household hygienic conditions, presence or absence of latrines (Pouedet et al., 2002). Hyg. Cond., hygienic conditions; Acc./No acc., access or no access to human faeces; Syst. of rear., system of rearing; Conf., confinement; Fr.-roam., free-roaming.

human consumption and thereby incurring sizable economic losses. In Mexico, for instance, the annual loss due to porcine cysticercosis was estimated at 43 310 524 USD (Acevedo-Hernandez, 1982). However, very few figures are available for Africa. According to the legislation in many African countries the meat of infected pigs are to be destroyed. However, due to the lack of well-organised meat inspection and to common illegal slaughtering, partial or total seizures due to cysticercosis are rather exceptional and almost all infected carcasses are marketed and/or consumed. Usually, a pig carcass infected with cysticercosis is sold at a decreased price. This decrease in value varies from country to country. In Cameroon it is on the average 30%, whereas in Benin it is about 25% or more for carcasses harbouring calcified or

living cysts, respectively (Codjia, personal communication). In Rwanda the losses may reach 50% of the carcass value (Geysen, personal communication). Taking into account a pig population of 14 100 000 in Cameroon (FAO, 1999), an average prevalence of cysticercosis of 9.75% (based on tongue inspection) and an average value of €50 for an adult pig, the annual economic losses due to cysticercosis in Cameroon can be estimated at minimum €2062 125. Table 5 shows that the estimated annual loss due to cysticercosis in 10 West and Central African countries reaches about €25 million based on an average loss of €15 per infected pig (30% of the value of an adult pig in Cameroon).

It has to be noticed that in some villages in West Cameroon pork infected with cysticerci is consid-

Table 4
Prevalence of adult *Taenia* spp. in some Central and West-African countries

Country	Target group	Prevalence (%)	References
Burundi	Schoolchildren ($n = 13\,841$)	0.22	Newell et al. (1997)
Cameroon	General population ($n = 3109$)	0.13 ^a	Vondou et al. (2002)
Guinée (Conakry)	Schoolchildren ($n = 800$)	3.8	Gyorkos et al. (1996)
Nigeria	Hospital patients ($n = 1525$)	8.7	Onah and Chiejina (1995)
Togo	Adult population ($n = 1170$)	0.09–0.26	Dumas et al. (1990)

^a 75% were *T. solium*, 25% *T. saginata*.

Table 5
Estimated economic losses (in Euro) due to pig cysticercosis in 10 West and Central African countries

Country	Porcine population ^a	Average prevalence ^b (%) of cysticercosis	Estimated loss ^c (in Euro)
Angola	800 000	3.4	408 000
Burkina Faso	587 000	0.6	52 830
Burundi	71 000	20.5	218 325
Cameroon	1 410 000	9.75	2 062 125
Chad	23 000	16.25	56 063
DR Congo	1 180 000	12.1	2 141 700
Ghana	339 000	11.7	594 945
Nigeria	7 600 000	15.3	17 442 000
Senegal	320 000	1.2	57 600
Togo	850 000	17	2 167 500
Total	13 180 000	12	25 201 088

^a FAO, 1999.

^b Estimated on the basis of the available prevalence figures.

^c 30% of the value of an adult pig, €15.

ered to have a better flavour than healthy meat. Therefore, pork harbouring cysticerci is sometimes sold at a higher price than uninfected meat (Zoli and Tchoumboué, 1992)!

3.2. Impact on human health

The impact of cysticercosis on human health is difficult to estimate, because of the highly variable clinical picture of the disease, ranging from asymptomatic to severe headache, epilepsy and even death. Roberts et al. (1994) estimated the average hospitalisation of a patient with cysticercosis at 8 days and the wage loss at 19 days. Furthermore, the costs of several visits to the physician, the costs for serology and/or CT-scan, transport and drugs (anthelmintic and/or symptomatic) have to be taken into account. Although in many African countries patients are not hospitalised during the treatment of neurocysticercosis, the losses due to the disease remain quite important. Djou (2000) estimated the costs (wage losses not included) for treatment of one cysticercosis patient in Cameroon at 170 000 FCFA (€260), which is far beyond the reach of the affected resource-poor population. Based on an average prevalence of active neurocysticercosis (i.e. presence of living cysticerci) in Cameroon of 0.7% (Nguekam et al., 2003) and taking into account a

treatment percentage of 50% of the patients, treating 52 000 people would cost €13 520 000.

Besides these purely economic aspects, the social stigma of epilepsy must also be taken into account. Most communities cast out epileptic patients, because epilepsy is considered a contagious and/or a shameful disease (Avodé et al., 1996; Preux et al., 2000). Therefore, epileptics are often isolated to prevent the spread of the ailment. According to surveys of Preux et al. (2000) in West Cameroon only 27% of epileptics get married and 39% fail to enter into any professional activity. Furthermore, certain practices of traditional healers might be quite harmful to the patients. A majority of healers explained epilepsy as the presence of excess foam in the abdomen. Some patients reported that they were asked to inhale smoke from burnt cola nut leaves and mistletoe as a form of treatment. Others had to restrict certain foodstuffs such as meat, eggs, sweet potatoes, sugar cane etc., which paradoxically are highly nutritious foods. Overall, the social burden of human cysticercosis may be very high, but this needs considerable further research.

4. Conclusions

The data presented in this review clearly underscore the importance of *T. solium* cysticercosis in man and pigs in West and Central Africa, albeit

that the available data are an underestimation of the true prevalence due to the unavailability of diagnostic tools. Therefore, cysticercosis must be considered as one of the most ‘neglected’ parasitoses, rivalling the well-documented significance of this zoonosis in Latin America.

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