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TAENIASIS AND CYSTICERCOSIS IN HOUSEMAIDS WORKING IN AFFLUENT NEIGHBORHOODS IN LIMA, PERU

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Abstract. *Taenia solium* taeniasis/cysticercosis is endemic in most developing countries, where it is an important cause of epileptic seizures and other neurologic symptoms. In industrialized countries, cysticercosis results from travel or immigration of tapeworm carriers from endemic areas. In both endemic and nonendemic countries, housemaids commonly immigrate from cysticercosis-endemic areas and can transmit the infection if they carry the adult tapeworm. Between July 2001 and July 2002, 1,178 housemaids (961 of them work in the top five most affluent districts of Lima, a metropolis of 8 million inhabitants considered nonendemic for cysticercosis) were evaluated for serum antibodies to *Taenia solium* and stool microscopy for taeniasis and cysticercosis. The serosurvey revealed a prevalence of cysticercosis-specific antibodies of 14.6% (95% CI 12.6–16.6%), and stool microscopy detected 12 *T. solium* tapeworm carriers, for a prevalence of taeniasis of 1.2% (95% CI: 0.6–1.8%). A nonrandom sample of 26 seropositive housemaids was examined by brain CT and 50% of them had brain lesions compatible with neurocysticercosis, mainly calcifications. From the families who used a tapeworm-carrier housemaid, cysticercosis antibodies were detected in 6 (23%) of 26 persons who agreed to participate. One seropositive member of the employer families was symptomatic for seizures and had brain calcifications. The prevalence of tapeworm infections in this housemaid group is similar to levels in endemic areas, constituting a source of neurocysticercosis infection.

INTRODUCTION

Taenia solium taeniasis/cysticercosis is an important public health problem in most developing countries, where it causes seizures and other neurologic problems.[1] As globalization increases, tourism, refugee movements, and immigration from endemic regions have resulted in more neurocysticercosis (NCC) cases in areas where it was previously considered rare or nonexistent.[2,3]

Ingestion of infected pork is not required to acquire cysticercosis, which is transmitted fecal-orally by the ingestion of infective eggs excreted by a tapeworm carrier. However, a common mistake is to look for a history of contact with pigs or infected pork and neglects the search for the tapeworm carrier, which in fact is the key for transmission. This was clearly exemplified in an "outbreak" of neurocysticercosis in unrelated families from an Orthodox Jewish community in New York in 1991, where the diagnosis of NCC was initially not considered by the attending neurologists.[4] The overall seroprevalence in this nonendemic community (1.3%) was unexpectedly high,[5] most likely originated from tapeworm-carrier housemaids who immigrated from cysticercosis-endemic areas.

In endemic countries, housemaids also usually migrate from cysticercosis-endemic areas to work in nonendemic areas for people with higher socioeconomic standards. We performed a serological and parasitological survey to determine whether taeniasis/cysticercosis was prevalent in housemaids working in five of the wealthier districts of urban Lima, a nonendemic metropolis with 8 million inhabitants.

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MATERIALS AND METHODS

Selected population. According to the ratings from the National Institute of Statistic and Informatics (considering a number of variables that include the educational level of family members, number of electrical appliances, communication services, and others),[6] San Isidro, San Borja, Miraflores, Surco, and La Molina are the most affluent districts of Lima, the capital city of Peru, considered nonendemic for cysticercosis. Houses in those districts have all modern amenities including potable water supply, bathrooms, closed sewage systems, and electricity. Residents of these districts normally buy food from local supermarkets and hardly ever eat at street food vendors. About 60% of those families hire domestic employees (housemaids) that cook, help in the kitchen, or take care of children. Housemaids are usually young females who migrated from rural areas, and most of them attend adult primary or secondary schools at the evenings.

Targeting this housemaid population, we recruited volunteers from eight adult schools and one free medical clinic for housemaids. Previous to recruitment, a house-by-house information campaign was launched including a flyer about cysticercosis and the study itself. The study was approved by the Ethics Committee of the Peruvian National Institutes of Health.

Before entry into the study, all subjects received detailed information about the procedures and the purpose of the investigation and were asked to read and sign a written informed consent form. A standard socioeconomic questionnaire was administered to all housemaids including questions on place of origin, history of pig husbandry, household characteristics (water supply, sewage), history of taeniasis, and neurologic symptoms including headache, seizures or fainting, and family history of seizures. Four blood drops were obtained by finger-stick from each subject and spotted on a filter

paper, which was then left to dry and stored at room temperature until use. This method of blood sample collection has been used before in epidemiologic studies.[7] To confirm seropositive cases, a second blood sample of 5 mL was taken by venipuncture on all subjects who tested positive on the filter paper sample. Both filter paper blood samples and serum samples were tested in the Cysticercosis Unit of the Instituto de Ciencias Neurologicas (ICN, the national referral center for neurology in Peru) by enzyme-linked inmunoelectrotransfer blot (EITB) assay using purified *T. solium* glycoprotein antigens as developed by the Centers for Disease Control and Prevention and originally described by Tsang and others.[8]

Participating individuals were also given disposable plastic cups and asked to collect three stool samples. We provided information to participants on personal hygiene, care during sample collection, sample management, and potential biohazards. Stools were microscopically examined after concentration by both the formol-ether method[9] and by sedimentation in water.[10] Individuals found to have *Taenia* spp. eggs in stools were treated with niclosamide and a purgative.[11] All samples from volunteers from the recruitment sites were accepted and processed, but the surveys were only administered to housemaids.

All tapeworm carriers and a nonrandom sample composed of the 30 first volunteer housemaids with positive serology were invited to have a noncontrasted brain CT scan performed at the ICN in a Siemens Somatom IV machine using 10-mm slices. A neuroradiologist who did not know the results of the EITB assay read the scans.

Contacts at households of employers. Housemaids diagnosed as carrying a tapeworm were interviewed in private to give them their results and asked for their permission to communicate the findings to their employers. All of them consented, and the study team visited each of these households, explained the disease and the purpose of the study, and invited all household members to participate in blood testing by EITB and noncontrasted brain CT scans.

Statistical analysis. Data entry and analysis was performed using SPSS 12.0 (SPSS Inc., Chicago, IL). Associations between categorical variables were assessed using the χ^2 test or Fisher's exact test as appropriate, and associations between continuous variables were tested by Student's *t* test or Mann-Whitney test.

RESULTS

Population characteristics. Between July 2001 and July 2003, a total of 1,183 female housemaids were recruited at 7 adult schools (N = 1,009, 85.3%) and one free medical clinic for housemaids (N = 174, 14.7%) and asked to fill out a written survey, provide a finger-prick blood sample, and collect three stool samples. These included 966 housemaids working in the target wealthier districts of Lima (five of whom refused blood sampling and were excluded) and 217 housemaids who worked in other districts. Although housemaids from other districts were not considered in the original study design, their characteristics were highly similar, differing significantly only in the proportion reporting mild headache (Table 1), so we decided to incorporate their data in the main analysis group.

The ages of the 1,178 participant housemaids ranged from 10 to 72 years with a mean of 22.7 years, a median of 20, and an interquartile range of 17 to 24 years. Most of them were born in departments from the highlands (904, 76.7%), some in the coast (223, 18.9%) and a small proportion in departments from the jungle (50, 4.2%); birthplace was not recorded in one case. Approximately half of those born in the coast (107 of 223, 48.0%) were born in Lima. Also, almost half of the participants reported having potable water at their house of origin (563 of 1,168, 48.2%), and a smaller proportion had sewage (454 of 1,167, 38.9%). Porcine husbandry was reportedly practiced by 72.2% (845 of 1,170) of the households of origin. The median length of residence in Lima for the housemaids (analyzed only in those not born in Lima) was 5 years, with an interquartile range between 3 to 8 years, mean of 7 years, and range from less than 1 month to 58 years.

TABLE 1
Comparison of baseline characteristics of housemaids from upper socioeconomic class districts (Group 1) and other districts (Group 2)

	Target districts, Group 1 (N = 961)	Other districts, Group 2 (N = 217)	P
Age	22.8 ± 9.0	22.3 ± 8.2	0.972
Origin	90 (9.4%)	17 (7.8%)	0.563
Lima	95 (9.9%)	21 (9.7%)	0.974
Other coastal cities	739 (77.0%)	165 (76.0%)	0.855
Highlands jungle	36 (3.7%)	14 (6.5%)	0.110
Length of stay in Lima (years)	7.1 ± 7.1	7.3 ± 8.4	0.391
Pig raising	686/955 (71.8%)	159/215 (74.0%)	0.587
Potable water	460/952 (48.3%)	103/216 (47.7%)	0.926
Sewage	370/952 (38.9%)	84/215 (39.1%)	0.982
Headache			
No	579/955 (60.6%)	149/215 (68.7%)	0.034
Mild	260/955 (27.2%)	42/217 (19.4%)	0.021
Moderate/severe	116/955 (12.1%)	26/217 (12.0%)	0.962
Seizures	34/953 (3.6%)	7/217 (3.2%)	0.966
Family history of seizures	136/955 (14.2%)	38/217 (17.5%)	0.264
Positive serology (EITB)	143 (14.9%)	29 (13.4%)	0.642
Stool samples collected	101 (10.5%)	61 (28.1%)	< 0.001
None	357 (37.1%)	100 (46.1%)	0.018
1	503 (52.3%)	56 (25.8%)	< 0.001
≥ 2	10/860 (1.2%)	2/156 (1.3%)	1.000
Positive to *Taenia*			

Seroprevalence. All positive results on filter paper were also positive when testing the serum sample obtained by venipuncture. Seroprevalence of specific antibodies to *T. solium* was 14.6% (172 of 1,178, 95% confidence interval 12.6–16.6%). The higher seroprevalence was found in housemaids from coastal departments excluding Lima (30 of 116, 25.9%), followed by those from the highlands (132 of 904, 14.6%). Lower seroprevalence ratios were found in housemaids born in Lima (8 of 107, 7.5%) or in the jungle where there was only one seropositive individual (1 of 50, 2.0%). Seropositive individuals reported having raised pigs in a higher proportion of cases (135 of 171, 78.9% versus 710 of 999, 71.1%, OR 1.53, P = 0.034). There were no statistically significant differences between seropositive and seronegative persons in regard to age, length of residence in Lima, seizures, headaches, or seizures in relatives.

Stool examination results. Overall coverage for stool sample collection was 86.2% (1,016 of 1,178). More than half of patients brought at least 2 stool samples (559, 55.0%). A

total of 12 *Taenia* carriers were detected, for an overall prevalence of taeniasis as detected by stool microscopy of 12 of 1,016, 1.2% (95% CI 0.6–1.8%). There were some differences in stool sample collection: coverage was higher in the target group of housemaids from wealthy districts (86.2%, 860 of 961) than in maids from other districts (71.9%, 156 of 217), as was the proportion of individuals who brought more than one stool sample (503 of 860, 58.5%, versus 56 of 156, 38.5%). However, the prevalence of taeniasis was similar (10 of 860, 1.16%, versus 2 of 156, 1.28%).

The 12 carriers were younger (mean age 17 years, median 16.5, IQR 15–18.8 versus mean 22.8, median 20, IQR 18–24, $P = 0.001$, Mann-Whitney test) and had lived in Lima for a shorter time (mean 3.1 years, median 3, IQR 1.3–4.0 versus mean 7.3, median 5, IQR 3.0–9.0; analysis considering only 8 tapeworm carriers not born in Lima) ($P = 0.036$, Mann-Whitney test). There were no statistically significant differences between tapeworm carriers and controls in regard to a history of raising pigs, sanitation, seizures, headaches, and seizures in relatives (albeit this analysis was limited by the small number of tapeworm carriers).

All tapeworm carriers were treated with niclosamide,[11] and the species diagnosis was confirmed to be *Taenia solium* infection after the recovery of proglottids, which were examined by histology and PCR.[12]

Prevalence of other parasites. Other intestinal parasites found were *Giardia lamblia* ($N = 58$, 5.7%), *Trichuris trichura* ($N = 31$, 3.1%), *Hymenolepis nana* ($N = 29$, 2.9%), *Ancylostoma duodenale/Necator americanus* ($N = 27$, 2.7%), *Ascaris lumbricoides* ($N = 19$, 1.9%), *Strongyloides stercoralis* ($N = 15$, 1.5%), *Enterobius vermicularis* ($N = 4$, 0.4%), and *Fasciola hepatica* ($N = 3$, 0.3%).

Computed tomography. Overall, 38 brain CT scans were performed to 26 seropositive subjects and 12 tapeworm carriers (also seropositive). Half of the seropositive had brain lesions compatible with NCC, mostly calcifications. Two had viable cysts. Brain lesions were less frequent in the tapeworm carriers (Table 2).

Cysticercosis among the families of employers. Two out of the 10 families in the target districts employing a tapeworm-carrier housemaid refused any participation. From 30 family members in 8 participating families, 26 gave blood samples and 16 had a brain CT scan performed. Six persons (23%) were positive by EITB and one person (6%) showed a brain calcification compatible with NCC (Table 3). This person had already been diagnostic with NCC and treated with antiepileptic drugs. Another family member had a nonconfirmed history of a brain inflammatory lesion in the past year.

TABLE 2
Brain CT findings on 23 seropositive volunteer and 10 tapeworm-carrier housemaids

Group	Brain CT scan findings
Seropositive volunteers	Normal ($N = 13$)
	Compatible with NCC ($N = 13$)
	Single calcification ($N = 4$)
	Multiple calcifications ($N = 7$) (2,2,2,3,3,4,5)
	Single viable cyst ($N = 1$)
	Multiple viable cysts and calcifications ($N = 1$)
Taenia carriers	Normal ($N = 9$)
	Abnormal, not NCC ($N = 1$) (cerebellar hemiatrophia)
	Compatible with NCC ($N = 2$)
	Single calcification ($N = 1$)
	Viable cyst ($N = 1$)

TABLE 3
Serological and CT scan findings in employer's family members

Family	Length of cohabitation	Family members	EITB (+)	NCC on CT scan
1	48	3	1/1	1/1 (calcifications)
2	48	2	0/2	0/2
3	30	2	0/2	—
4	60	1	0/1	0/1
5	24	8	4/8	0/5
6	36	2	0/2	0/1
7	3	4	0/4	0/4
8	24	8	1/6	—
Total		30	6/26 (23.1%)	1/14 (7%)

DISCUSSION

The 1.2% prevalence of tapeworm infection found among housemaids working in upper socioeconomic class households in Lima is comparable with prevalence levels in endemic villages, marking these individuals and their employer families at risk of acquiring cysticercosis infections and potentially neurocysticercosis. Surveys in disease-endemic communities report prevalnces between 0.3% and 6%,[13] and populations with prevalence over 1% are considered hyperendemic.[14] Despite being high, the prevalence of taeniasis detected by our survey is probably an underestimation. Microscopy is poorly sensitive for detecting taeniasis. Cases detected increase 2- to 3-fold when stool antigen detection by ELISA (coproantigen detection) is used.[14] We were not able to use coproantigen results because the technique was still being standardized in our laboratory at the time of this study.

The housemaid population represents a migrant group generally typified by young women from rural areas who recently arrived in a big city, and domestic work is usually their first job. The age-specific prevalence distribution for taeniasis shows a sharp decrease and completely disappears after age 22 (Figure 1). This is compatible with a short life span of the tapeworm (current assumptions calculate the life span of *T. solium* between 3 to 5 years). However, there was one tapeworm carrier who had lived in Lima for 7 years. She could have been infected during return visits to her hometown or by eating pork products sent by relatives from endemic areas. Albeit unlikely, we cannot exclude the possibility that some of them became infected in Lima. Three of the tapeworm carriers lived in the same neighborhood and shopped for meat in the same market.

Seroprevalence in endemic villages ranges from 5% to 20%.[14] Age-specific seroprevalences for young females using EITB can only be extracted from two field serosurveys, and they were 3%[15] and 11%,[16] not different from the average seroprevalence in these populations. The seroprevalence for cysticercosis in this series (14.6%) is among the higher reported values and thus is consistent with an immigrant endemic population. We used finger-prick samples collected in filter paper for screening serology.[7] This collection method

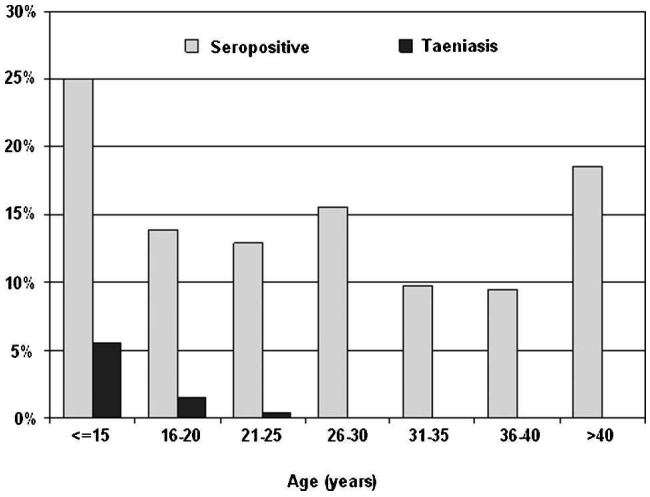

FIGURE 1. Prevalence of serum antibodies to cisticercosis on EITB and intestinal taeniasis by age group.

proved highly reliable: all positive results were confirmed with a venous blood sample. Whether the sensitivity of the diagnosis was affected and the real seroprevalence was even higher cannot be assessed by this study design.

An important characteristic of this study was the access to housemaids outside their work environment, which facilitated their cooperation. Many of them could have refused to participate if the study was conducted at their work places because of the lack of control on access to their test results by their employers. Many housemaids are insecure about their work positions. Our approach to recruitment permitted us to explain the disease and its mode of transmission to the housemaids and assure them that they will be treated and cured so that their employers would not have any excuse for terminating them from their jobs.

CT scan showed that 50% of a selected sample of seropositive subjects had brain lesions compatible with NCC, but there was no correlation between lesions and symptoms. This has also been shown by some epidemiologic studies in endemic areas.[17,18] We cannot conclude that NCC is asymptomatic in this group of patients because some of them could have hidden their symptoms to avoid being stigmatized by their classmates. It is also unknown whether asymptomatic patients with cerebral lesions could turn symptomatic later.

We found 6 seropositive cases of infection (23%) in the employer's upper socioeconomic class families. Given that employer's family members were in general reluctant to participate, control families (employers from housemaids who did not carry a tapeworm) were not recruited because their cooperation for blood sampling and time-consuming CT tests was even less likely. However, the seroprevalence found in this subgroup differs strikingly from other surveys performed in Lima[19] (where seroprevalence levels around 1% were found in two different groups), suggesting a strong association between living with a tapeworm-carrier housemaid and being seropositive for cysticercosis.

Both the prevalence of taeniasis in housemaids and the proportion of seropositive family members in the employer families are similar to prevalence values in endemic villages, pointing toward active transmission of infection in this setting. There could be more employer families that are exposed to tapeworm carriers because of the frequent turnover of housemaids in households and the fact that some housemaids who tested negative for tapeworms may have been infected and lost the worm before the survey. This situation parallels that of industrialized countries where immigrants from endemic countries are hired, often without work permit, to do domestic work. We recommend that all housemaids from endemic areas be screened for intestinal parasites including specific search for tapeworm infections, under appropriate confidentiality safeguards.

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