ORIGINAL ARTICLE

Knowledge and Practices of Pig Farmers Regarding Japanese Encephalitis in Kathmandu, Nepal

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Impacts

- Pig farming in Nepal exposes farmers to many risk factors for Japanese encephalitis (JE), but their knowledge about and options for personal protection were limited
- The Nepal pig farming community was poor, had little ownership of land and had limited education, making use of standard methods for JE control unfeasible for this group
- Health education programmes for JE control in Nepal must be aware of literacy and gender issues revealed in this study

Keywords:
Japanese encephalitis; pig; farmer; knowledge; Nepal

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Summary

Japanese encephalitis (JE) is the single largest cause of viral encephalitis in the world and has been endemic in Nepal since the early 1980s. Since then, it has spread from its origins in lowland plains to the Kathmandu Valley as well as in hill and mountain districts. Pigs are amplifying hosts for the virus. The Nepal government has been encouraging the development of pig farming as a means of poverty alleviation. Whereas other countries have reduced JE through vaccination programmes and improvements in pig husbandry, these options are not economically possible in Nepal. The objective of this study was to examine the occupational risk of pig farmers in Nepal and to determine their level of knowledge and practice of JE prevention techniques. We surveyed 100 randomly selected pig farmers in the Kathmandu District and found that pig farmers were exposed to many JE risk factors including poverty and close proximity to pigs, rice paddy fields and water birds, which are the definitive hosts for the virus. Forty-two percent of the farmers had heard of JE, 20% associated it with mosquito bites and 7% named pigs as risk factors. Few protective measures were taken. None of the farmers were vaccinated against JE nor were any pigs, despite an ongoing human vaccination campaign. This farming community had little ownership of land and limited education. JE education programmes must consider gender differences in access to public health information as there were an equal number of male and female farmers. We provide findings that can inform future JE education programmes for this vulnerable population.

Introduction

Japanese encephalitis (JE) is the single largest cause of viral encephalitis in the world (Kinchi et al., 2010) with annual clinical case reports ranging from 30 000 to 50 000 (Solomon, 2006). These data under-represent the significance of JE because of the fact that it is an underreported disease (Tsai, 2000), and it is spreading beyond its historic distribution in South and South–east Asia (Ghosh and Basu, 2009). JE has been endemic in Nepal since 1980s with epidemic peaks occurring every 2–5 years (Parajuli et al., 1992; Bhattachan et al., 2009; Pant, 2009).

The disease was first detected in the lowland plains of the Terai region, a region bordering the northern states of India and the source of most JE cases in the country (Pant, 2009). Through ongoing surveillance, surveys and outbreak investigations, JE has now been documented in 54 of the 72 districts of Nepal, including 24 hill and mountain districts, and is considered to be endemic in the Kathmandu Valley (Partridge et al., 2007; Bhattachan et al., 2009; Pant, 2009; Impoinvil et al., 2011). The high mortality and disability rates of JE have made it a public health priority for Nepal.

Japanese encephalitis transmission is highly dynamic, and its patterns of spread and outbreaks are influenced by a combination of fluctuating environmental and social factors in a manner that is not yet understood (LeBeaud, 2008; Erlanger et al., 2009). *Culex tritaeniorhyncus*, a major JE vector, is found in rice paddy ecosystems (Kinchi et al., 2010). Pigs play an important role in human JE epidemiology as viral amplifying hosts (Solomon et al., 2000). Social factors also play an important role. Although poverty is an insufficient indicator of the occurrence and patterns of JE (LeBeaud, 2008), like other tropical diseases, the poor are likely to be affected more frequently and severely. Ardeid wading birds are considered as the primary enzootic host for JE virus (JEV) (Rodrigues et al., 1981) and migratory birds as well as bats are suggested to play a role in spreading or reintroducing JEV (Nga et al., 2004; and Van den Hurk et al., 2009). Rice fields not only represent preferred breeding sites for the vector, but also provide a foraging site for water birds susceptible to JEV infection. Thus, JE is directly associated with irrigated rice agriculture (Van den Hurk et al., 2009; Impoinvil et al., 2011). The intensification of rice production system together with the extension of flooded surface area has been associated with increases in cases, spread and outbreaks of JE (Keiser et al., 2005). In Nepal, ducks have also been incriminated as a possible vertebrate hosts and a potential risk factor for JE transmission (Joshi et al., 2004; Pant, 2006). Climate change, changes in land use (particularly rice and pig farming and urbanization) and access to health care have been nominated as important variables that could drive the re-emergence or spread of JE (LeBeaud, 2008; Erlanger et al., 2009).

The Nepal government has been encouraging the development of pig farming as a means of poverty alleviation. The government supports and assists poor citizens to acquire and raise pigs for income and food supplementation. The total population of pigs in Nepal has been estimated to be about 1 064 860, scattered in all districts of the country (MOAC, 2010). The concentration of animals is higher in some districts, where the pig-raising ethnic community predominates. While the ethnic taboo against raising native pigs is very strong in some communities, this barrier is found to be eroding gradually for exotic pigs and their cross-breeds. An increased demand of pig meat in the urban areas has stimulated the growth of pig rearing especially in the peri-urban areas. This growth is most evident in the eastern and central regions of the country where the traditional pig-raising community predominates.

Other countries like Japan, South Korea and Taiwan have successfully controlled JE by human and pig vaccination, modernization of pig farms, change in agricultural practices and improved living standards (Igarashi, 2002; Erlanger et al., 2009). The economic investments required to achieve these changes are beyond the current socio-economic conditions of Nepal. Even regular human vaccination is not affordable or sustainable at the present time. Therefore, low-cost JE prevention methods that can be put into place by farmers must be found. A first step towards finding low-cost, frontline JE prevention opportunities is understanding the knowledge and capacity of farmers to prevent JE. The objective of this project was to survey randomly selected pig farmers to document their exposure to risk factors, characterize their knowledge and practices for JE control and identify factors that could influence the design of future JE education programmes for pig farmers.

Methods

This research was conducted from September 2011 to December 2011 in the Kathmandu District, one among three districts of Kathmandu Valley. This district was selected because JE was known to be endemic in the district, there was known active pig farming occurring at the time of the study, there was reason to believe the farmers would have some knowledge of JE because of ongoing JE education and active immunization campaign in the district, and the district was accessible to the study team. Within the Kathmandu District, there were four sites known as active pig farming areas namely Gothatar, Gokarna, Balaju and Jadibuti-Manahara. A sampling list was created for each of these areas by a complete count of pig farms in each area (total = 180 farms). One hundred farms were selected by simple random sampling to accommodate the budget, logistics and time line for the project.

Each farm was visited by a team of veterinarians who offered free physical examinations of the pigs owned by participating farmers and treatment of any ill animals found. Farmers were also offered a short training session on JE and its preventive measures after they completed a survey. There were six main parts to the survey; (i) farmer attributes such as gender, education, income, training etc., (ii) farm attributes such as the number and breed of pigs raised, management, source and marketing of pigs, etc., (iii) farmer exposure to known risk factors such as proximity to rice fields, to pig barns, standing water, etc., (iv) knowledge about JE and what can be done to prevent the disease, (v) specific practices used by the farmer for themselves, their pigs and their family including vaccination and mosquito avoidance and (vi) information on clinically compatible signs or past diagnosis of JE in people or animals on the farm. As this project was focused on farmer knowledge and exposure to known risks, we did not undertake a serosurvey of people or animals to document the prevalence of JE, but instead relied on self-reported illness. The survey was pre-tested for clarity and feasibility on a sample of 20 farms in a region outside of the study area. The interviewer read a standardized survey form and recorded the answers.

Before visiting the farms, the survey team went to the survey area and introduced the project to the para-veterinarians servicing the area and to community leaders to increase compliance. Local para-veterinarians were informed about any health issues or animal treatments after each visit to ensure follow-up. Participation in the survey was voluntary, and all farmers were informed of their right to withdraw at any time in the survey and were required to give their consent to participate. All responses were recorded anonymously and without any identifying information. Ethical approval was provided by the ethics committee of the National Zoonoses and Food Hygiene Research Centre. This approach resulted in 100% compliance of the randomly selected farmers.

The survey contained both open- and closed-ended questions. Open-ended questions were grouped based on their similarities and turned into closed-ended form after a thematic review of the answers. All answers were coded and entered into the SPSS software version 19 (http://www-01.ibm.com/software/analytics/spss/). Descriptive statistics used for analysis included frequencies, sums, ranges and means, and the chi-squared test was used as a test of association with $P < 0.05$ selected as the level for statistical significance. Logistic regression using the enter procedure was used for multivariate analysis of potential predictors of farmer's knowledge about JE, with $P < 0.05$ used as a threshold for statistically significant interactions.

Results

There was an equal number of male ($n = 50$) and female farmers ($n = 50$) in our randomly selected study group. The level of education ranged from 39% of the farmers having no formal education, 33% with primary education, 22% with secondary education and 6% with some college education. The monthly income of 70% of the farmers was <10 000 Nepalese rupees per month (approximately 120 USD). Pig farming was largely a family business as only 5% of farmers employed workers additional to family members. Pig farming was the sole source of income for 73% the farmers. Jobs used to supplement farm incomes were typically temporary and very low-income generating like farming, working on daily wages, working as a hotel worker or as a porter for tourists. Eighty-five percent of the farmers were raising pigs on lands they leased, leaving only 15% farming on their own land. Those renting land reported that their farm was mobile; once the contract with landlord terminated, they moved to another place within the Valley. All the farms had poor sanitary considerations. Pigs were confined, but in open sheds with roofs. The average number of pigs per farm was 26 (range 1–300). Sixty-seven of the 100 farmers bred and raised their own piglets; the remainder purchased piglets for rearing.

All farmers accepted our offer of free pig examinations and education. None of the 2604 pigs available for this study showed signs clinically compatible with JE, but this survey did not take place in JE season. Forty-nine percent ($n = 1282$) of the pigs were >4 months of age and thus lived in the past JE season. When queried about farm medical history, some signs compatible with possible JE were reported by farmers to have occurred in the past year on their farms as follows: abortions (36% of farms), weak piglets (36%), convulsions (20%), false pregnancy (12%), hydrocephalus in piglets (2%) and swollen testicles (2%). None of the farmers had access to diagnostic testing to confirm or rule out JE. Similarly, none of the farmers reported JE in themselves or families, and few reported JE signs. Twelve farmers had a history in the past year of severe headaches, two experiences unconsciousness at some point, one farmer had neck rigidity and one farmer experienced convulsions. None were diagnosed or treated for JE, but access to diagnostic tests and health care was limited for this subpopulation. There was no association between whether or not a farmer had formal education and reported any clinical signs compatible with JE ($\chi^2 = 2.21$; $P < 0.97$).

All farm houses were located within a short distance of known risk factors. Houses were all located within 20 m of pigpens with nine farms as close as 0.5 m. The vast majority of farmer's houses were within 1 km of rice fields (95%) and standing water sources (99%). All farmers reported being bitten by mosquitoes and seeing their pigs being bitten. All farmers had encountered birds on their farms, all year round, including wading birds, waterfowl and other wild birds. Pigs and ducks were raised together on 39% of the farms. Ducks were raised under free range system, allowing direct contact with pig housing, food and water sources. The remaining 61% that did not keep ducks reported that the nearest duck farm was within 0.5 km from their household.

Experience in pig farming ranged from 27% with <3 years experience, 55% with 3–6 years and 18% with more than 6 years experience. Having more than 3 years of experience was not associated with knowledge of JE ($\chi^2 = 2.80$; $P < 0.25$). Only 16% of the farmers had received training on pig husbandry, management or disease, with the latter topic being mentioned by only four farmers. Governmental offices were the most common source of training (used by 11/16 farmers) followed by farmer groups (3/16) and non-governmental organizations (2/16). Many of farmers having no training ($n = 84$) responded either they were unaware of training (56%) and/or they did not know where and how to approach for training (42%). Most (75%) said they learned about diseases of pigs from friends and/or through personal experiences, while 25% reported veterinarians as the source of pig health information. However, field veterinarians were the predominant source (95%) of information who informed immunization decisions, with friends and community members being the source of vaccine information for 5% of the farmers.

Forty-two of the one hundred farmers knew there was a disease called JE; 33% knew it was a disease of humans; 7% knew it caused problems in pigs; 20% knew it was transmitted by mosquito bites; 19% knew it is a vaccine-preventable disease in people; and 11% knew there was a vaccine for pigs. Most farmers (72%) knew that people could acquire infections from pigs, but on subsequent questioning, only 14 farmers could name a disease that could be acquired from pigs. Half of these 14 farmers could name JE as a pig-associated zoonosis, followed by swine flu (6/14) and neurocysticercosis (1/14). There was a significant association between sex of the farmer and whether or not they had heard of JE ($\chi^2 = 5.911$; $P < 0.05$); men more often had heard of JE than women. However, there was no relationship between attendance at a pig farming training session and whether or not they had heard of JE ($\chi^2 = 1.588$, $P = 0.208$). Friends and community was found to be the major source of JE and zoonotic disease information (48%) followed by mass media (38%), training (12%) and academic study (2%). Of those farmers who were aware that pigs could be a source of human disease ($n = 72$), they recognized the following possible sources of infection: pig manure (50%), mosquito bites (47%) and undercooked meat (47%).

The Government of Nepal had launched an active vaccination campaign in the Kathmandu Valley the year before and in the Kathmandu District in the year of our study. The vaccination programme was conducted through different health centres free of cost and was accompanied by an awareness campaign. However, none of the pig farmers were vaccinated against JE. In some cases, the interviewed farmer reported his or her family was also unvaccinated, but in other cases, the farmers did not know the vaccine status of his or her family members. Despite the fact that 87% of the pig farmers had vaccinated their pigs for other diseases (82% vaccinated for classical swine fever and 5% for both classical swine fever and foot and mouth disease), none vaccinated for JE. Reasons for not providing any vaccines to pigs included they did not know there were vaccines available or they felt their pigs did not need them. All but one of the pig farmers claimed they knew about mosquito bite prevention techniques and used at least one technique. Techniques used included using mosquito coils (69%), mosquito nets (41%), wearing full-length cloths (40%), staying indoors at dawn and dusk (39%), maintaining proper drainage (38%), using repellents (25%) and using window screens on the house (11%). There was no relationship between whether a person knew about JE and whether they used at least one of these measures ($\chi^2 = 0.731$, $P = 0.392$). There was also no relationship between using at least 1 measure and attendance at training sessions ($\chi^2 = 0.192$, $P = 0.661$). Seventeen of the 100 farmers reported they practiced mosquito avoidance techniques in the pig shed. Their techniques involved spraying chemical (10/17, 59%), maintaining cleanliness (1/17, 6%), smoke from fires (5/17, 29%) and using repellents (1/17, 6%).

Although only 1 variable (farmer sex) was statistically significantly associated with farmer knowledge of JE, we attempted to develop a logistical regression model to explore interactions between variables. No statistically significant models could be created, and the R-squared for the models were all very low (<0.05), indicating that other unanalyzed variables played a larger role in determining whether a person had or had not heard of JE.

Discussion

This study confirmed that Nepalese pig farmers are subject to conditions that both expose them to a suite of JE risk factors as well as restrict their ability and options for personal protection against the disease. This pig farming community was poor, had little ownership of land and had limited education. While 30% earned more than the median household annual income of 127 281 Rs (approximately 1500 USD) (mean 202 374 Rs) in 2010/11 (CBS, 2011), such an income still leaves little opportunity for investment in home improvements, health protection or swine management. Households in Nepal dependent on agriculture wages and illiterate and landless tend to remain poor (World Bank, 2006). Considering these scenarios, JE control interventions targeting pig farms that require capital input or infrastructure seem unlikely in Nepal.

This study highlights the importance of spatial attributes for assessing the risk of specific subgroups, such as pig farmers. *Culex tritaeniorhynchus*, the predominant vector for JE (Philip Samuel et al., 2000), has an average flight range of 1.5 km (Henrich et al., 2003). We found these farmers lived well within 1.5 km of mosquitoes and virus sources including paddy fields, pigs, ducks, standing water and wild birds. A strong association was previously found in Nepal between JE incidence and percentage of irrigated land, mainly the paddy field (Impoinvil et al., 2011). A case–control study in Bali, Indonesia (Liu et al., 2010), showed that proximity to rice field and pig ownership by family or neighbourhood were independently associated with risk of JE. Amerasinghe (2003) found in Sri Lanka in 1985/86 and 1987/88 that the highest number of cases were reported from areas with irrigation and pig husbandry and no cases from non-irrigated areas with few pigs. Indian research involving rice paddy ecosystem with and without herons revealed an association between the presence of herons and the serostatus of children (Mani et al., 1991). Ducks have been implicated as a possible JEV source in Nepal (Joshi and Gaidamovisch, 1981/82), and the farmers in this study all lived very close to duck farms. It is unclear how these various risk factors affect each other, making it difficult to quantify the occupational risk of JE for pig farmers to determine whether it is significantly greater than the general population. No research has been carried out to attribute different rates of JE to different socio-economic groups in Nepal. Additional epidemiological studies required to quantify attributable risk will need to confront social and economic impediments to compelling people to participate in serosurveys and/or to overcome limits in access to diagnostic services for poor people in Nepal.

Effective vaccination and environmental changes like separation of houses and pigpens have contributed to significant reduction in JE cases elsewhere (Obara et al., 2011). Rao's (2000) proposal of locating households 5 km from pig farms is likely unfeasible in Nepal because the majority of the farmers did not own their land, frequently were required to move and favoured riparian and peri-urban areas near paddy fields. There was an active immunization programme for people conducted in our study area at the time of this project; however, there was no uptake among the pig farmers. Reasons for this lack of uptake were not explored in this project. Some of these farmers resided on government land and may have wanted to avoid interactions with government agencies. Illiteracy in others may have excluded them from some vaccine awareness campaigns. Although the farmers vaccinate their pigs for other diseases, they either were not aware of swine JE vaccine or saw no direct benefit to themselves from vaccination. Pig JE immunization will, therefore, likely require public investment.

Mosquito-avoiding practices can be low-cost JE preventive measure. For example, a population-based case–control study in China found that use of insecticide-treated mosquito nets was associated with significant reduction in JE cases (Luo et al., 1994). Despite all but one farmer reporting they knew about mosquito bite prevention techniques and used at least one technique, their subsequent answers suggested a low application of mosquito avoidance techniques. The low uptake of these measures found in our study area was consistent with past surveys in Nepal (Houston and Chhetry, 2003) and is of particular concern, given that there are a number of significant mosquito-borne infections in Nepal including dengue haemorrhagic fever and malaria. Understanding the enablers and barriers to changing mosquito avoidance behaviours should be a priority in this vulnerable population. Research in Sri Lanka found that participation in a community-based educational programme led to changes in agricultural practices and an increase in environmentally sound measures for mosquito control (Yasuoka et al., 2006).

'Health education and training is an important part of JE control' (Anon, 2002). Forty-two percent of the farmers had heard of JE, but fewer knew about its risk factors or means of prevention. A previous survey of 1800 households in six districts in Nepal noted a lack of awareness about potential JE risk factors (Houston and Chhetry, 2003). We found that knowing about JE was not a predictor of whether or not people adopted preventive measures for themselves or their family. Further work will be required to determine why there was a relatively low rate of use of JE prevention. Our study provides some data that can inform future education programmes for this vulnerable population. Given that there was an equal number of male and female farmers, education programmes will need to consider differences between men and women on how they access public health information. Culturally, men in Nepal have more activities outside of the home, have greater reach into mass media and there is greater male involvement in trainings and academic study. The level of general education in our study group was not high overall, but was consistent with national trends wherein 77% of the urban and 57% of the rural populations are considered to be literate (CBS, 2011). As over 1/3 of our study group was illiterate, JE awareness campaigns will need to consider media other than print media to deliver its messages. This will be particularly important for women farmers, given that the literacy level in women is lower than for men in Nepal

(UNICEF, 2010). The heavy reliance on friends and neighbours as information sources shows the potential for social networks as a means for knowledge mobilization. Veterinarians and para-veterinarians were revealed as trusted sources of information for immunization, suggesting that professional education targeting these groups should also be a component of JE education efforts.

We do not know whether our results can be generalized to the rest of Nepal. On one hand, JE is relatively new in the Kathmandu region. It could be expected that the level of JE knowledge and prevention is higher in areas of the country where the disease has been endemic for over 30 years, such as in the Terai region. On the other hand, our study population was in the capital city and was in the midst of a JE vaccination campaign, suggesting they may have had higher levels of recent exposure to information on JE than people in other regions. Our team plans to repeat this study in four regions in Nepal in 2012 and will couple this survey with the research designed to document the degree of circulating virus in the environment and with a more detailed household survey that includes pig farmers and non-farmers. Our results are in agreement with previous work examining socio-demographic factors associated with taeniasis and cysticercosis in Nepal (Sharma, 2006). This author reported high exposure risks from co-habitation of pigs and people, poor sanitary conditions, low education and low awareness about disease and disease control. She recommended mass awareness campaigns to increase capacity for farmers to reduce their risks to these parasites, but also recognized the constraints of poverty that preclude investments in improved sanitation and husbandry. We believe that our results are sufficient to recommend targeted actions towards pig farmers who not only contribute to JE risk by farming JEV reservoir species in high-risk environments, but also experience an occupational risk of exposure that is greater than their current capacity to eliminate or reduce the risk.

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