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Original Article

Environmental Risk Factors Associated with Leptospirosis among Butchers and Their Associates in Jamaica

PD Brown[1], M McKenzie[2], M Pinnock[2], D McGrowder[3]

Abstract

Background: Leptospirosis, a spirochetal zoonosis, is considered an occupational disease of persons engaged in agriculture, sewage works, forestry, and butchery.

Objective: To determine the environmental sources and the knowledge, attitude and practices for leptospirosis among butchers and slaughterhouse workers, as well as the seroprevalence of leptospirosis among cattle and pigs presented for slaughter.

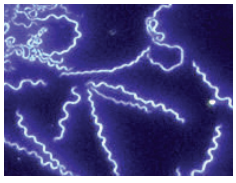
Methods: Using an interviewer administered questionnaire, all 110 butchers and other slaughterhouse workers in the parishes of Kingston and St. Andrew, Jamaica were surveyed. In addition, 179 blood samples from animals presented for slaughter were tested for anti-*Leptospira* antibodies using the microscopic agglutination test (MAT).

Results: Analyses indicated that people with the studied occupations are at risk for developing leptospirosis due to several environmental risk factors that exist in slaughterhouses. Among the risk factors, limited knowledge of the disease and its transmission, lower educational level attained, younger age and unhealthy behaviors (*e.g.*, hand washing and improper or lack of use of personal protective gears), presence of stray dogs and rodents, and inadequate maintenance of physical plants, were found to be important. Of the total number of animal samples tested, 20 (11%) were positive. Canicola and Hardjo (among cattle) and Bratislava (among pigs) were the major seroreactors.

Conclusion: Butchers and slaughterhouse workers engaged in animal handling and slaughtering could be frequently exposed to leptospirosis, and hence control strategies targeting at these populations should be implemented.

Keywords: Leptospirosis; Abattoirs; Risk factors; Occupations; Weil disease; Forestry; Zoonoses

[1]Biochemistry Section, Department of Basic Medical Sciences, Faculty of Medical Sciences, [2]Department of Chemistry, Faculty of Pure and Applied Sciences, [3]Department of Pathology, Faculty of Medical Sciences, The University of the West Indies, Mona, Kingston 7, Jamaica



Introduction

Leptospirosis is a zoonotic disease with worldwide distribution. It affects both humans and animals and is emerging as an important public health problem in many developing countries.[1-4] Leptospirosis is an important occupational hazard to butchers, animal handlers, agriculture manual laborers, sewage workers, forestry workers and other outdoor workers who work in wet conditions. The disease has a cosmopolitan distribution. Epidemiological studies have shown a clear predominance of this infection in low remuneration professions.[5] Trans-

Correspondence to
Paul D. Brown, PhD
Biochemistry Section, Department of Basic Medical Sciences, University of the West Indies, Mona, Kingston 7, Jamaica
Tel: +876-927-2290
Fax: +876-977-7852
E-mail: paul.brown@uwimona.edu.jm

TAKE-HOME MESSAGE

- Leptospirosis is an important public health problem in many developing countries and affects both humans and animals.
- It usually occurs through direct contact with urine, blood and organs from infected animals.
- Dairy farm workers, cane cutters, butchers and farmers are occupationally exposed to this infection. Therefore, control strategies targeting at these populations should be implemented.
- Suitability of the environment for the survival of the organism appears to be a critical factor in maintaining the infection and transmission to humans.

mission of leptospirosis usually occurs through direct contact with urine, blood and organs from infected animals. This mode of transmission is not uncommon in slaughterhouse workers.[5,6] The transmission cycle of the disease involves interaction between one or more animal hosts harboring leptospires, a favorable environment for its survival, and human beings. In 2004, the Ministry of Health's record showed that there were 37 cases with leptospirosis reported for the South East Region of Jamaica (which includes the parishes of Kingston and St. Andrew, among two others). Butchers and their associates are exposed occupationally to this disease and may have clinical or subclinical manifestations that are not being detected and treated. This disease can be spread both recreationally and occupationally in man.[1,3]

Leptospirosis has been recognized in Jamaica since 1953 and the disease is endemic with an annual incidence rate of six per 100 000 population (Brown, unpublished results). In animals, a dominant feature of leptospirosis is abortion which may lead to infertility. Often these animals are culled from the herd and sold to unsuspecting persons, including butchers. Furthermore, it is well known that many animals may have sub-clinical infections and may be persistent shedders of the organism in their urine.[3] A serological study on leptospirosis in livestock carried out by Grant and co-workers between 1984 and 1988, revealed that the predominant infecting serovars were Portlandvere, Canicola, Icterohaemorrhagiae and Jules.[7] They noted that more than 50% of the cattle and more than 60% of the pigs tested were positive. The study also showed good correlation among certain occupations: dairy farm workers had the highest positive rate (75%) followed by cane cutters, butchers and farmers having 60%, 57% and 57%, respectively. There is limited information on the impact of leptospirosis on livestock productivity in Jamaica. Knowledge of the prevalence of this disease in animals and its ability to indicate some of the likely sources of infection within the human population at risk is therefore necessary. Serological tests are usually used to confirm the clinical diagnosis, to determine the prevalence of the disease in a herd and to conduct epidemiological studies. Furthermore, because of the increased importance of food safety and food security, more attention is being paid to animals presented for slaughter to ensure to continued health of consumers.

The major objectives of this study were to determine the level of awareness and to identify possible environmental risk factors associated with leptospirosis among butchers and their assistants in Kingston and St. Andrew, Jamaica. We also determined the seroprevalence of the *Leptospira* organism among cattle and pigs presented for slaughter.

Materials and Methods

This cross-sectional study was conducted in September and October 2008 among butchers and their assistants in 21 slaughterhouses within the parishes of Kingston and St. Andrew, and was granted ethical approval by the University of the West Indies Ethics Committee. All 110 butchers and assistants freely signed the informed consent form.

Two instruments were developed and used in this study. First, a 28-item interviewer-administered structured questionnaire was prepared by the authors. The questionnaire included a full range of response options, designed to identify the practitioner's knowledge, attitudes and practices related to leptospirosis. Prior to its use, a pilot study was done at a slaughter house in Spanish Town, St. Catherine parish among a similar population outside of the study area, who were asked to fill out the questionnaire and return with their comments and criticism. Minor changes were made to the final instrument. The initial part of the questionnaire consisted of demographics such as occupation, age, gender, and the years of service in the occupation. The second part of the questionnaire comprised of questions regarding their knowledge, attitudes and practices on the job. This part also assessed awareness of safety procedures, exposure to biological agents and awareness of potential harm when exposed to these agents, presence of rodents and dogs, and availability and use of protective equipment. It took approximately 20 minutes to complete each questionnaire. Before administration of the questionnaire, the purpose of the study was explained to each respondent and confidentiality of the information assured.

Second, an 8-item interviewer-administered observational/inspection survey instrument was prepared to assess and identify environmental risks factors at slaughterhouses. The premises were examined for overgrowth of vegetation, solid and liquid waste management, state of the building and compound, water supply, workers health and welfare, excreta disposal and signs of rodent infestation.

Blood sample collection and analysis

The mean number of pigs and cattle slaughtered each month in Kingston and St. Andrew was 1599 and 190, respectively. To have a representative sample, we studied a minimum of 10% of both populations. Random blood samples were taken from apparently healthy animals presented for slaughter from Monday to Friday (weekly slaughtering schedule) during the study. The site was first cleaned with an alcohol swab; blood was drawn into a tube with red stopper from the jugular vein of the cattle or from the ear vein of the pigs. Tubes were placed in ice-packed igloos at temperature <10 °C for transport to the Ministry of Agriculture Veterinary Services Division, Hope Gardens, Jamaica for analysis.

Serum was separated from blood samples and stored at -70 °C until processed. All sera were tested for the presence of anti-*Leptospira* antibodies using the microscopic agglutination test (MAT) following standard procedures.[8,9] Those sera presenting ≥2+ agglutination in the dilution 1:100 were considered positive; these sera were then diluted progressively until the determination of the maximum positive dilution.

Data Analysis

Data from the questionnaires were coded and analyzed by SPSS® ver 18.0 for Windows®. Strict confidentiality was maintained throughout the analysis. All data

Table 1: Demographic characteristic of respondents

Variable	n (%)
Profession	
Butcher	35 (31.8)
Butcher assistant	75 (68.2)
Gender	
Male	74 (67.3)
Female	36 (32.7)
Age group (yrs)	
<20	3 (2.7)
20–29	17 (15.5)
30–39	24 (21.8)
40–49	28 (25.5)
50–59	21 (19.1)
≥60	17 (15.5)
Educational achievement	
Primary	53 (48.2)
Secondary	52 (47.3)
Tertiary	5 (4.5)
Year of service	
1–5	17 (15.5)
6–10	28 (24.5)
11–20	22 (20.0)
21–30	19 (18.2)
>30	24 (21.8)
Type of training	
Formal training	6 (5.5)
On-the-job training	104 (94.5)

were stored in computers at a secured location, with access provided only to the researchers involved in the study. χ^2 test was used to analyze categorical variables, and Pearson's correlation coefficient was used to assess the extent of correlation between non-parametric continuous variables. A p value <0.05 (two-tailed) was considered statistically significant.

Results

Table 1 presents demographic information on the studied population of butchers and their assistants. The majority were butcher assistants (68%), and male (67%) with mean±SD of 43.8±31.0 (range: 17–90) years. Forty percent of the population were less than 40 years old; 35% aged 50 years or more. While 48% of the study group completed primary education, only 5% attained a tertiary level education. Sixty percent of the study population had over 10 years of exposure to the work environment, almost one-third of whom had more than 30 years of experience. Most (95%) of the studied population had no formal training but learnt the job by observation at a slaughterhouse. Slaughterhouses are normally monitored by a public health inspector who, in addition to evaluating the quality/safety of the meat for human consumption, is supposed to educate workers on how to prevent cross-contamination of meat products, the proper disposal of wastes from the trade and how to protect themselves from infection.

Ninety-one (83%) respondents correctly noted that the disease can be transmitted from animals to man, while 78% of the study group had heard about leptospirosis. Of this proportion, 43 indicated that they learnt about the disease from a public health inspector and 37 learnt it through the print and mass media. While 33% of the respondents thought that leptospirosis was a bacterial disease caused by rats and/or farm animals, 66% did not know or could not give an answer.

Although most (90%) of workers had health certification, only 54% of respond-

Table 2: Awareness of leptospirosis stratified by some variables

Variable	Awareness of leptospirosis* n (%)
Gender	
Male	74 (67.3)
Female	36 (32.7)
Diseases can be transmitted from animals to humans	
Yes	91 (82.7)
No	19 (17.3)
Ever heard of leptospirosis	
Yes	86 (78.2)
No	24 (21.8)
Source of information	
Media	37 (33.6)
On-the-job	5 (4.5)
Public Health Inspector	43 (39.1)
Veterinarian	1 (0.9)
Other/No response	24 (21.8)
Perceived definition	
Bacterial disease	1 (0.9)
Cancer	1 (0.9)
Disease caused by rats	22 (20.0)
Disease caused by farm animals	12 (10.9)
Disease caused by rats & farm animals	2(1.8)
Don't know/No response	72 (65.5)
Perceived mode of transmission	
Contact with rats or rat urine	56 (50.9)
Eating improperly cooked meat	2 (1.8)
Flies or mosquitoes	2 (1.8)
Tending to infected farm animals	7 (6.4)
Working bare-footed	1 (0.9)
Don't know/No response	42 (38.2)
Safety information shared	
Keep clothes clean	4 (3.6)
Keep surroundings clean	19 (17.3)
Wash hands	4 (3.6)
Wear protective gears	13 (11.8)
Other/Don't remember	70 (63.6)

Continued

Table 2: Awareness of leptospirosis stratified by some variables

Variable	Awareness of leptospirosis* n (%)
Had leptospirosis in the past	
Yes	1 (0.9)
No	84 (76.4)
Don't remember/No response	25 (22.7)
Believe that leptospirosis can be cured	
Yes	65 (59.1)
No	4 (3.6)
Don't know	41 (37.3)
Annual medical examination required	
Yes	59 (53.6)
No	51 (46.4)
Last medical exam	
Current year	17 (15.5)
1 year before	27 (24.5)
2 years before	5 (4.5)
3 years before	3 (2.7)
4 years before	2 (1.8)
Can't remember/No response	56 (50.9)
Protective equipment in use	
Yes	92 (83.6)
No	18 (16.4)
Begin work day with clean protective clothing	
Always	94 (85.5)
Sometimes	16 (14.5)
Never	0 (0.0)

*The awareness of leptospirosis was significantly ($p<0.001$) different among subgroups of each variable studied.

ents indicated that they were required to do an annual medical examination. Of note was that a serological test for leptospirosis was not included. Half of the respondents could not remember when they had their last medical examination, while 44 (40%) had a medical examination within the past 12 months. Twenty-three percent of the workers could not remember or did not give an answer when they were

asked whether they had leptospirosis in the past; 1% admitted having a previous infection. The majority (59%) of studied workers believed that leptospirosis could be cured. Personal protective gear (gowns/aprons, boots, gloves and hats) and use of clean gear at the start of each day were thought to be very important by more than 80% of respondents. In addition, almost all respondents indicated that hand washing was an important safety procedure after soiling with body fluids from animals in the work environment.

The most significant positive correlations were observed between having ever heard of leptospirosis and leptospirosis cure ($r = 0.672$, $p<0.001$) or transmission to man ($r = 0.516$, $p<0.001$) or receiving information about the disease ($r = 0.431$, $p<0.001$). Significant negative correlations were noted between several variables. These were all less than -0.4. Of interest were the negative associations between age and educational level ($p<0.001$), age and having ever heard of leptospirosis ($p=0.024$), and educational level and hand washing ($p=0.048$).

At the time of inspection, livestock animals present included cattle, pigs, sheep and goats. Stray dogs were also observed either on or near six (29%) of the premises, and live rodents were observed at 5% of slaughterhouses ($p<0.001$). However, no dead rodent, gnaw marks, rodent droppings, nesting or burrows were observed. It was noted that fodder, slaughterhouse waste, animal drinking troughs and water stored were left unprotected overnight. Personal protective gear inclusive of water boots and gowns/aprons were observed in use at nine (43%) of slaughterhouses inspected; use of water boots only were observed at one facility and the remainder had no personal protective gear in use ($p=0.018$). The majority (57%) of premises had unsatisfactory personal protective gears. Approximately, 62% of premises had satisfactory collection/storage and disposal of waste, and a similar proportion was in a satisfactory state of repair. Drainage, control of vegetation, and feeding and watering troughs for holding pens were adequate in about two-thirds of facilities inspected. The drainage system comprised of paved and unpaved channels that lead to the surrounding yard. The main exception was seen in the case of the Kingston slautherhouse where the liquid effluent was channelled to the public sewerage system. However, in many cases, blood, gut contents and meat scraps were seen in these open drains. In addition, 62% of premises had unsatisfactory rodent-proof material on the buildings.

As it related to water supply, 95% of premises had satisfactory storage of water with 80% receiving water from the municipal supply source. On average, change rooms, bathroom facilities, and separate facilities for sexes were unsatisfactory in 76% (range, 62%–90%) of the facilities inspected. Most (90%) facilities had valid health certification for operation.

Of the 160 cattle sampled, 10% tested positive; the most frequent serovars detected were Canicola and Hardjo (Figure 1) with titres ranging from 1:100 to 1:200. Of the 19 pigs examined, four (21%) were found positive with serovar Bratislavia being the most prevalent.

Discussion

Jamaica is known to be endemic for leptospirosis with the majority of the population exposed to the disease throughout the year. However, the disease incidence peaks during the second rainy season between October and December with considerable morbidity. Suitability of the environment for the survival of the organism appears to be a critical factor in maintaining the infection and transmission to humans. Most of the affected population

either belong to the farming community or work in slaughterhouses. The likelihood of contracting the infection—directly or indirectly—is more in these high-risk communities.[6] The study showed that the environmental risk factors for developing leptospirosis are prevalent among the butchers and slaughterhouse workers.

Because sustainable food production is a major concern, finding an alternative to the industrial meat supply chain is almost impossible, hence, the critical presence of slaughterhouses. For the typical sustainable meat buyer, when local meat is considered, at first a farm comes to mind; it then followed by a steak or pork chop. Unless that consumer is willing to do the work of slaughtering and processing the animal himself, access to a local slaughterhouse is as difficult to find as local beer without the brewery. This industry has traditionally been a male-dominated occupation and remains significantly so as demonstrated in this study. What was noteworthy was that 40% of the butchers and slaughterhouse workers in Kingston and St. Andrew were younger than 40 years, with many productive years ahead of them. Consequently, occupational exposure to a preventable and possible debilitating and/or fatal disease is a major risk. This is against the background that about half of the respondents had attained basic literacy (primary level), which has implications for their ability to both access and appreciate relevant health information. Hence, this occupational group needs more than just knowledge testing as a criterion for certification. The certifying authority should make serological examination become part of the annual certifying procedure for this group of workers. Furthermore, since a substantial number of the study population have had over 10 years of exposure to the work environment, it is likely that they would have had previous sub-clinical infections.

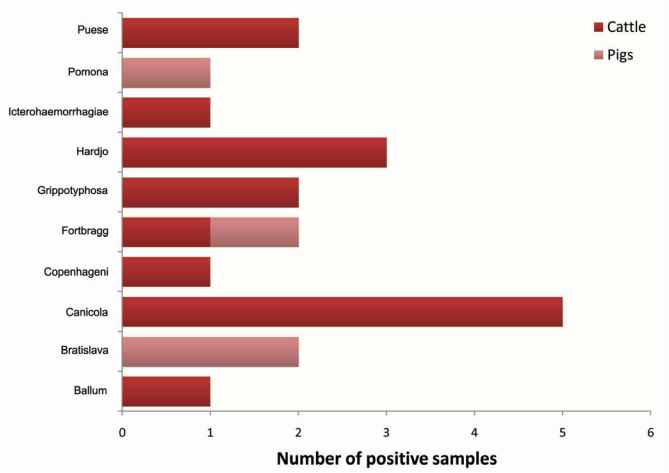


Figure 1: Number of positive samples and serovars in cattle and pigs

Since there is not much cross-protection among serovars of *Leptospira*, previous infections do not necessarily result in antibody production which gives protection from future (serious) infection.[3] However, cost continues to be a prohibitive factor as butchers and their assistants have to pay for the service out of pocket if testing for leptospirosis is required for themselves or their livestock.

Majority of the respondents were quite knowledgeable about rodents being the carrier of leptospirosis and they knew about their ability to transmit the disease. As informed as the study population seemed to be about the existence of leptospirosis (86%), most of them were relatively ignorant of the meaning of "leptospirosis." This highlights the need for continuous education of the study population, augmented by strengthening the means currently being used, as perceived knowledge is likely to yield levels of false security within the population which could lead to irresponsible behavior. Furthermore, the study found that workers were constantly exposed to feces, blood and other liquid waste from slaughtered animals without the appropriate personal protective gears. Appropriate signage regarding safety and

proper conduct is indispensable in these regards. Also, regular washing down of the floors and walls of the premises will remove contaminants and reduce the risk of cross-contamination of products and infection to workers. Health education is not a continuous process for this category of workers. Observations revealed that 90% of workers had health certification. As part of the health certification process, it is mandatory for butchers and associates to be given a training session once per year. The training session focuses on the role and responsibilities of butchers and associates as they relate to food hygiene.

At the time of inspection, stray dogs were also observed either on or near some of the premises. The proximity of these animals could at any time expose humans to several serovars of *Leptospira*. Live rodents were also observed at 5% of slaughterhouses. With fodder, slaughterhouse waste, animal drinking troughs and stored water left unprotected overnight, the presence of rodents increases the risk of possible contamination with their urine, serving as a source of infection for both man and animals. Also when infected animals are slaughtered, the blood—if not properly disposed—becomes a source of infection for anyone who comes in contact with it and even a wider environment becomes at risk in the event of rainfall and local flooding. Solid waste from the slaughterhouse serves as a major harborage and feeding ground for rodents and other animals. The potential for the spread of leptospirosis is multiplied in these facilities without proper collection and storage of waste. Moreover, the absence of personal protective gears, or their inconsistent usage, would undoubtedly expose the workers to possible infection if the organism is present.

Most (95%) of the buildings at the studied slaughterhouses were in an unsatisfactory state of repair. These buildings were constructed mainly of wood, cement, concrete and metal sheets. The lack of proper maintenance rendered them unsatisfactory. This allowed for the entry and nesting of animals including rodents into the buildings. Only 20% of excreta disposal facilities were noted to be in a satisfactory condition. Satisfactory facilities were those that satisfied public health requirements. These were properly functioning systems, so constructed and maintained as to prevent access to insects and rodents.

One of the factors that will militate against exposure to the disease is accessibility to running water and disinfectant, which can be used for periodic hosing down the floor surfaces. The water on the premises was seen in drums, tanks, open-drains, floors of slaughter hall and in puddles on the compound. Leptospires can remain in these water samples or wet areas for a considerable period (days to months),[3] and this explains the tendency of the infection to be prevalent in locales with an insufficient drainage. Furthermore, this collected water can be an important factor for the dissemination of the infection to the animals of the herd.[6] We noted in this study that on several occasions, animals were left to roam the compound and had access to these bodies of water. This practice could allow animals to infect themselves with *Leptospira* organisms if present and transmit these to humans who have to come in contact with them for slaughter or regular care. Organisms from infected animals presented for slaughter could easily contaminate the water which now becomes a source of infection for man and animals. Any type of waste from these animals could become contaminated with leptospires so every precaution must be taken to remove it as quickly as possible to minimize the possibility of infection and cross-contamination. The lack of proper maintenance of almost all of the premises observed rendered them in an unsatisfactory state of

repair. Rodent proofing the buildings is essential to prevent and discourage them from entering buildings where they may contaminate food contact surfaces and destroy fixtures and equipment.[6] The installation of rodent proofing is a requirement for all food establishments (including points of origin) and appropriate measures should be put in place to ensure that buildings meet the minimum recommended standards for certification. The absence of rodent proofing of buildings at slaughterhouses could unwittingly expose the workers to the disease and would constitute an environmental risk factor for the spread of leptospirosis.

The study revealed that 10% of cattle and 21% of pigs sampled had evidence of exposure to leptospiral infection. In making a serological diagnosis of leptospirosis, the infecting serovar and the clinical condition involved must be fully considered. It must be borne in mind however, that even though the samples were positive for the infecting serovar it does not constitute confirmation that the animal has leptospirosis. Samples were collected from presumably healthy animals and in order for the animal to be confirmed with the disease the animal would have had to be showing signs of the disease. Invariably, the fact that these animals tested positive for the infecting serovars implies that these workers were exposed to the disease organism and every effort should be put in place to ensure that they are appropriately attired to prevent infection. The relatively high prevalence rate of leptospiral infection represents a significant occupational risk to humans, particularly butchers and slaughterhouse workers, and an economic cost to the cattle and pig industry in terms of possible reproductive loss and illness. While Langoni and co-authors[6] suggest that leptospiral transmission from cattle does not present a known risk to the food supply, the public might react unfavourably to knowledge that leptospiral infection of cattle is common. These authors also reported that at slaughterhouses which had good zoosanitary handling, the prevalence of *Leptospira* antibodies was lower in cattle, reinforcing the importance of proper hygiene. Improper hygienic practices can disseminate the micro-organism to the herd, and contaminate the meat products as well.

Rattus norvegicus is a major reservoir of leptospires, and *Rattus rattus* and *Mus musculus* respectively, with roof and domiciliary habits have a little contribution to the maintenance of leptospires in nature.[6,10] Other animals, such as stray dogs and wild rodents, including the mongoose (*Herpestes javanicus*) and wild field mice (*Akodon spp*. and *Apodemus agrarius*), can perform an important role in the transmission and maintenance of leptospires in nature.[3,10-12] Rats are known reservoirs of the serovar Icterohaemorrhagiae,[1,3] and can also harbor Portlandvere and Jules in Jamaica (Brown, unpublished work). The sighting of rats is very significantly associated with leptospirosis (OR=11.05; 95% CI: 3.18–45.9).[13] In a similar study, Sarkar, *et al*,[14] reported that sighting rats in peri-domiciliary was a significant risk factor for leptospirosis (OR=3.40; 95% CI: 1.74–11.78).

Living in close proximity to accumulated garbage was found to be significantly associated with leptospirosis (OR=4.31,;95% CI: 1.41–14.76).[15] In contrast, Sarkar, *et al*,[14] noted that living in close proximity to open sewers was found to be significantly associated with leptospirosis (OR=5.07; 95% CI: 2.04–12.64) while living in close proximity to accumulated garbage was not found to be significantly associated with leptospirosis (OR=1.53; 95% CI: 0.7–3.31). Identification of residential proximity to places with accumulated garbage and household rat infestation as risk factors reveals that much of urban leptospirosis

during the epidemic season may be acquired through peri-domiciliary transmission. The established role of domestic rats as the principal reservoir (during urban epidemics) also supports this finding. Cases did not report direct contact with rats, suggesting that leptospiral transmission appears to occur primarily through exposure to an environment contaminated by the urine of rodent reservoirs. In the distant past, isolated cases of leptospirosis in adults due to exposure to rat urine have been reported in Mumbai, India.[16]

The present study had two main limitations. First, serologic testing was not done on the slaughterhouse workers so the seroprevalence of occupational leptospiral exposure, and thus direct risk, could not be determined. Second, we obtained specimens only from a small sample of cattle from slaughterhouses in Kingston and St. Andrew. Therefore, from the data obtained, it would be impossible to draw a firm conclusion about the prevalence of *Leptospira* in Jamaican cattle and pigs outside this geographical region. More systematic, geographically distributed surveillance of *Leptospira*-infected cattle and pigs would be necessary to determine rates of infection.

However, the data presented here confirm previous evidence that cattle and pigs in Jamaica continue to be potential sources of leptospiral infection for humans and other cattle.[7] Given that leptospiral infection can lead to illness and fetal wastage in cattle and other domestic livestock,[17,18] it would be of economic importance to reduce leptospiral infection in animals. Of direct importance to human health, butchers and other slaughterhouse workers in Kingston and St. Andrew remain at risk for leptospiral infection, since exposure to infected blood, urine and carcasses in this occupation setting is common and widespread.

In conclusion, the prevention and control of leptospirosis remains a public health concern in Jamaica. This study highlighted the fact that butchers and their assistants are at risk of contracting leptospirosis as an occupational disease because several potential environmental risk factors exist for transmission of the organism from animals presented for slaughter. The level of awareness among this category of workers remains low. Effective control of this disease among the animal population is an essential component of a basic package of health care, and environmental conditions must be addressed promptly if the health and safety of the occupational group is to be preserved. Finally, the findings from this study indicate that attention must be focused on an interdisciplinary and collaborative approach.

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Conflicts of Interest: None declared.

References

1. Brown PD. Leptospira spp. Encyclopedia of Medical Genomics and Proteomics, **2005**.
2. Sehgal SC. Leptospirosis in the horizon. *Natl Med J India* 2000;**13**:228-30.
3. Levett PN. Leptospirosis. *Clin Microbiol Rev* 2001;**14**:296-326.

4. Anonymous. Leptospirosis in India—report of the investigation of a post-cyclone outbreak in Orissa, November 1999.*Wkly Epidemiol Rec* 2000;**75**:217–223.
5. Ratnam S. Leptospirosis: an Indian perspective. *Indian J Med Microbiol* 1994;**12**:228–39.
6. Langoni H, de Souza LC, Da Silva AV, *et al*. Epidemiological aspects in leptospirosis. Research of anti-Leptospira spp antibodies, isolation and biomolecular research in bovines, rodents and workers in rural properties from Botucatu, SP, Brazil. *Braz J Vet Res Anim Sci São Paulo*;2008;**45**:190-9.
7. Grant GH, Smith G, Schloss W. Seroprevalence of leptospiral antibodies in Jamaican livestock population. *Vet Rec* 1988;**122**:419-20.
8. OIE. Update: Leptospirosis, Manual of Diagnostic Tests and Vaccines for Terrestrial animal, 5th Edition 2004 Chapter 2.1.9. Available at: http://www.oie.int/eng/Normes/mmanual/2008/pdf/2.01.09_LEPTO.pdf
9. Ryu E. Rapid microscopic agglutination test for Leptospira without non-specific reaction. *Bull Off Int Epizoot* 1970;**20**:285-92.
10. Maciel EAP, Carvalho ALF, Nascimento SF, *et al*. Household transmission of Leptospira infection in urban slum communities. *PLoS Negl Trop Dis* 2008;**2**:e154.
11. Vinetz JM. Leptospirosis is everywhere, just have to know what to look for. But how? *Swiss Med Wkly* 2004;**134**:331-2.
12. Vinetz JM, Glass GE, Flexner CE, *et al*. Sporadic urban leptospirosis. *Ann Intern Med* 1996;**125**:794–8.
13. Bhardwaj P, Kosambiya JK, Desai VK. A case control study to explore the risk factors for acquisition of leptospirosis in Surat city, after flood. *Indian J Med Sci* 2008;**62**:431-8.
14. Sarkar U, Nascimento SF, Barbosa R, *et al*. Population-based case-control investigation of risk factors for leptospirosis during an urban epidemic. *Am J Trop Med Hyg* 2002;**5**:605-10.
15. Sharma S, Vijayachari P, Sugunan AP, *et al.* Seroprevalence of leptospirosis among high-risk population of Andaman Islands, India. *Am J Trop Med Hyg* 2006;**74**:278–83.
16. Dalal PM. Leptospirosis in Bombay city (report of 5 cases). *Indian J Med Sci* 1960;**14**:295-301.
17. Langoni H, Souza LC, Silva AV, *et al.* Incidence of leptospiral abortion in Brazilian dairy cattle. *Prev Vet Med* 1999;**40**:271–5.
18. Smyth JA, Fitzpatrick DA, Ellis WA. Stillbirth/perinatal weak calf syndrome: a study of calves infected with Leptospira. *Vet Rec* 1999;**145**:539–42.