

Full length Research paper

A systematic review of taeniasis/cysticercosis and perspectives in Cote d'Ivoire

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The objective of this study was to conduct a systematic review of studies reporting Taeniasis/ cysticercosis in Côte d'Ivoire for implementation of control or elimination strategies. A systematic review of the literature was conducted to gather valid information on Taeniasis/cysticercosis in Cote d'Ivoire using search engines: PubMed, British Library, ScienceDirect, African Journals Online and GoogleScholar using the search terms: Taeniasolium, cysticercosis, Taeniasis, neurocysticercosis, neglected tropical diseases, helminths, control, efficiency etc. Thesis, master, reports activities of universities and research institutes and veterinary services have been reviewed too. Pharmacy (12) and medicine (4) thesis work and the annual reports of the Department of Parasitology Mycology at the Institute Pasteur of Côte d'Ivoire (1990-2010) reported varying prevalence of Taeniasp from 0.3% to 11.1%, with higher rates at Toumodi (11.1%), Divo and Lakota (5.4%) and Abidjan (2.5%). Four publications reported cases of human cysticercosis, the most recent dated from 1999, with two cases of neurocysticercosis determined by CT scan. Two veterinary thesis conducted in 1978 and one in 1991 show a prevalence of porcine cysticercosis at 2.5%, with higher prevalence at Korhogo (3.9%) and Bouaké (5, 7%). Existing data is old and not identify risk areas. Further research remains important to improve tools.

Keywords: Review Taeniasis, Cysticercosis, Côte d'Ivoire.

INTRODUCTION

Scientific evidence is instrumental to improving global public health, as health policies should be based on accurate and meaningful data.

Neglected tropical diseases (NTDs) are a public health

issue worldwide and especially in developing countries, where risk factors for their transmission are common (Hotez and Brown, 2009). These conditions tend to affect the poorest of the poor, which has led to limited research interest and investments for these infections. The few research initiatives that have been undertaken to estimate the burden of NTDs have been criticized for grossly underestimating their global impact (Edwards G

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and Krishna S, 2004; Hotezet *al.*, 2008; Wagner and Newton, 2009). In addition, the burden of several zoonotic NTDs, such as *Taeniasolium* cysticercosis, has never been estimated.

Taeniasolium is a tapeworm transmitted among humans and between humans and pigs. Taeniasis is acquired by humans when eating raw or undercooked pork contaminated with cysticerci, the larval stage of *T. solium*.

Porcine cysticercosis is due to the establishment of the larva stage of *Taeniasolium* in different parts of the body (Flisseret *al.*, 2006). It is acquired by ingestion of eggs released by human tapeworm carriers (Ngowiet *al.*, 2007). In endemic areas, *T. solium* infection is associated with poverty, absence of latrines and free access by scavenging pigs to human faeces on the environment (Moseset *al.*, 2010).

Human cysticercosis is a disease associated with poverty in areas where people eat pork and traditional pig husbandry is practised. It is endemic in sub-Saharan Africa.

However, cysticercosis can also occur in individuals who do not raise pigs or consume pork. Cysticercosis of the central nervous system is an important cause of chronic epilepsy, which places particular demands on the health services.

Neurocysticercosis (NCC) is the most severe manifestation of cysticercosis, i.e., the infection with the larval stages of *Taeniasolium* (Garcia *et al.*, 2003). Seizures and epilepsy are the most common manifestation of NCC occurring in approximately 80% of patients (Carabinet *al.*, 2011).

Data on the incidence of and prognosis for epilepsy in sub-Saharan Africa are scarce but the high prevalence of epilepsy and low life expectancy indicate that incidence is high. Infections, in particular cysticercosis in its endemic areas, cause most cases of epilepsy (Diopet *al.*, 2003; Preuxet *al.*, 2005).

It is evident that health priorities in Côte d'Ivoire focus on major diseases such as HIV/AIDS, malaria or tuberculosis.

Common NTD's such as, soil-transmitted helminth infections (STH), schistosomiasis, filariasis and onchocerciasis are known to be widespread among the poor population in Côte d'Ivoire.

Taeniasolium cysticercosis in both pigs and human has also been reported. Although the full disease burden of cysticercosis in Côte d'Ivoire remains largely unstudied, *T. solium* is anticipated to be present in most of the pig-raising regions of Côte d'Ivoire. There are still many regions where pigs are raised traditionally and where all conditions (poor sanitation in particular) are fulfilled for transmission from pigs to humans and vice versa. Cysticercosis has received little attention from national and regional authorities.

The main objective of this study is to conduct a systematic review of studies reporting Taeniasis/

cysticercosis in Côte d'Ivoire for implementation of control or elimination strategies and coordinated actions.

The specific objectives are the following: Summarize empirical data, support discussion for experts, analyze and select the strategies or combinations thereof for the country in the hope of establishing control systems

METHODOLOGY

This analysis constituted a desk review of the currently available evidence for presence of *Taeniasolium* in Côte d'Ivoire. Documentary evidence was collected as follows: A literature search was conducted using the search engines; IngentaConnect, PubMed, Library of Congress, British Library, ScienceDirect, African Journals Online and GoogleScholar using the search terms listed here: *Taeniasolium*, Cysticercosis, Taeniasis, neurocysticercosis, neglected tropical diseases, Helminths, control, intergrated, efficacy, praziquantel, niclosamide, albendazole, mass drug administration, TSOL18, vaccination, diagnosis, oxfendazole, education, latrines, sanitation, husbandry and combinations thereof. Duplicates were removed. Additional resources were identified through solicitation from experts and accessing citations within selected papers which had not appeared in the original search. Such documents have so far been forthcoming. Pig population data were downloaded from the FAO statistical database. The most recent pig population estimates (those of 2010) were used.

The authors screened articles found by electronic search and evaluated their appropriateness based on title and abstract according to the established criteria. Exclusion criteria were: 1) studies concerning wrong agent (for example *Taeniasaginata* or *Echinococcus* spp.); 2) reviews, letters or editorials without original data; 3) duplicated data.

Dissertations, theses, and memoirs were included. Moreover, due to the under-representation of publications from Sub-Saharan Africa, unpublished studies were reviewed.

RESULTS

Epidemiology of human *taeniasolium*/ cysticercosis (TS/CC) in Côte d'Ivoire

The routine national health surveillance program requires that cases of human cysticercosis are reported to national authorities. Under-reporting routinely occurs due to lack of access of the population to health care, misdiagnoses of aetiological factors or poorly established data reporting systems. We found 12 pharmacy and 4 medicine thesis work and the annual reports of the Department of Parasitology Mycology at the Institut Pasteur of Côte d'Ivoire (1990-2010). Studies conducted



Figure 1. Human *Taeniasis* sp. (source: institute Pasteur Côte d'Ivoire).

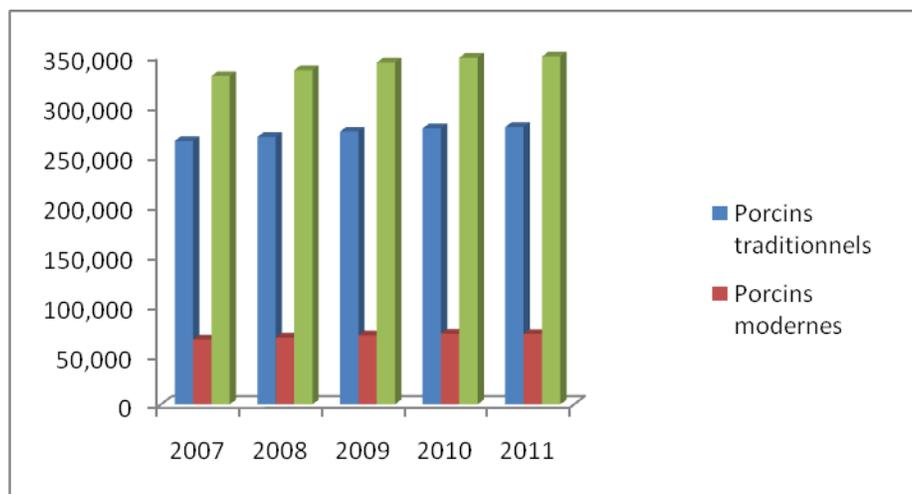


Figure 2. Livestock pig population (Source: MIRAH/DPP).

in schoolchildren and in the general population by Institute Pasteur have reported human taeniasis prevalence, without determining or reporting the species causing infection, ranging from 0.3% to 11.1%, with a high degree of spatial variation. High prevalence was observed in the Toumodi (11.1%), Divo and Lakota (5.4%) and Abidjan (2.5%) departments (figure 1). In Côte d'Ivoire, evidence of human cysticercosis is limited to a few studies. In a retrospective study conducted by N Dri *et al.* in 1999, two cases of NCC was determined by computed tomography (CT). Heroin *et al.* described one case of cutaneous cysticercosis in 1972. Two studies noticed one case of neurocysticercosis (Giordano *et al.*, 1976; Bullock, 1980).

Taeniasis infections are endemic throughout Côte d'Ivoire and individuals are commonly co-infected with combinations of helminths (Institut Pasteur of Côte d'Ivoire, unpublished data).

Pig Industry and Porcine Cysticercosis in Côte d'Ivoire

Pork comprises approximately 22% of total meat consumption in Côte d'Ivoire, where 1341 farmers in 2011 produced 8,447 tons of meat, representing a turnover of 10.9 billion CFA francs. The modern pig pro-

duction sector is based around the SIVAC (Société Ivoirienne d'Abattage et de Charcuterie) which produces 21% of pork in the country and is the only place at which routine inspection for *T. solium* is carried out. 79% of pork is produced in the traditional way, providing around 40% of the meat consumed in the city of Abidjan and over 98% of the pork consumed in other towns and villages (Figure 2).

The true prevalence of porcine cysticercosis remains underestimated. The documentation of the disease is still scanty with few available reports. In 1978 the prevalence of porcine cysticercosis was reported to be 2.5% with high prevalence in Korhogo (3.9%) and Bouaké (5.7%) (Mishra and N'Depo, 1978). In 1991 Danho et al. reported a national prevalence of 3.6% (Danho T, 1991). A recent surveillance system report by the Direction des Services Vétérinaires of the Ministère des Ressources Animales et Halieutiques (DSV/MIRAH) in 2013, identified 72 cases of porcine cysticercosis by meat inspection with 23 cases from Abidjan in the south and 38 cases from Yamoussoukro in the centre of the country. In 2014, 78 cases of porcine cysticercosis from few localities were reported by DSV/MIRAH.

DISCUSSION

Epidemiological studies in sub-Saharan Africa are not easily accessible to the scientific community. More than half of these studies have been published in regional journals that have very low distributions and are not indexed in the international databases. Methodological constraints and inconsistencies make epidemiological studies on epilepsy difficult to compare. The biggest constraint in these studies is data collection clear endpoints are difficult to measure and representative populations hard to recruit.

While *T. solium* is progressively being recognized as an important parasite at the global level, to date scientists in several developing countries endemic for the parasite are struggling to bring the disease to the national attention. Failure of *T. solium* endemic countries to recognize the importance of the parasite is attributed partly to lack of knowledge by stakeholders on the presence, magnitude and impacts of the parasite. This landscape analysis was done, in order to guide discussion and to provide guidance for the country in the selection of control strategies. This document constituted a detailed review of all current evidence identified in the literature.

Data from the country are rather old. This suggests that research on human and porcine cysticercosis in the country has been inactive for quite some time. Adequate prevalence data are scarce.

In Côte d'Ivoire, pig keeping is popular in many regions. However, there has been no study that has clearly described the pattern of pig production and the overall status of porcine cysticercosis on the country. This is important in order to understand the importance of the pig

enterprise in the country as well as the potential for porcine cysticercosis to constrain the industry. Africa is one of the regions where the full cycle of *T. solium* is occurring because of the favourable environmental conditions and poverty, which inhibit application of effective control measures for the parasite. Thus Africa provides a suitable ecology for *T. solium* endemicity.

NCC is considered a major public health problem in Africa (Phiri et al., 2003; Mafojane et al., 2003; Zoli et al., 2003), but data are sparse for many countries including Côte d'Ivoire.

Neuroimaging is the tool of choice for the establishment of a diagnosis of NCC and ideally is combined with serological tests for detection of *T. solium* antigens and/or antibodies.

Veterinary inspection of pigs prior to sale at market as well as meat inspection to monitor food safety normally take place in urban areas but are rarely carried out in rural areas.

A number of challenges exist for control of *T. solium* in Côte d'Ivoire, including: the persistence of traditional, free-roaming production systems, poor waste management, cultural norms for the consumption of raw pork, lack of interest from the health system in TS/CC and poor capacity of the veterinary system to enable adequate meat inspection in the rural communities. The current staffing levels are insufficient for the monitoring of all slaughterhouses, especially the small-scale ones. Therefore, not all meat destined for market is adequately inspected, especially in rural areas, and infected pigs in the community are not diagnosed and treated.

Although a National Reporting System for Infectious Diseases has been established, TS/CC is not yet included and there is currently a paucity of valid, up to date, data on prevalence available. Due to the paucity of data available it is difficult to make evidence based recommendations on control strategies to be used for this parasite.

Baseline data on pig populations should be collected and country wide mapping and assessments of the burden of human TS/NCC, and porcine cysticercosis undertaken. Low, medium and high TS/CC prevalence areas should be properly defined so that strategies may be developed according to endemicity. Key points of identification should be targeted, the disease in both humans and pigs made notifiable, and a surveillance system with a central coordination body set up, further research remains important to improve tools and permit easy application and standardization of intervention measures to effect control of cysticercosis particularly in resource-poor regions.

We propose a number of improvements to existing systems in order to achieve intensified control of *T. solium*:

- Establishment of a collaborative network for the study and control of cysticercosis in Côte d'Ivoire: epidemiology, research, training.

- Implementation of a standard serological method
- collecting of available data about *taeniasis* over the country and implementation of surveys
- collecting data about epilepsy cases, as index cases to target high transmission area
- Training of medical and veterinary laboratory staff in a standardised serological method for human and porcine diagnoses undertaking of epidemiological survey on farms and slaughterhouses for porcine cysticercosis.
- Undertaking human *taeniasis* surveys and provision of anthelmintic treatment to carriers
- Production and distribution of a protocol for active surveillance with establishment of a robust reporting system at all levels of existing medical and veterinary services
- Ensuring regular analysis of the incoming data for use in further decision-making at the national and/or local levels.
- Promotion of regional and international cooperation and collaboration among medical, veterinary and non-medical institutions in the implementation of control measures.

CONCLUSION

Existing data is old and not identify risk areas. Due to the paucity of data available it is difficult to make evidence based recommendations on control strategies to be used for this parasite. Further research remains important to improve tools and permit easy application and standardization of intervention measures to effect control of cysticercosis in Côte d'Ivoire.

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REFERENCES

- Agbaya SS, Yavo W, Menan EI, Attey MA, Kouadio LP, Kone M (2004). Helminthiases intestinales chez les enfants d'âge scolaire: résultats préliminaires d'une étude prospective à Agboville dans le sud de la Côte d'Ivoire. *Sante*, 14: 143-7.
- Anonymous.FAOSTAT.<http://faostat.fao.org/site/573/default.aspx#ancor> (accessed 12 June 2014)
- Bullock A (1980). La cysticerose cérébrale. A propos d'une observation clinique, électrique et anatomique. Medical Thesis. Abidjan, Côte d'Ivoire. 75 pages.
- Carabin H, Ndimubanzi PC, Budke CM, Nguyen H, Qian Y, Cowan LD, Stoner JA, Rainwater E, Dickey M (2011). Clinical manifestations associated with neurocysticercosis: a systematic review. *PLoS Negl Trop. Dis.* 5: e1152.
- Danho T (1991). Cysticerose musculaire et trichinellose du porc: cas particulier de la Côte d'Ivoire. PhD Thesis, École National Vétérinaire de Lyon. 75 pages.
- Diop AG, de Boer HM, Mandlhate C, Prilipko L, Meinardi H (2003). The global campaign against epilepsy in Africa. *Acta Trop*, 87:149–159.
- Edwards G, Krishna S (2004). Pharmacokinetic and pharmacodynamic issues in the treatment of parasitic infections. *Eur. J. Clin. Microbiol. Infect. Dis.* 23: 233–42.
- Evi JB, Yavo W, Barro-kikpc, Menan EH, Koné M (2007). Intestinal helminthosis in school back ground in six towns of south western Coted ivoire. *Bull. Soc. Pathol. Exot.*, 100: 176-177.
- Flisser A, Rossanna, Willingham III AL (2006). Control of the taeniosis/cysticercosis complex: Future developments. *Vet. Parasitol.*, 139: 283-292.
- Garcia HH, Gonzalez AE, Evans CA, Gilman RH (2003). *Taeniasoliumcysticercosis*. *Lancet*, 362: 547–556.
- Giordano C, Hazera M, Badoual J (1976). Aspects épidémiologiques, cliniques et électriques de l'épilepsie en Côte d'Ivoire (Abidjan). *Med. Afr. Noir.* 23, 305-322. (Article in French).
- Heroin P, Loubière R, Doucet J (1972). Un cas de Cysticerose sous-cutanée en Côte d'Ivoire. *Rev. Méd. Côte d'Ivoire.* 8, 26.
- Hotez PJ, Brindley PJ, Bethony JM, King CH, Pearce EJ, *Jacobson J.* (2008). Helminth infections: the great neglected tropical diseases. *J. Clin. Invest.* 118: 1311–1321.
- Hotez PJ, Brown SA (2009). Neglected tropical disease vaccines. *Biologicals* 37: 160–164.
- Mafojane NA, Appleton CC, Krecek RC, Michael LM, Willingham AL (2003) The current status of neurocysticercosis in Eastern and Southern Africa. *Acta. Trop.*, 87: 25–33.
- Menan EIH, Rouamba E, Ouhon J, Nebavi NGF, Adjetey TAK, Barro-Kiki PCMK, Penali LK, Kone M (1997). Helminthiases intestinales: Résultats de cinq années de coprologie parasitaire a` l'Institut Pasteur de Cocody (Abidjan - Côte d'Ivoire). *Med. Afr. Noire*, 44 :415.
- Mishra GS, N'Depo AE (1978). Les cysticerques des animaux abattus a l'abattoir de Port-Bouet (Abidjan), (Cote d'Ivoire). *Rev. Elev. Med. vet Pays trop.* 31(4), 431-436.
- Moses G, Olufemi OF, Abdulkadir UJ, Joseph PF, Okinyemi OF (2010). Some risk factors for *Taeniasoliumcysticercosis* in semi-intensively raised pigs in Zuru, Nigeria. *Vet. Ital.*, 46(1): 57-67.)
- N'Dri K, Thera M, Bedi MO, Konan A, Ettien F, Zunon-Kipre E, Burdin-Mensah GD, Abby CB, Keita AK (1999). Contribution of computed tomography in the diagnosis of symptomatic epilepsy. *Cahiers Santé.* 9, 61-4.
- Ngowi HA, Mlangwa JED, Carabin H, Mlozi MRS, Kassuku AA, Kimera SI, Willingham III AL (2007). Financial efficiency of health and pig management education intervention in controlling porcine cysticercosis in Mbulu District, northern Tanzania. *Livest. Res. Rural Dev.*, 19(62).
- Phiri IK, Ngowi H, Afonso S, Matenga E, Boa M,

Mukaratirwa S, Githigia S, Saimo M, Sikasunge C, Maingi N, Lubega GW, Kassuku A, Michael L, Siziya S, Krecek RC, Noormahomed E, Vilhena M, Dorny P, Willingham AL 3rd. (2003). The emergence of *Taeniasoliumcysticercosis* in Eastern and Southern Africa as a serious agricultural problem and public health risk. *Acta Trop*, 87: 13–23.

Preux PM, Druet-Cabanac M (2005). Epidemiology and aetiology of epilepsy in sub-Saharan Africa. *Lancet Neurol*, 4: 21–31.

Wagner RG, Newton CR (2009). Do helminths cause epilepsy? *Parasite Immunol* 31: 687–705.

Zoli A, Shey-Njila O, Assana E, Nguekam JP, Dorny P, Brandt J, Geerts S (2003). Regional status, epidemiology and impact of *Taeniasoliumcysticercosis* in Western and Central Africa. *Acta Trop*, 87: 35–42.