

The marketing of cysticercotic pigs in the Sierra of Peru

The Cysticercosis Working Group in Peru¹

In Peru pork supplied through regulated slaughterhouses is primarily restricted to the large cities on the coast. Approximately 65% of the pork consumed in the country is obtained through informal channels that are not inspected or supervised. The pathways via which pigs are commercialized were studied in Huancayo, a city in the Peruvian Sierra where cysticercosis is endemic. Official purchase, slaughter, and market records were reviewed. Also, direct surveys and participant observation were carried out at two local live pig markets and at two informal meat markets.

Pigs were not processed in local slaughterhouses; instead, they were butchered informally. The proportion of cysticercotic pigs detected by tongue examination ranged from 14% to 25% of the total sold. Since cysticercotic pigs and pork are sold through informal markets, surveys of abattoirs and meat markets are not a reliable way to monitor the prevalence of porcine cysticercosis in Peru. We estimate that 48% of the pork traded informally and 23% of the total pork consumed in Huancayo is derived from pigs that are infected with cysticercosis.

Introduction

Cysticercosis, a disease caused by the metacestodes of *Taenia solium*, is a serious public health problem in many developing countries in Latin America (1), Asia, and Africa (2). In humans, the cyst of the taenia tapeworm can produce severe neurological disability and mortality (3–7). In Peru, up to 12% of the neurological beds in hospitals are devoted to patients with cysticercosis (8). The disease is chronic and sufficiently severe to prevent employment of the affected individual. Cysticercosis is a zoonosis, pigs

being the normal intermediate host, but unlike other taeniid tapeworms, the cystercerci of *T. solium* also may develop in humans.

In the Peruvian highlands and high jungle, pigs are an important part of the village economy. WHO has suggested that control of cysticercosis is most easily accomplished through slaughterhouse inspection (9).^a In areas such as Peru, where human cysticercosis is highly endemic, official slaughterhouse records indicate very low rates of porcine cysticercosis because nearly all pigs are killed clandestinely. In the Peruvian highlands, the average household owns 2–3 pigs (10). These pigs are one of the few items that can be easily and rapidly converted into cash and, therefore, have a significant commercial value to the *campesinos* (peasant farmers). Without a realistic understanding of the sale and consumption of pork, suitable control measures for cysticercosis cannot be initiated. This study details how *T. solium*-infected and non-infected pigs and pork are marketed in a central sierra zone of Peru where cysticercosis is highly endemic.

Materials and methods

Huancayo (population, 500 000) is located at an altitude of 3215 m (560 km west of Lima) and is the major agricultural and commercial centre of the

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Department of Junin in the Peruvian central highlands. Agricultural products from the western part of the country are funnelled through Huancayo to Lima.

All the observations and counts were made from 5 May to 1 June 1989, except for the purchase of 52 butchered pigs in May 1988.

Formal sector

Official sources. General information on the sale of pigs in Huancayo was obtained first by interviewing officials of the regional office of the Ministry of Agriculture, the Huancayo National Statistics Office, and the veterinary inspector of Mercado Modelo, the official local wholesale market in Huancayo.

Slaughterhouses. Interviews were conducted at two local government slaughterhouses in the El Tambo and Huancayo districts (Fig. 1) to determine the number of pigs killed annually and the number and fate of cysticercotic pigs. In both abattoirs veterinarians were in charge of meat inspection. The veterinarians corroborated that the official slaughterhouses are responsible for enforcing the rules for porcine cysticercosis and stated that all infected pigs must be incinerated without economic compensation to their owners.

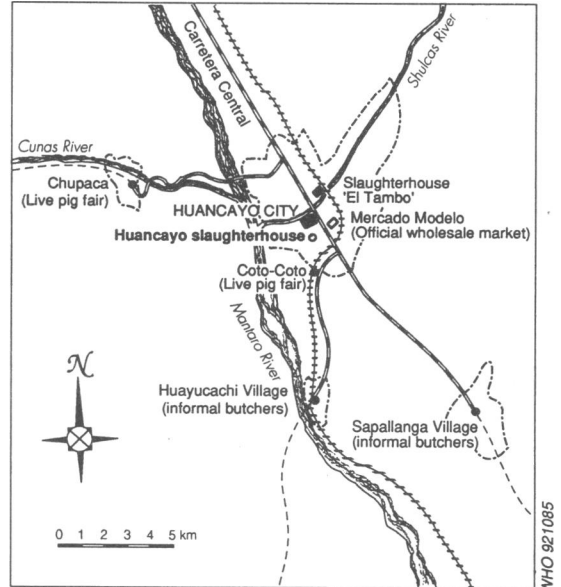
Central meat market. The Mercado Modelo (Fig. 1) is the local wholesale market for all the meat sold officially in Huancayo. The meat inspector and butchers were interviewed at this market. The inspector was asked about the source of the meat, the number of pigs killed, and the number and fate of cysticercotic pigs. Ten individuals who sold pork in the Mercado Modelo were interviewed and asked where they bought their meat, to whom they sold it, and what they do if they have infected meat.

Informal sector

Live pig markets (fairs). *Description.* Observations were made at two local live pig markets (sale fairs) in Coto-Coto and Chupaca, on the periphery of Huancayo (see Fig. 1), where pigs are brought for non-regulated sale once a week. No official inspection of pigs is made at these markets. Pigs are bought in the following fashion. First, a buyer will agree on a price and pay the seller; the pig's tongue is then examined by a local expert. If the tongue is negative, the pig is accepted by the buyer. If the findings of tongue examination are questionable or positive, the money is returned to the buyer. The buyer then either renegotiates a lower price or cancels the transaction.

Local market observations. Pigs' tongues were examined by a local village expert prior to the pur-

Fig. 1. Map of Huancayo showing the locations of the formal and informal pig fairs and markets.



chase of each pig. The examination consisted of palpating nodules and/or visual identification of cysticercus cysts. Each pig was placed on its side and firmly restrained, and a hard rubber or wooden rod was used to keep its mouth open. A veterinarian then gently pulled the tongue using a cloth and examined and palpated the base. The pig was considered positive for cysticercosis if cyst-like nodules were either seen or felt. The results of the tongue observations by local experts and the buyer-seller-negotiated transactions were used to determine the proportion of cysticercosis-positive pigs. The number of positive and negative tongue examinations performed in the two pig fairs over the study period was determined.

Purchase of live pigs. A total of 18 live pigs with cysticercosis-positive tongue examinations were purchased at the two live pig fairs and later slaughtered (11). The sellers were subsequently asked where they bought and sold infected pigs. An unstructured format was used to question the sellers because of their reticence to answer direct questions about cysticercotic pigs.

Informal butchers. *Description.* Pigs are sold to butchers who slaughter them at their homes in the villages of Huayacachi and Sapallanga on the periphery of Huancayo (Fig. 1). The butchers then sell the carcasses to meat vendors or directly at the infor-

mal meat market. Meat sold at the latter market is bought for resale at the formal meat market where inspections are carried out.

Purchase of butchered pigs. Informal butchers at six illegal butcheries in the village of Huayucachi were visited. Usually, 2–5 pigs are killed weekly in each butchery. All pigs that were being killed were inspected by the study team after paying a small examination fee. Veterinary inspection to detect cysts was performed as described previously (11). In addition, the pigs' heads, facial muscles, and brains were examined for cysts; the proportion of animals with cysts was determined from these examinations. The butchers also provided information on where and how they sell infected meat.

Informal meat market. Description. An informal meat market is held once a week in Huayucachi and Sapallanga; whole carcasses, rather than meat cuts, are primarily sold. Only cysticercosis-negative meat is offered openly. However, cysticercosis-positive meat is clandestinely traded to well-known customers.

Pig and pork counts at informal markets. Two observers at each live pig fair counted the number of pigs (>3 months old) sold weekly for four consecutive weeks. Counts of the number of whole carcasses sold were also made at the informal markets over the same period.

Informal sources. Interviews were performed at village pig sale fairs, at local unofficial meat markets, and with village butchers. Three questions were asked at each interview: Where was the pig bought? Where will the pig or pork be sold? What will you do if the pig has evidence of cysticercosis? A total of 20 interviews were conducted with each of the following three groups of individuals: sellers of live pigs at fairs; those buying pigs at the fairs for the purpose of slaughter; and sellers of pig carcasses in the informal meat market in Huayucachi.

Processed meat. All the infected meat is mixed with healthy meat and sold clandestinely by meat processors. Data on meat processing and trading were obtained from two sellers of infected meat who were interviewed after having won their confidence.

Results

Formal sector

Official information. Based on estimates by the National Statistical Office, in 1988 there were 35 000 pigs in Huancayo (XVI Agrarian Sector). Of this number, 25 000 are butchered per year (ca. 1220 tonnes of meat per annum). Officially none of

the inspected and condemned meat in Huancayo was reported to be cysticercotic. The two official abattoirs butchered only 18 pigs in 1988 and none in 1989. Personnel from these abattoirs denied knowing where to buy or sell live pigs.

Official meat market. The meat sold in this market was graded for its quality and inspected for cysticercosis. No restrictions were placed on the sale of the meat, based on where or how the carcass was obtained. Infected meat was not sold in this market. The number of adult pig carcasses offered for sale in the formal market in 1989 is shown in Table 1. At four visits to the market (every Monday over the observation period), 220 pig carcasses were inspected and two were found to be infected. These carcasses were then returned to their owner.

Informal sector

Live pig markets (fairs). Official pig inspections were never observed in over 10 separate visits to each fair. Instead, tongue inspections were routinely performed by local peasants to help set the price of the pigs. Infected pigs were often sought by buyers because of their lower price. Buyers mentioned that they also examined the pigs' tongues for scars; sellers apparently would excise cysts from the tongue in order to increase the price of the pig. Based on the findings of the tongue examinations performed by buyers, about 15% of the pigs sold at the fairs were considered to be infected (see Table 2).

The sellers of infected pigs indicated that infected meat was butchered and sold only to individuals who were known to them. Sellers stated that meat was also occasionally transported to other cities for sale.

Table 1: Number of adult pig carcasses offered for sale in the formal market (Mercado Modelo), Huancayo, 1989^a

Day	Mean number of carcasses \pm SD
Monday ^b	55.00 \pm 9.70
Tuesday	16.50 \pm 3.10
Wednesday	20.25 \pm 4.35
Thursday ^b	56.75 \pm 6.13
Friday	24.00 \pm 12.93
Saturday	41.50 \pm 6.35
Sunday	39.50 \pm 5.74

^a Shown are the mean number of carcasses offered for sale on each day of the week over a 4-week observation period: 5 May to 1 June 1989 (data from Mercado Modelo records).

^b Most carcasses were bought on Monday and Thursday ($P < 0.001$).

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Table 2: Results of the tongue examinations at Chupaca and Coto-Coto live animal fairs^a

Week ^b	Chupaca		Coto-Coto	
	No. of pigs	No. positive	No. of pigs	No. positive
1	45	7 (16) ^c	61	9 (15)
2	52	9 (17)	57	8 (14)
3	39	6 (15)	69	10 (14)
4	48	7 (15)	72	9 (13)

^a The examinations were performed by an expert peasant.

^b Observation period: 5 May to 1 June 1989.

^c Figures in parentheses are percentages.

Live pig purchases. We bought infected pigs (based on observations of previous negotiations) at the Chupaca and Coto-Coto fairs to establish their price and obtain information on the sale of infected pigs and meat. Our buyer purchased only infected pigs. In every instance, owners asked the same price for these animals as for noninfected pigs (in general, the mean price per kilo was around US\$ 1.14). After bargaining, 18 pigs were sold (estimated price per kilo for infected meat: US\$ 0.89 ± 0.192).

Informal butcheries. A total of 52 pigs were inspected at six informal butcheries. Examination of the heads and carcasses of these pigs indicated that seven (14%) had cysticercotic cysts in the muscles or brain. Interviews with the informal butchers revealed that infected meat was sold either to another city or for use in *chicharrones* (fried pork). Infected meat was sold only to individuals known to the seller.

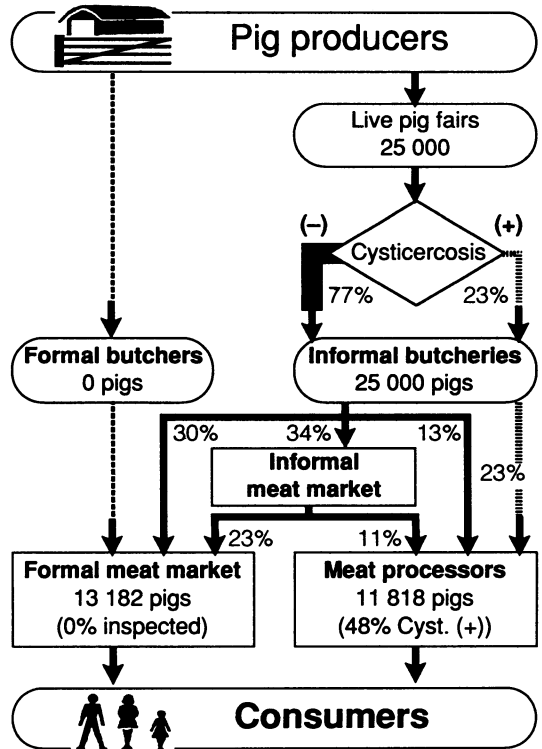
Pig counts. A total of 271.75 ± 61.81 live pigs (95% confidence limits) were traded at Coto-Coto and 265.25 ± 73.25 in Chupaca. In addition, 91 ± 26 adult pig carcasses were registered in Huayucachi and 73 ± 15 in Zapallanga.

Processed meat market. Two processed meat sellers were interviewed. Both admitted to selling infected meat: small quantities of infected meat were mixed with noninfected meat and the mixture was then roasted or fried in fat (*chicharrones*).

Market survey

Questionnaires did not reveal any sources of pigs or pork other than those described above. Based on the responses to these questionnaires, the various market options for infected and noninfected meat are shown in Fig. 2. The tongue test used by the village experts is 70% sensitive and 100% specific (13). We conservatively estimate that 16% of pigs offered for sale in the fairs are tongue-positive for cysticercosis. Based on these assumptions, we calculate that 48% of the

Fig. 2. Schematic representation of marketing pathways for pigs sold in the vicinity of Huancayo.



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meat sold to meat processors and up to 23% of the pigs sold to consumers are infected with cysticercosis.

Discussion

The study demonstrates that in the Peruvian Sierra pigs are sold only in the informal sector. Pigs were not brought to official government slaughterhouses for butchering. Porcine cysticercosis is so common in the study area that one out of every five or six pigs is likely to be infected. Such pigs would normally be confiscated and destroyed if they were channelled through the formal sector. Pigs are not killed in official slaughterhouses in the other two largest Andean cities, Cuzco and Huaraz; however, pigs are killed in slaughterhouses that carry out inspections in the large coastal cities where porcine cysticercosis is rare (12-14). Statistics based on slaughterhouse records in areas where pigs are killed clandestinely are therefore misleading and should not be used to estimate the incidence of porcine cysticercosis in Peru.

Cysticercosis severely modifies marketing customs. In areas that are endemic for porcine cysticercosis, few if any *campesinos* have their pigs inspected formally; instead, they use local informal butcheries (15). Consequently, the owners of the pigs do not suffer severe economic loss since they can sell the carcasses or meat clandestinely.

Infected pigs have tremendous market value to their owners and the threat of confiscation without recompense by official inspectors forces farmers to use the informal sector to sell their pigs. The current system of control, or lack thereof, reinforces the clandestine marketing of pigs and enables sellers to camouflage infected meat by mixing it with healthy meat or dyeing it with red sauce at the time of sale.

One way to circumvent these problems would be to establish an official market for infected meat. The meat bought there at a somewhat lower price could then be processed using methods that would kill all cysts. Such a method is currently in use in Mexico (16). Preliminary studies carried out in Peru in conjunction with the present study indicate that administration of albendazole to infected pigs for 1–3 days may kill the cysts in muscle; this or other drugs could be used prior to slaughtering the animals or in village control programmes. Educational programmes also would be helpful; for example, farmers could be educated to corral their pigs, and consumers could be made aware that eating cysticercosis-infected meat might result in human infection, with attendant symptoms.

Estimation of the true prevalence of porcine cysticercosis, especially in areas where the human form of the disease is endemic and where clandestine sales of pigs are common, will require pigs to be sampled in the villages or fairs using either necropsy, tongue examination, or serology. Slaughterhouse records often obscure rather than assist attempts to estimate the extent of porcine cysticercosis.

A surprisingly high proportion of the pork sold in Huancayo came from pigs that were infected with cysticercosis. This may explain why over 10% of neurological patients in Peru are serologically positive for cysticercosis (8). The true prevalence of human cysticercosis in many developing countries, such as Peru, remains unquantified. The rates, however, may be quite high in rural areas because *campesinos* and vendors purposely bypass formal slaughterhouses and sell cysticercosis-infected meat. Such meat, if improperly handled, can cause human infection. In addition, the continued practice of allowing pigs to feed from open pit latrines used by humans can only continue to exacerbate the problem. The belief that *S. taenia* is not common anywhere in the world (17) is gradually beginning to disappear.

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Résumé

La commercialisation des porcs atteints de cysticercose dans la sierra péruvienne

La cysticercose humaine, causée par les larves de *Taenia solium*, est devenue un important problème de santé au Pérou. Les dossiers des abattoirs officiels indiquent un taux d'atteinte très faible chez le porc (hôte intermédiaire), la plupart des porcs étant abattus puis vendus par des voies non officielles. Comme ce sont les hôtes intermédiaires naturels de *T. solium*, nous avons mené une enquête au Pérou afin de déterminer de quelle manière les porcs infestés et non infestés sont commercialisés dans la région d'Huancayo, connue pour être une région d'endémie de la cysticercose du porc.

Les renseignements relatifs aux méthodes d'abattage, à l'inspection, et à la commercialisation officielles des produits finis du porc ont été obtenus auprès des autorités du Ministère de l'agriculture et des inspecteurs vétérinaires des abattoirs officiels, ainsi que sur le marché de gros local. Des renseignements correspondants pour les pratiques officieuses ont été rassemblés au cours d'inspections et d'entretiens informels avec des vendeurs et des acheteurs de bêtes sur pied dans les foires, dans des boucheries non officielles et sur les marchés parallèles de la viande.

Sur les 35 000 porcs élevés dans la région d'Huancayo en 1988, 25 000 ont été vendus sur pied et abattus de façon non officielle. Pratiquement aucun porc n'a été abattu dans les abattoirs officiels. Environ 23% des porcs vendus étaient atteints de cysticercose, révélée par l'examen de la langue. Toute la viande ainsi contaminée a été soit vendue à des clients bien connus, soit mélangée à de la viande saine et vendue après transformation. La viande non contaminée (77%) a été distribuée sur le marché officiel de la viande (30%), sur le marché parallèle (34%) ou pour transformation (13%). La viande introduite sur le marché parallèle par cette voie a ensuite été soit commercialisée officiellement (23%), soit vendue pour transformation (11%). D'après les renseignements recueillis, on estime que dans la région d'étude, environ 48% de la viande vendue pour

transformation et 23% de la viande vendue aux consommateurs sont contaminés.

En raison de la valeur que représentent les porcs pour leurs propriétaires dans les régions où la cysticerose est endémique, peu d'entre eux prennent le risque de faire inspecter leurs animaux. Au lieu de cela, des méthodes parallèles d'inspection, de vente, de boucherie et de commercialisation sont employées pour faire en sorte que les propriétaires ne souffrent pas du manque à gagner qu'entraîne la confiscation de la viande contaminée par les autorités officielles. En attendant que des mesures appropriées de lutte contre la cysticerose soient mises en place pour répondre à la situation, il est probable que les porcs comme les populations de ces régions continueront à montrer des taux élevés de cysticerose. Ces données s'avéreront peut-être un jour utiles pour définir des stratégies de lutte contre cette infestation.

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