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Review article

A systematic review on the global occurrence of *Taenia hydatigena* in pigs and cattle

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ABSTRACT

Taenia hydatigena, a non-zoonotic tapeworm species shares the same intermediate hosts with other *Taenia* zoonotic species, such as *Taenia solium* in pigs and *Taenia saginata* in cattle. The occurrence of *T. hydatigena* in pigs and cattle may cause cross-reactions in immunodiagnostic tests and therefore, complicate the diagnosis of the zoonotic species. This study was conducted to systematically review the data on the prevalence of *T. hydatigena* in pigs and cattle, with the aim to assess the potential interference in serological diagnosis of zoonotic *Taenia* spp. due to *T. hydatigena* infection. We searched PubMed, Web of Science, Africa Journal Online, website http://www.google.com and article reference lists in English, French and Vietnamese with no restriction on research time and publication status. Eligible studies included observational studies that showed the occurrence of *T. hydatigena.* Twenty-six studies, divided into two animal groups, i.e. pigs and cattle, met the eligibility criteria for qualitative synthesis and 17 studies were included for the meta-analysis in three continents. *T. hydatigena* was found by necropsy in all included studies, which mostly were abattoir surveys. Overall, results showed the worldwide occurrence of *T. hydatigena* cysticercosis in pigs and cattle. In pigs, there was a marked higher prevalence in Asia and South America that was 17.2% (95% CI: 10.6–26.8%) and 27.5% (CI: 20.8–35.3%), respectively, compared to a low prevalence of 3.9% (95% CI: 1.9–7.9%) in Africa. Overall, the prevalence of *T. hydatigena* in cattle was low with a mean of 1.1% (95% CI: 0.2–5.2%). These results show that interpretation of results of sero-diagnostic tests for zoonotic *Taenia* species in pigs and cattle has to take into account the prevalence of *T. hydatigena* infections in different settings.

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1. Introduction

The genus *Taenia*, which belongs to the class Cestoda, subclass Eucestoda, order Cyclophyllidea and the family *Taeniidae*, contains many species infecting humans and domestic animals. Some members of this genus such as, *Taenia solium*, *Taenia saginata* and *Taenia asiatica* are responsible for taeniosis in humans; *T. solium* also causes human cysticercosis. Taeniosis is acquired by eating undercooked pork or beef containing cysticerci (Murrell, 2005). Diagnosis in animals of these zoonotic diseases requires methods that are highly sensitive and specific to prevent infection of humans. Necropsy of animal carcasses is the "gold standard" method when the entire carcass is dissected; routine meat inspection however, has a low sensitivity. Serological methods, such as antibody and antigen detection assays, are more sensitive than meat inspection (Gonzalez et al., 1990). In addition, the benefits of immunodiagnosis are: tests offer diagnosis on live animals; blood sampling followed by serological testing is more sensitive than the classical tongue examination in pigs infected with *T. solium*; and the tests are relatively inexpensive and easy to perform on large numbers of serum samples (Dorny et al., 2003). Unfortunately, the antigens of the different *Taenia* species are very similar and therefore, cross-reactions between *Taenia* spp. are common in immunodiagnosis. Craig and Rickard (1980), and Brandt et al. (1992) recorded cross-reactions between *Taenia hydatigena* and *T. saginata* in cattle while cross-reactions between *T. hydatigena* and *T. solium* in pigs are rather the rule than the exception in most antibody and antigen detecting tests (Dorny et al., 2003). This reduces the specificity of the diagnostic test, thereby seriously impairing the usefulness of immunodiagnostic methods for zoonotic cysticercosis.

T. hydatigena is a ubiquitous tapeworm found in domestic animals worldwide. Dogs and other carnivores such as, foxes, wolves and cats are the definitive hosts of *T. hydatigena* while the metacetodes are found in sheep, goats, cattle, pigs and wild boars, which act as the intermediate hosts (Soulsby, 1982). In pigs, the pathological picture of the migratory phase of the *T. hydatigena* cysticerci is characterized by haemorrhagia within the liver parenchyma and under the liver surface (Blazek et al., 1985). Immature stages migrate through the liver and lung before reaching their predilection sites. Dogs are kept throughout the world and in rural areas these are often free-roaming (stray) dogs; therefore, gravid proglottids containing eggs are excreted ubiquitously through the feces, thereby contaminating the environment. When these eggs are ingested by intermediate hosts they develop into large cysticerci in the abdomen and visceral organs of these animals. High prevalence of the tapeworm in definitive hosts may lead to high prevalence of *T. hydatigena* cysticercosis in pigs and cattle (Lan et al., 2011).

Considering the impact on the use of immunodiagnostic tools for the detection of *T. solium* cysticercosis in pigs and *T. saginata* cysticercosis in cattle, a clear view on the actual occurrence of *T. hydatigena* in the intermediate pig and cattle host is needed. Therefore, a systematic review of the prevalence of *T. hydatigena* cysticercosis in pigs and cattle was conducted with the objective of estimating the occurrence of *T. hydatigena* in different continents.

2. Materials and methods

Studies that related to the occurrence, incidence and prevalence of *T. hydatigena* in pigs and cattle were collected. This review included studies in English, French and Vietnamese language with no restriction on research time and publication status. The PRISMA flowchart was used for performing the study (Moher et al., 2009).

2.1. Search

Searching was done systematically in PubMed, Web of Science, Africa Journal Online with search terms and key elements using Boolean operators: (*Taenia hydatigena* OR *cysticercosis tenuicollis* OR cysticercosis) AND (epidemiology OR prevalence) AND (pig OR swine OR porcine OR sow OR bovine OR cattle OR calf OR cow). Articles were also searched on the website: http://www.google.com and the National library of Vietnam with key words: prevalence/epidemiology of helminths in cattle/bovine/pigs/swine/pork; prevalence of *Taenia hydatigena*/*Cysticercus tenuicollis*; abattoir survey in pigs/cattle. Other articles were retrieved from the reference section and citation lists of the full-texts such as original research articles and reviews.

The last search date in PubMed, Web of Science, Africa Journal Online, National library of Vietnam was 30th March, 2015, on the website http://www.google.com this was 25th April, 2015. However, three full-text articles, which were retrieved in PubMed after these dates (11th August, 2015), were also added the review.

2.2. Study selection

After removing duplicates, the titles and abstracts of articles were screened and rejected if they were not related to the pig and/or cattle host such as, human, sheep, goats, carnivores, wildlife; studies on pathology, biology, immunology, treatment, prevention, control, eradication or other diseases were also excluded.

Full-text records were rejected for the following reasons: unsuitable language (not English, French, Vietnamese); not reporting the occurrence of *T. hydatigena* in pigs, cattle; review articles; two articles using the same data. Remaining full-text records were included in a qualitative synthesis. Included records above were rejected for quantitative synthesis if records presented the incidence of *T. hydatigena*, sampling was not comprehensive such as: non-random sampling, the sample size was not clear or the sampling was only done on one of the organs.

2.3. Data collection

Titles, authors, year of publication were collected from every selected article and information of studies such as, animals, time, place, sample size, number of positive samples and diagnostic method were collected from the studies included in the qualitative and quantitative synthesis.

2.4. Statistical analysis

The prevalence of *T. hydatigena* in pigs in individual continents of the world and the prevalence of *T. hydatigena* in cattle in general were estimated using meta-analysis in R Software with package "meta" and based on a random effects model. The difference in prevalence between two continents was considered to be statistically significant in case their 95% confidence intervals did not overlap.

3. Results

3.1. Processing of the research articles used for the analysis

The process for selecting the articles is shown in Fig. 1. From 850 initial records and three extra articles, 104 full texts were retrieved. Twenty six studies were included in the qualitative synthesis. For the quantitative synthesis, the prevalence of *T. hydatigena* cysticercosis was determined in 17 studies, 10 studies in pigs, 6 studies in cattle and one study in both pigs and cattle (Table 1).

Table 1
Characteristics of included studies.

No.	Country	Animals	Period	Region/province	Place	Sample size	No. Pos.	Prevalence (%)	Included	Reference
1	China	Pigs	2009–12	Hunan Province	A	690	177	25.7	P	Yin et al., 2013
2[a]	Vietnam	Pigs	2010–11	Phu Tho Province	A	641	161	25.12	P	Lan et al., 2011
3	Vietnam	Pigs	1983–93	12 southern provinces	H/F	891	283	31.8	P	Huan, 1994
4	Lao	Pigs	2008	Northern Lao	A, C	590	132	22.4	P	Conlan et al., 2012
5	Nepal	Pigs	2008–09	Itahari and Mrigauliya	H/F	–	–	–	O	Devleesschauwer et al., 2013
6	India	Pigs	1977–79	Mathura	A	765	41	5.35	P	Varma and Ahluwalia, 1986
7	India	Pigs	N/A	Uttar Pradesh State	A	1040	83	8.30	P	Pathak and Gaur, 1982
8	Nigeria	Pigs	1972–73	Jos Plateau State	A, H/F	450	10	2.2	P	Fabiyi, 1979
9	Ghana	Pigs	1997	Upper East Region	H/F	60	4	–	O	Permin et al., 1999
10	Tanzania	Pigs	1997–98	Mbulu	A	70	1	1.4	P	Ngowi et al., 2004
11	Tanzania	Pigs	2014	Mbeya	A	243	16	6.6	P	Braae et al., 2015
12	Zambia	Pigs	2001	Southern and Eastern Provinces	A, H/F	65	4	6.15	P	Dorny et al., 2004
13	D.R. Congo	Pigs	N/A	Haut-Zaire	A	N/A	N/A	N/A	O	Chartier et al., 1990
14	South Africa	Pigs	1968–69	Pretoria municipal	A	N/A	N/A	N/A	O	Horak, 1980
15	Ecuador	Pigs	1999	Ibarra, northern Andes	A	N/A	N/A	N/A	O	Rodriguez-Hidalgo et al., 2003
16	Peru	Pigs	N/A	Lima and Huancayo	H/F	N/A	N/A	N/A	O	Gonzalez et al., 1990
17	Peru	Pigs	N/A	Tumbes		142	39	27.5	P	Gomez-Puerta et al., 2015
18	Brazil	Pigs	2008–12	Rio Grande do Sul State	A	N/A	N/A	N/A	O	Monteiro et al., 2015
19	Scotland	Pigs	1964–67	Aberdeenshire to Ayrshire	A	N/A	N/A	N/A	O	Jacobs and Dunn, 1969
20	New Zealand	Pigs	N/A	Carterton, Wairarapa, Auckland, Wellington Manawatu	A	N/A	N/A	N/A	O	Ineson, 1954
21[a]	Vietnam	Cattle	2010–11	Phu Tho	A	369	79	21.41	P	Lan et al., 2011
22	Vietnam	Cattle	N/A	Ha Noi	A	114	6	5.26	P	Chat, 1996
23	Iran	Cattle	2011	Fars	A	500	0	0.00	P	Oryan et al., 2012
24	Iraq	Cattle	2009–10	Ninevah Governorate	A	300	18	6.00	P	Al-Bakri, 2012
25	Saudi Arabia	Cattle	1997	Al-Quassim Area	A	259	1	0.38	P	El-Metenawy, 1999
26	Turkey	Cattle	2008	Malatya –Middle Turkey	A	513	0	0.00	P	Kara et al., 2009
27	Nigeria	Cattle	1977–78	Kano abattoir	A	4844	4	0.10	P	Dada and Belino, 1978

N/A: no information; A: abattoirs; H/F: households or farms; O: study included for qualitative assessment only; P: study included for qualitative and quantitative assessment.
[a] Same study.

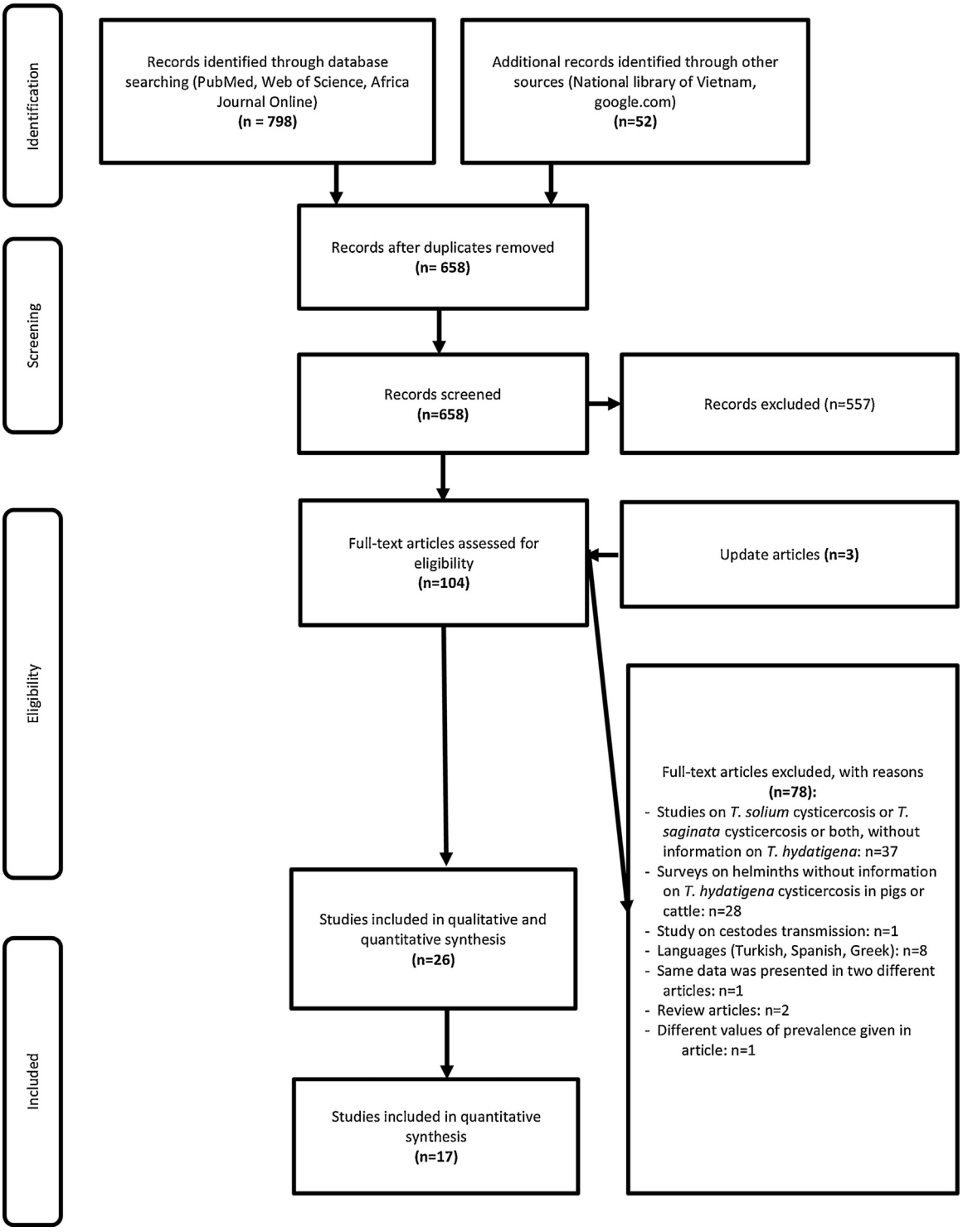

Fig. 1. Flow diagram of search strategy steps.

3.2. *Occurrence of* T. hydatigena *cysticercosis*

T. hydatigena cysticercosis in pigs and cattle was described in all continents (Fig. 2) and necropsy was used as the diagnostic method in all selected articles.

In 12 studies done in nine countries in **Asia**, *T. hydatigena* cysticercosis was present in eight countries and its prevalence in pigs was higher than in cattle. In Southeast Asia, studies showed that *T. hydatigena* not only occurred in pigs, but also in cattle. A survey in slaughterhouses in Phu Tho, Province in North Vietnam reported that 25.1% pigs had *T. hydatigena* cysticercosis (Lan et al., 2011). The burden of cysticercosis was recorded from 1 to 56 cysts. Another survey from 1983 to 1993, reported *T. hydatigena* infection in 31.8% out of 891 pigs in 12 provinces of southern Vietnam (Huan, 1994). In Hunan Province of China, *T. hydatigena* infection was recorded in 25.7% of 690 adult pigs in a survey in local abattoirs between 2009 and 2012. The intensity ranged from 1 to 32 cysts. The predilection site of the cysticercus was the

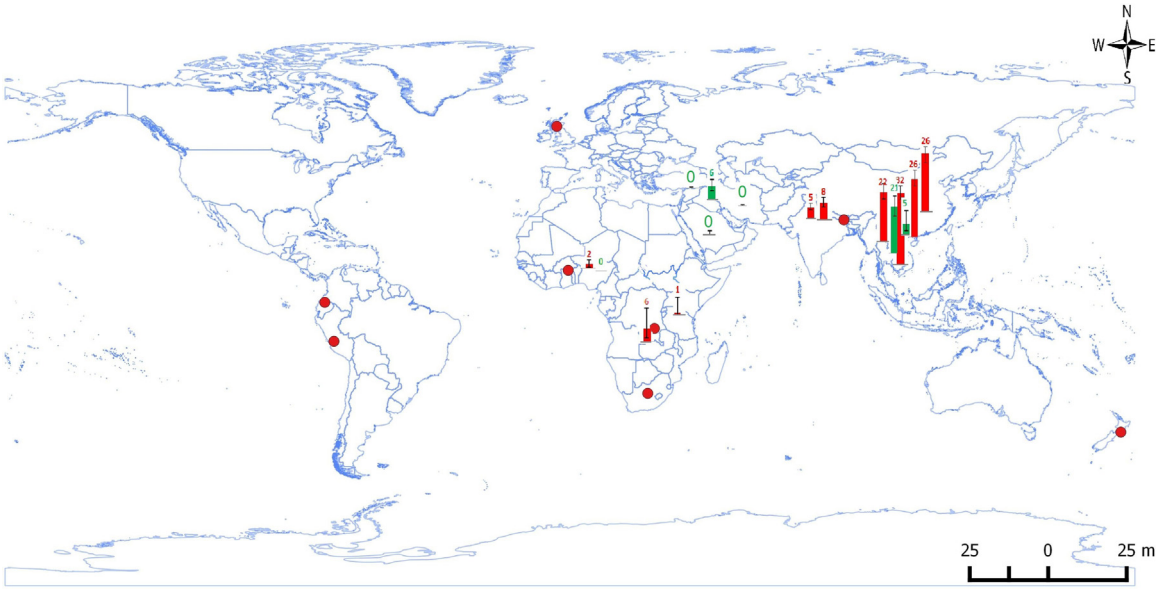

Fig. 2. The global occurrence of *T. hydatigena* cysticercosis in pigs and cattle (based on studies in the review).

mesentery (Yin et al., 2013). In Laos, 590 pigs were examined in slaughterhouses in Xieng Khouang and two collection points in Houa Phanh and Luang Prabang provinces in 2008–2009 (Conlan et al., 2012). The maximum-likelihood adjusted prevalence of *T. hydatigena* in pigs was 55.9% (95% CI = 47.5–64.3%). The observed prevalences of *T. hydatigena* in pigs of different production systems such as, penned/corralled, free roaming and mixed were 19.4% (95% CI: 15.2–23.6%), 29.3% (95% CI: 22.4–36.3%) and 33.3% (95% CI: 0.0–74.4%), respectively (Conlan et al., 2012). In South Asia, 3 studies were conducted in pigs in Nepal and India. In a sentinel pig study in Nepal, 18 one-month-old local piglets were randomly distributed to farmers in two villages and they were allowed to roam freely during twelve months. *T. hydatigena* was revealed by necropsy in two pigs, indicating the occurrence of *T. hydatigena* in pigs in this region (Devleesschauwer et al., 2013). A study on 1040 pigs slaughtered in various abattoirs in Uttar Pradesh State, India during different seasons of the year reported an observed prevalence of *T. hydatigena* of 8.3% (Pathak and Gaur, 1982). In the abattoirs in Mathura, a province of Uttar Pradesh State in North India, *T. hydatigena* infection was recorded in 34 out of 765 pigs (4.6%) in the period between 1977 and 1979 (Varma and Ahluwalia, 1986).

In Phu Tho, North Vietnam 79 out of 369 (21.4%) slaughtered cattle were infected with *T. hydatigena* cysticerci and harbored from 1 to 38 cysts (Lan et al., 2011). In Southern and Western Asia, surveys in India and Iraq reported *T. hydatigena* infection in cattle, while no infection was detected in 500 slaughtered cattle in Iran and 513 slaughtered cattle in Turkey (Kara et al., 2009; Oryan et al., 2012). In Mosul municipality, Iraq, visual routine carcass examination from 2009 to 2010 showed that 18 out of 300 carcasses (6%) of young bulls were positive for *T. hydatigena* cysticerci, while no cysticerci were found in cows and old aged bulls (Al-Bakri, 2012). Only single cysts were seen and they had an average diameter of 5 cm. In Saudi Arabia, only one bull out of 259 indigenous cattle was found infected in a survey at Bureidah abattoir in 1997 (El-Metenawy, 1999).

In **Africa**, there were eight records of *T. hydatigena* cysticercosis, seven of them in pigs and only one in cattle. The prevalence of this infection in pigs and cattle was low. In Nigeria, in Jos Plateau State, an investigation on helminths was carried out on 384 porkers, baconers and adults at various abattoirs and on 66 suckling pigs that died of various causes. Ten pigs were infected with *T. hydatigena* cysticerci in the first groups, no suckling pigs were infected (Fabiyi, 1979). In Ghana, a cross-sectional study was carried out in the Upper East Region to estimate the prevalence of parasitic infections in local cross-bred pigs, between October and November 1997 (Permin et al., 1999). Four of 60 examined pigs (6.7%) from 10 villages had *T. hydatigena* cysts. In southern African countries, during a slaughter survey in four areas of Northern Tanzania between December 1997 and March 1998, only one out of seventy one to two year-old pigs (1.4%) was found infected with *T. hydatigena* cysticerci (Ngowi et al., 2004). Sixteen (6.6%) of 243 slaughtered pigs from Mbeya district, Western Tanzania were infected with *T. hydatigena* cysts. Intensity of infection was low, with the majority of pigs harboring one cyst and a few pigs harboring two cysts (Braae et al., 2015). In Zambia, a study on *T. solium* in 65 pigs (from the Chibolya slaughter slab in Lusaka and from villages in the Katete and Petauke districts in the Eastern Province) showed that four pigs were infected with *T. hydatigena* cysts (Dorny et al., 2004). Infection with *T. hydatigena* was also reported in slaughter pigs in Haut-Zaire, Congo in 1986–1987, in a study on helminths in 82 pigs, but the prevalence was not mentioned (Chartier et al., 1990). In a study on helminths in lungs, livers and gastro-intestinal tracts of pigs, collected in the Pretoria municipal abattoir in South Africa in 1968–1969 (Horak, 1980), the presence of *T. hydatigena* in pigs was also reported. In cattle, a survey on cysticercosis in Kano abattoir in Nigeria from September 1977 to March 1978 showed a low observed prevalence of *T. hydatigena* with 1% infected out of 4844 animals examined (Dada and Belino, 1978).

Several studies reported the occurrence of *T. hydatigena* cysticercosis in pigs in **South American** countries. In Peru, a study on estimating the prevalence of *T. solium* and comparing different diagnostic techniques showed that out of 66 pigs selected from Lima and Huancayo, 4 pigs were infected with *T. hydatigena* cysticerci on necropsy (Gonzalez et al., 1990). Another study in Tumbes Province, an endemic area for *T. solium* cysticercosis in North Peru, reported a prevalence of *T. hydatigena* of 27.5%, with a parasite burden of 1–12 cysts per animal (Gomez-Puerta et al., 2015). In neighboring Ecuador, a study on *T. solium* cysticercosis in pigs, cattle and humans conducted in 1999, showed the occurrence of *T. hydatigena* in pigs in a slaughterhouse in Ibarra (Rodriguez-Hidalgo et al., 2003). In Brazil, fifty-eight cysts were found in livers during veterinary inspection of swine slaughtered in the central/northern

region of Rio Grande do Sul State from 2008 to 2012; in 56.9% of those cysts (33/58) infection with *T. hydatigena* was confirmed by PCR (Monteiro et al., 2015). However, no information was given on its occurrence in cattle in two slaughterhouses.

Only one study in **Europe** and one in **New Zealand** were found. In Scotland, *T. hydatigena* was seen in one of 3800 pigs from 1964 to 1967 (Jacobs and Dunn, 1969). In New Zealand, in a study on the parasites of wild and domestic pigs examined at the slaughterhouse of J.C. Hutton, *T. hydatigena* cysticerci were found in 30 out of 59 pigs (Ineson, 1954).

3.3. *Estimating the prevalence of* T. hydatigena *cysticercosis in pigs and cattle*

In **pigs,** the sample size, number of positive samples with *T. hydatigena* cysticercosis was extracted from 10 studies: six in Asia, four in Africa and only one in South America. The pooled prevalence of *T. hydatigena* cysticercosis in pigs in Asia was higher than in Africa. With a 95% confidence interval, the prevalence in Asia was between 10.6% and 26.8%, the prevalence in South America was between 20.8% and 35.4%, which were significantly higher than the prevalence of 1.9% to 7.9% in Africa. Especially, in eastern Asian countries such as China, Vietnam and Laos, *T. hydatigena* cysticercosis in pigs was common with prevalences between 22% and 32%.

In **cattle,** the number of studies on *T. hydatigena* was limited. From six studies in Asian countries and one study in Africa, the pooled prevalence was between 0.2% and 5.2% with 95% confidence interval.

4. Discussion

Our study has revealed that few data on *T. hydatigena* prevalence in pigs and cattle are available and that data are unevenly distributed, as such solid conclusions are difficult to draw. However, some marked differences between continents were found.

In pigs, the prevalence was around 17.4% in Asia, which was significantly higher than the 3.9% found in Africa. In Asia, the reported prevalence of *T. hydatigena* tapeworm infection in dogs is high in general (Pathak and Gaur, 1982; Adinezadeh et al., 2013; Ajlouni et al., 1984; Lan et al., 2011). In addition, Lan et al. (2011) reported a strict proportional relationship between the prevalences of *T. hydatigena* tapeworms in dogs and cysticerci in pigs. Therefore, the high prevalence of *T. hydatigena* in dogs in Asia may explain the high prevalence of *T. hydatigena* cysticercosis in pigs. However, the prevalence of *T. hydatigena* in dogs in Africa was also found to be high in some countries (Bentounsi et al., 2009; Islam and Chizyuka, 1983; Pandey et al., 1987). Although *T. hydatigena* is also commonly reported in sheep, goats and dogs in Africa (Wondimu et al., 2011; Nwosu et al., 1996; Saulawa et al., 2011), the lower prevalence of this parasite in pigs is in contrast with the situation in Asia. One reason could be that different isolates of *T. hydatigena* occur in these continents and that an "Asian" *T. hydatigena* isolate would be more adapted to a dog-pig lifecycle or more common than an "African" isolate. Indeed, a high level of genetic variation was observed within *T. hydatigena* (Rostami et al., 2015). Abidi et al. (1989) reported that *T. hydatigena* of goat and pig origin probably represent two different strains; while two different strains infecting sheep and goats were also reported based on morphological characterization of *T. hydatigena* (Singh et al., 2015).

Although very few data were found on *T. hydatigena* in pigs in South America, the few records show a high prevalence, comparable to that in Asia. For instance, a recent study in Peru reported a 27.5% prevalence (Gomez-Puerta et al., 2015). In the Valdivia province of Chile, 44.5% out of 344 pigs examined were found to be infected with *T. hydatigena* (Oberg and Valenzuela, 1977).

Few studies on *T. hydatigena* in cattle were found. Although there was a low prevalence in general, some studies showed a high prevalence in some areas such as in Vietnam with 21% of the cattle infected (Lan et al., 2011). It is difficult to explain the reasons for the lower prevalence in cattle compared to pigs. It could be due to the different feeding behavior of pigs and cattle, or, as mentioned above for the pig host, related to different isolates of *T. hydatigena.*

These findings should be considered in the context of some limitations. Firstly, most of the surveys were conducted in abattoirs; therefore, the number of adult animals is overrepresented, in comparison with younger age groups. Specific information of the animals such as, management systems and age was lacking. Secondly, all studies used carcass inspection as a diagnostic method and the result depends on the skills of the inspectors. Thirdly, most of the studies were on the prevalence of helminths in general, only five of the 26 studies included specifically investigated the prevalence of *T. hydatigena.* The non-zoonotic aspect of these parasites probably explains the low interest of inspectors/researchers; therefore, the absence of information on the presence of *T. hydatigena* might be due to no diagnosis rather than on not being present. Finally, differentiation of *T. hydatigena* cysticerci and hydatid cysts may be difficult, leading to possible misclassification.

Despite these limitations, the findings on the prevalence of *T. hydatigena* in pigs and cattle in different areas may assist in assessing the usability of serodiagnostic methods of zoonotic cysticercosis in these animal species in different contexts. In regions where the prevalence of *T. hydatigena* in pigs or cattle is high, serological tests that are prone to cross-reactions should not be used (Rodriguez-Hidalgo et al., 2006). In African countries, where the prevalence of *T. hydatigena* in pigs and cattle is lower and the expected prevalence of zoonotic cysticercosis in these animals is high, immunodiagnostic methods can be considered for prevalence estimation because the number of false positives due to cross-reaction is less significant. However, the existence of a proportion of false-positives has to be taken into account and should be assessed in every study. This can be done by necropsy and dissection of at least a subset of seropositive animals. When control programs will be implemented the reduction in prevalence of zoonotic cysticercosis calls for a reconsideration of diagnostic tools to be used. If the prevalence of *T. hydatigena* in pigs and cattle is low and the expected prevalence of zoonotic cysticercosis in the same animals is also low, using these methods will significantly effect on results, because the number of false positive tests due to *T. hydatigena* and the number of true positive tests will equally contribute to positive test results. If immunodiagnostic tests are used, well-designed and controlled pen trials to measure the competitive interactions in the pig intermediate host, serologically and by cyst enumeration, would be very valuable (Conlan, 2013).

From another perspective, the presence of *T. hydatigena* cysticercosis may provide pigs with protective immunity because of genus-conserved immunogenic antigens (Conlan et al., 2012). Porcine cysticercosis (*T. solium*) has been reported as endemic in Latin America, some parts of Asia and Africa. Therefore, with a concerted effort to identify, treat, and follow-to-cure *T. solium* tapeworm carriers, thereby reducing the infection pressure on pigs, continued exposure of pigs to *T. hydatigena* eggs may assist in further reducing *T. solium* transmission (Conlan et al., 2012).

5. Conclusions

A high prevalence of *T. hydatigena* in pigs was recorded in Asia and South America while the prevalence in Africa was low. In cattle, overall prevalence was low. However, in general, few studies

on the occurrence of *T. hydatigena* cysticercosis in pigs and cattle have been conducted; therefore, more studies are needed to gather comprehensive data on the occurrence of *T. hydatigena*. The possibility of biological differences in *T. hydatigena* isolates should be explored to find out whether genetic variation could explain the different prevalences recorded between animal species and between regions. In addition, the specificity of serological tests for the diagnosis of zoonotic cysticercosis in pigs and cattle should be improved to avoid cross-reactions with *T. hydatigena*.

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