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**RUNNING HEAD:** Epilepsy and Cysticercosis in Western Kenya

**Abstract**

Cysticercosis is the leading cause of acquired epilepsy worldwide and has been shown to be highly prevalent in pig populations in Western Kenya. We conducted a community-based door-to-door survey in a region of Western Kenya with a high proportion of pig-keeping households. Persons with epilepsy (PWE) were determined using a screening questionnaire followed by a neurologist evaluation. Cysticercosis serum apDia antigen ELISAs and Western blot for LLGP and rT24h antigen were performed on all PWE and 2% of screen-negative patients. All PWE or with positive apDia underwent contrast-enhanced brain computed tomography (CT). Of a sample of 810 village residents, 660 (81%) were present in the homestead of whom 648 (98%) participated. Of these, 17 were confirmed to have lifetime epilepsy, an estimated crude prevalence of 2.6%. No humans with (n=17) or without (n=12) epilepsy had serological evidence of cysticercosis infection. Fourteen PWE and one individual with borderline positive apDia antigen ELISA underwent brain CT; none had radiographic findings consistent with neurocysticercosis. Nearly 30% of households kept pigs with 69% always tethered in both wet and dry seasons. Over 8% (6/72) of pigs had palpable lingual cysts; these pigs all originated from homesteads with latrines, one-third of which were free-ranging at least some of the time. Epilepsy prevalence in our study was greater than the national prevalence, but we found no individuals with epilepsy attributable to cysticercosis. Additional studies are required to identify causes of epilepsy, human and porcine cysticercosis, the role of spatial clustering, and protective factors like host-pathogen immunity.

## 1. Introduction

Nearly 65 million people are estimated to have epilepsy worldwide of whom 80% live in developing countries and between 56 and 75% do not receive appropriate epilepsy treatment (known as the epilepsy treatment gap).(1-4) Further, mortality rates in persons with epilepsy (PWE) are approximately 2-3 times higher in low-income countries than in the middle- and high-income countries.(5) Active epilepsy prevalence in rural coastal Kenya is between 2.9 and 7.8 per 1000 people, nearly 3-6 times higher than the global active epilepsy prevalence,(6, 7) and over 70% of Kenyan PWE are not receiving appropriate epilepsy treatment.(8)

Neurocysticercosis is the leading cause of acquired epilepsy in the developing world and is due to infection of the brain with the larval form of the pork tapeworm *Taenia solium*. Approximately 50 million people are infected with neurocysticercosis worldwide, and neurocysticercosis is thought to occur in up to 30% of people with epilepsy or seizures in endemic regions such as India, Central and South America.(9-11) However, the prevalence of neurocysticercosis in persons with epilepsy in sub-Saharan Africa varies widely, ranging from 23.2% in an endemic area of Zambia,(12) but only 2.8% in northeastern Tanzania.(13) Moreover, exposure to other parasites, such as *Onchocerca volvulus* or *Toxoplasma gondii,* is associated with active epilepsy in sub-Saharan Africa (sSA).(14)

In Kenya, little is known about human neurocysticercosis though porcine cysticercosis is common and has been widely studied.(15, 16) Studies of small-holder pig-keeping communities in Kenya revealed that 10-17% of pigs had lingual cysticercal cysts.(17, 18) In rural Western Kenya, the prevalence of porcine cysticercosis by HP-10 Antigen (Ag) ELISA testing was 32.8% in a rural population(15) and 37% among pigs entering the food chain.(16) Spatial clustering of cysticercosis has also been demonstrated in several regions throughout the world, which may

79 greatly affect susceptibility of pig-to-human cysticercosis transmission and subsequently
80 neurocysticercosis prevalence.(20-22) Our objective was to to determine the prevalence of
81 epilepsy, human neurocysticercosis and human and porcine cysticercosis in a village with
82 unknown cysticercosis and neurocysticercosis prevalence located within a region of Western
83 Kenya. This region was of particular interest as it has been previously reported to have a high
84 proportion of pig-keeping households and elevated prevalence of human and porcine
85 cysticercosis throughout.(16, 18).
86
87 **2. Methods**
88 We conducted a three-stage door-to-door community-based assessment of a typical Western
89 Kenyan village with a high proportion of pig-keeping households between 25th February and 3rd
90 June 2015 to determine the prevalence and association between epilepsy, human and porcine
91 cysticercosis.
92 **2.1.** ***Study population and sampling****:* We selected a sub-location (Busibwabo) from a region in
93 Western Kenya that was roughly a 45km radius semi-circle centered on the town of Busia,
94 Kenya. This region was chosen as it is representative of the wider Lake Victoria crescent zone
95 and is known to have a high prevalence of human and porcine cysticercosis based on results of
96 prior studies.(16, 18) We subsequently identified a village (Bumanyi) within this region with a
97 high proportion of pig-keeping households based on discussions with local representatives of the
98 Ministry of Agriculture, traders in pork meat, village elders, and a reconnaissance of the area.
99 We included all household members irrespective of age or sex, and we did not have any
100 particular exclusion criteria.

**2.2. *Human Procedures:*** In *Stage 1*, we surveyed the head of the household to answer a household questionnaire, as well as a 9-question epilepsy screening questionnaire adapted from Placencia, et al. that was translated into the local languages (Kiswahili and Kiluhya).(24, 25) This questionnaire reliably detects convulsive epilepsies, but its sensitivity for other epilepsy types is unknown(26). A caregiver was asked to answer on behalf of children under age 12 years. A brief health examination was performed on all individuals.

In *Stage 2*, all human individuals who screened positive for epilepsy on the epilepsy screening questionnaire underwent a detailed history and physical examination by a study neurologist (ACM and DS), as well as phlebotomy and blood testing for detection of Ag (cysticercal antigen). A random sample of 2% of the individuals who screened negative for epilepsy also underwent venipuncture.

In *Stage 3*, all human individuals with confirmed lifetime epilepsy who were ≥5 years of age underwent contrast-enhanced Computed Tomography (CT) of the brain at Aga Khan Hospital in Kisumu, Kenya. Head CT was done in children <5yrs only if they had a focal neurological deficit or positive cysticercal Ag. Head CT was also performed in individuals who screened negative for epilepsy but had a positive cysticercal Ag result. Contrast-enhanced CT of the brain was performed using standard protocols and read by two independent radiologists blinded to the cysticercal serostatus and presence or absence of epilepsy. One radiologist had expertise in local epidemiology (PR) and the second was a neuroradiologist with expertise in East Africa (FM). Any discprepancies would be resolved by a 3$^{rd}$ radiologist. However, there were no discrepancies between the neuroradiologists. CT protocol was performed with and without contrast, including 8mm slice thickness with a 4mm gap between CT slices in the

supratentorial brain region, and 5mm slice thickness with a 2.5mm gap in the infratentorial region.

**2.3. *Porcine Procedures:*** We examined all pigs in the household. We excluded pigs who were <3 months of age, pregnant or lactating. We administered a brief health survey and performed a physical examination and phlebotomy. Physical examination and phlebotomy were undertaken by trained and experienced animal health technicians. We excluded pigs who were pregnant, lactating or under 3 months of age and an exam was not performed on these. The ventral surface of the tongue was examined for the presence of cysticerci after restraining the pig with a snare behind the canine teeth and using a short stick to open the mouth and cotton gauze to protract the tongue. Anterior vena cava blood samples were collected.(28)

**2.4. *Cysticercosis testing:*** Blood samples were collected in BD Vacutainer® 10-ml plain tubes and were transported to the field laboratory on ice where they were centrifuged at 3000 rpm for 20 minutes at room temperature. Sera were then aliquoted into 2ml cryovials and stored at -40°C between 2 to 5 months until they were transported on dry ice to the International Livestock Research Institute (ILRI) facility in Nairobi where they were stored at -80°C between 2-16 months prior to laboratory analysis. Ag ELISA was performed at ILRI using the apDia Cysticercosis Ag ELISA kit, a commercially available enzyme immunoassay for qualitative determination of viable metacestodes (cysticerci) of *Taenia spp* (ApDia, Turnhout, Belgium). Cut-off values were calculated according to kit instructions. Subsequently, samples were transported on dry ice to the Centers for Disease Control and Prevention (CDC) in the United States where enzyme-linkned immunoelectrotransfer blot (EITB) assay developed at the Center for Dsiease Control in the US using lentil lectin-bound glycoproteins (LLGP) extracted from *T. solium* cysticerci were performed, with a sensitivity of 99% and specificity of 99% for

diagnosing NCC(30) on all human and porcine samples. The EITB detects antibodies to any one of seven cyst-derived glycoproteins including GP50, GP39-42, GP24, GP21, GP18, GP14 and GP13. The sensitivity of EITB with two or more intracranial cysts present is 100% with 99% specificity in serum.(30, 31). rT24h antigen, a recombinant *T. solium* protein antigen, was also performed at the CDC on all human and porcine samples with a sensitivity of 99% and specificity of 100% for detection of NCC.(30)

***2.5. Definition of study outcomes***

We defined human and porcine cysticercosis and human neurocysticercosis using the following definitions:

1. Epileptic seizure: An epileptic seizure is a clinical manifestation (sudden and transitory abnormal phenomena) presumed to result from an abnormal and excessive discharge of a set of neurons in the brain, perceived by the patient or an observer. It might include alteration of consciousness or motor, sensory, autonomic, or psychic events. Febrile and eclamptic seizures were excluded from analyses.(32)
2. Lifetime Epilepsy: Lifetime epilepsy consisted of two or more unprovoked epileptic seizures in a lifetime. An episode of status epilepticus or multiple seizures occurring in a 24-hour period were considered a single event.(32)
3. Active epilepsy: A person with active epilepsy is an individual who meets criteria for lifetime epilepsy *and* has had at least one epileptic seizure in the previous 5 years, regardless of antiepileptic drug treatment.(32)
4. Treatment Gap: The proportion of individuals with active epilepsy not currently taking anti-epileptic drugs.(33)

5. Human cysticercosis, neurocysticercosis and neurocysticercosis-related epilepsy: Standard clinical diagnostic criteria were used for human neurocysticercosis relying primarily on CT scans and serological testing as this community-based sample did not have acute complaints. Neurocysticercosis-related epilepsy was defined as an individual with active epilepsy and probable or definite neurocysticercosis.(34, 35)
6. Porcine cysticercosis: was defined as the presence of lingual cysts or positive-Ag on the ApDia Ag-ELISA.(15)

**2.6. *Statistical Analyses:*** We used each household as the primary sampling unit. We described the demographic and health characteristics of the human and porcine study participants. We generated crude, age and age- and sex-adjusted prevalence estimates using an internal reference population both for active and lifetime epilepsy using binomial regression. All analyses were conducted in Stata version 14.

**2.7. *Ethics:*** This study was approved by the Institutional Research Ethics Committee (ILRI-IREC2014-16) and Institutional Animal Care and Use Committee (ILRI-IACUC2014.36) of the International Livestock Research Institute (ILRI), Kenya and the Human Investigation Committee (HIC) at Yale University, USA. ILRI IREC is registered and accredited by the National Commission for Science, Technology and Innovation in Kenya and approved by the Federalwide Assurance for the Protection of Human Subjects in the USA. The IACUC at Yale exempted the protocol.

## 3. Results

The village was made up of 154 households among which five did not consent to participate and four were not present for at least two attempted visits. Of 810 village residents, 660 (81%) were

191 present in the household of whom 648 (98%) participated (Figure 1). Median household size was
192 4 (Interquartile Range [IQR]: 3, 6) and the median number of children per household was 4
193 [IQR: 3, 7], and 24% grew crops for sale (Table 1). About one-third of adults were married
194 (32%), and around two-thirds had primary school education or less (73%) and were farmers
195 (76%).

196 Over 28% (41/145) of households kept pigs, of which 97% (70/72) were the local pig
197 breed and 58% (41/71) were procured from another village, and 23% (16/71) from another home
198 in the same village. The median number of pigs in pig-keeping households was 1 [Range:1-7]
199 and two households had suckling piglets. Less than half (43%) of pigs had been given veterinary
200 treatment in the prior 12 months (83% of these a general de-wormer) and among those 30 pigs,
201 the primary treatment provider was a household member (86%) with a minority receiving
202 treatment from an animal health assistant (6%) or veterinary drug supplier; Table 3.

203 Approximately 70% (52/72) of pigs were always tethered in both wet and dry seasons.
204 Over 73% (469/643) of individuals reported always using a latrine (Table 1), and significantly
205 more pig-keeping households having a latrine that was completely closed (33% vs. 16% among
206 non-pig-keeping households; p=0.03). Pig-keeping households were significantly more likely to
207 keep other livestock: cattle (p=0.004), chickens (p=0.24) and dogs (p=0.001) in the home. Nearly
208 one-quarter of non-pig keeping households had electricity in the household, while 42% of pig-
209 keeping households had access to electricity (p=0.04) (Table 1).

210 **3.1.** ***Epilepsy:*** There were 36 individuals who screened positive for epilepsy and one additional
211 individual was identified as a PWE by a family member. Of these, 30 were evaluated by a
212 neurologist of whom 17 were confirmed positive after neurologist review (Figure 1). Alternative
213 diagnoses included syncope (5), chills (1), fasciculations/muscle fatigue (3), Parkinson's Disease

(1), behavioral episodes (1), febrile seizure (1). Crude lifetime epilepsy prevalence was 26.2 per 1000 population (95%CI: 15-42) and age- and sex-adjusted prevalence was 36 per 1000 population (95%CI: 13-59). Crude active epilepsy prevalence was 22 per 1000 population (95%CI: 13-36) and age-and sex-adjusted prevalence was 36 per 1000 population (95%CI: 15-57) (Table 2).

The median age of PWE was 16 years [IQR: 12, 21] and 53% were female (9/17). The clinical phenotype of seizures in a majority was generalized tonic-clonic, though 12% (2) reported focal onset of seizures. The median age of seizure onset was 8 years (IQR: 2, 13) and only two individuals had onset above 18 years of age. A family history of epilepsy was reported in 53% (9/17) of PWE (first- and second-degree relatives). A history of malaria was reported in 41% (7/17) and febrile seizures in 18% (3/17). An abnormal neurological exam was reported by the examining neurologist for 29% (5/17) of PWE and developmental delay in 24% (4/17). The current epilepsy treatment gap was 71% (12/17) but 59% (10/17) reported having taken AEDs in the past. Nearly half (47%; 8/17) ever sought treatment for seizures from traditional healers at least once. Among five PWE currently taking AEDs, three were taking carbamazepine and two phenobarbital.

**3.2. *Human and Porcine Cysticercosis:*** None of the PWE had serological (n=10) or radiographic (n=15) evidence of cysticercal infection by Ag-ELISA, (Figure 1, Table 2). Of the 12 randomly sampled individuals without epilepsy for whom serological testing was performed, two individuals without epilepsy with trace positive Ag-ELISA had CT scans performed. Neither had radiographic evidence of cysticercal infection and follow-up Western Blot testing was negative. Over 8% (6/71) of pigs had palpable lingual cysts; these pigs all originated from

236 households with latrines and 33% (2/6) were free-ranging at least some of the time. None (0/53)
237 of the pigs had serological evidence for cysticercosis (Figure 1).

238 **4. Discussion**

239 Epilepsy prevalence across sSA, including East Africa, varies widely. Our study found a
240 lifetime epilepsy prevalence of 2.6%, comparable to studies from other countries of sSA(36-39),
241 higher than others(8, 41-45) attributable to differences in sampling, screening methods and
242 diagnostic criteria utilized.(46) The treatment gap in our study was 64%, similar to other
243 treatment gap prevalence reported in the region (67%-79%)(8, 37, 42, 46-49). NCC is thought to
244 be the most common cause of epilepsy worldwide, however, our study did not find evidence of
245 NCC among those who screened positive for epilepsy, nor among the sample that screened
246 negative for epilepsy.(9-11) Prior studies from nearby regions demonstrated the prevalence of
247 human *Taenia spp*. infection was 19.7% (95% CI 16.7-22.7) and porcine *Taenia spp.* infection
248 was 17.2% (95% CI 9.1-25.3) using Ag-ELISA.(18) Another study from the same region
249 reported an even higher porcine cysticercosis prevalence of 37.6% (95% CI 29.3-45.9%) using
250 the same assay.(16)

251 Despite reports of high prevalence of human *Taenia* infection and porcine cysticercosis in
252 the region,(16, 18) all PWE nor pig had negative cysticercal serology using either Ag-ELISA or
253 immunoblot antibody testing in this small study. There may be several reasons for this. First,
254 Most of the data on NCC and epilepsy come from Latin America, with few studies from Eastern
255 Africa. One study from rural Tanzania(52) found that definite NCC lesions were present on CT
256 in only 2.4% of persons with epilepsy compared with 1% of the study population without
257 epilepsy. A higher prevalence of CT-defined NCC was reported in Rwanda with 7.4% of PWE
258 having definite NCC lesions on CT.(53) Variability exists across sSA with several factors that

may contribute to NCC prevalence across the region. Environmental, animal husbandry, household and individual risk factors known to affect the prevalence of human and porcine cysticercosis are similar between the low cysticercosis prevalence village we studied and the high prevalence surrounding Kenyan,(18, 19) including age and gender distribution, pork consumption, low household wealth, limited access to and use of latrines, and free-roaming pigs.(19, 54-56) In our study, all households with pigs in our study were kept in homes with a latrine,and some evidence suggests that this may decrease the risk of cysticercal seropositivity(57). Moreover, other causes of epilepsy, such as other endemic infections (i.e. *Onchocerca volvulus* or *Toxoplasma gondii*) associated with epilepsy in sSA,(14) or traumatic brain injury or hypoxic brain injury at birth should be considered.

Extensive inter-country variability exists in human cysticercosis prevalence ranging from 0 to 21.5% and in porcine cysticercosis (0 to 56.7%) using cysticercal Ag detection.(19, 59) One potential explanation for the variability of cysticercosis prevalence may be spatial clustering of infection leading to inter-village variability, a finding that has been reported in endemic regions worldwide.(19, 20, 22) One recent study in Peru found that strong clustering of porcine cysticercosis occurs near areas with a high prevalence of tapeworm carriers within rural northern Peru.(22) Therefore, a better understanding of potential protective factors against cysticercosis infection and special clustering may inform future refinements to the design of elimination strategies.(60)

Although no pig was antigen nor antibody positive, there were six pigs with palpable lingual cysts. Palpation of lingual cysts is known to be poorly sensitive for porcine cysticercosis, thus, our results may have been due to other infectious causes of cysts such as *Taenia hydatigena* or *Taenia asiatica*(61). We do not expect a false positive lingual cyst finding as all veterinary

technicians were trained in porcine lingual palpation, therefore, it is possible that the lingual cysts detected were from an infection other than *Taenia solium* as the potential for cross-reactivity between *Taenia* species exists.

Limitations to this study included only testing a small proportion of individuals with serum sample for seral cysticercal Ag or head CT which may have underestimated the true prevalence of cysticercosis and neurocysticercosis in this single village. Moreover, since we surveyed only one village in this region of Western Kenya, the findings from this study cannot be generalized to the district or national level. In addition, more recent guidelines recommend a cut-off of one year of time to define active epilepsy due to problems of recall over longer periods of time.(68) In our study, we used a five-year cut-off to define active epilepsy using other guidelines which may be more susceptible to inaccurate reporting and recall.(32) We did not collect stool samples as part of the study which may limit the findings of this study.

## 5. Conclusions:

The prevalence of epilepsy and the epilepsy treatment gap were high in a rural village of Western Kenya. Untreated hypertension was also common in this group. In contrast to regional estimates, the prevalence of human and porcine cysticercosis in this village was very low and no individuals with epilepsy were found to have neurocysticercosis on head CT. This may be due to spatial clustering of infection, partial immunity due to prior infection with other *Taenia spp.*, a small geographical size sampled, or other unmeasured social and environmental factors. Moreover, the ecology of free range pig-keeping means that the household level risk associated with latrine provision may be strongly influenced by provision at broader geographical scales.(58) Wide scale surveys of infectious causes of epilepsy are required to establish baseline prevalence of neurocysticercosis in areas of known cysticercosis transmission and to create an

indicator for measuring impact of *Taenia* control activities.Future research to better understand potential protective factors and the impact of spatial clustering on the epidemiology of cysticercosis may aid in tailoring cysticercosis elimination strategies. In addition, a better understanding of the infectious and non-infectious causes of epilepsy in developing countries is an important step toward reducing epilepsy burden.

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543 **Table 1. Household and individual human health and demographic characteristics (n=144).**
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545

| | Overall |
|---|---|
| **Household Characteristics** | (n=144) |
| Household Size [median (IQR)] | 4 (3, 6) |
| | |
| **Latrine** | |
| Household has a latrine [% (n)] | 76% (109) |
| All latrines in household completely closed [% (n)] | 20% (29) |
| | |
| **Keep Other Animals** | |
| Cattle [% (n)] | 62% (89) |
| Goat [% (n)] | 12% (17) |
| Chicken [% (n)] | 88% (126) |
| | |
| **Socio-Economic Status** | |
| Electricity [% (n)] | 29% (42) |
| Mains | 7% (10) |
| Solar | 19% (28) |
| | |
| **Individual Characteristics** | n=643 |
| Females [% (n)] | 57% (365) |
| Age in years [median (IQR)] | 14 (7, 32) |
| Child [% (n)] | 61% (389) |
| Married [% (n)] | 32% (203) |
| Years lived in village [median (IQR)] | 18 (6,35) |
| Number of children [median (IQR)] | 4 (3, 7) |
| | |
| **Education/Occupation Among Adults** | |
| Primary school education or less [% (n)] | 73% (185) |
| Farming as primary occupation [% (n)] | 76% (192) |
| | |
| **Health and Sanitation** | |
| Worms in feces in last year [% (n)] | 27% (156) |
| Took de-worming medication in last month [% (n)] | 2% (14) |
| Always uses latrine for defecation in last month [% (n)] | 73% (469) |
| Livestock have access to home [% (n)] | 75% (484) |
| | |
| **Water Source** | |

| | |
|---|---|
| Primary water source, wet season [% (n)] | |
| Well or Borehole | 66% (472) |
| Roof | 85% (604) |
| Primary water source, dry season [% (n)] | |
| Well or Borehole | 61% (439) |
| River or Spring | 87% (619) |
| Do not treat drinking water [% (n)] | 15% (99) |
| | |

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**Table 2. Crude and adjusted prevalence of lifetime and active epilepsy, human and porcine cysticercosis*.**

| | Prevalence (per 1000 population) [95% CI] | |
|---|---|---|
| **Lifetime Epilepsy** | | |
| Crude | 26 | [15, 42] |
| Crude Female | 22 | [9, 42] |
| Crude Male | 32 | [15, 60] |
| Age-Adjusted | 30 | [12, 49] |
| Age-Sex-Adjusted | 36 | [13, 59] |
| **Active Epilepsy** | | |
| Crude | 22 | [13, 36] |
| Crude Female | 14 | [6, 32] |
| Crude Male | 32 | [17, 61] |
| Age-Adjusted | 26 | [9, 43] |
| Age-Sex-Adjusted | 36 | [15, 57] |
| | | |
| **Cysticercosis** | | |
| *Human* | | |
| Epilepsy | 0 | [0, 308]* |
| Without Epilepsy | 0 | [0, 265]* |
| *Porcine* | | |
| Lingual examination | 85 | [32, 175] |
| Serology | 0 | [0, 67]* |

* One-sided, 97.5% confidence interval

**Crude, age and age-and-sex-adjusted prevalence estimates were generated using an internal reference population as the reference population.

557 **Table 3. Demographic and health characteristics of the porcine population (n=72).**
558

| **Porcine Population:** | |
|---|---|
| Local Pig Breed [%(n/N)] | 97% (70/72) |
| Age (months) [median (IQR)] | 4 (2, 6) |
| Females [%(n/N)] | 55% (40/72) |
| Pregnant | 18% (7/40) |
| Lactating | 10% (4/40) |
| Pig Source [%(n/N)] | |
| Another village | 58% (41/71) |
| Another home, same village | 23% (16/71) |
| Home | 18% (13/71) |
| Market | 1% (1/71) |
| Obtained any treatment for pig in prior 12 months [%(n/N)] | 43% (30/69) |
| Treatment type [%(n/N)] | |
| De-worming Tablet | 83% (25/30) |
| Drench | 10% (3/30) |
| Tablet and Spray | 3% (1/30) |
| Multivitamin | 3% (1/30) |
| Self or household member was Treatment provider [%(n/N)] | |
| Self or Household member | 86% (26/30) |
| | |
| Pigs always tethered in dry season [%(n/N)] | 72% (52/72) |
| Pigs always tethered in wet season [%(n/N)] | 74% (53/72) |
| | |
| Palpable tongue cyst on examination [%(n/N)] | 8% (6/71) |
| Raise pigs to sell [%(n/N)] | 93% (67/72) |
| | |
| | |

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561 **Figure 1. Recruitment and Study Flow.**
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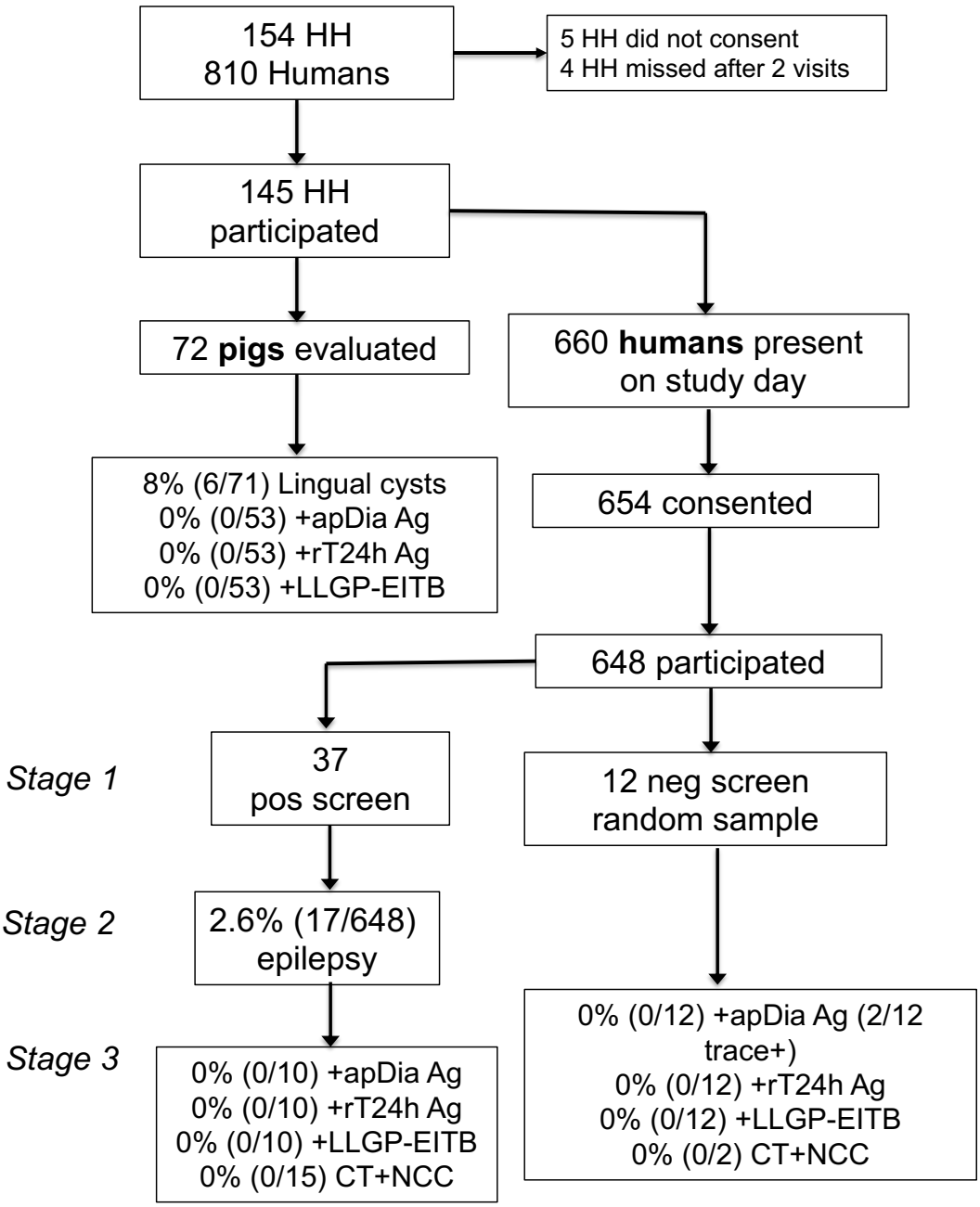


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565 * Two individuals had trace positive testing on the apDia Cysticercosis Antigen ELISA.
566 Abbreviations: +CC serology: apDia Cysticercosis Antigen ELISA, LLGP, rT24 Ag above cut-
567 off value; CT+NCC: Contrast-enhanced Computed Tomography of the Brain consistent with
568 diagnosis of neurocysticercosis; HH: Household; neg: negative; pos: positive.