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Abstract

We estimated the number of stray dogs in Kathmandu, Nepal, where human rabies cases still occur, and in Shimotsui, Okayama Prefecture, Japan. In Kathmandu, the stray dog density was 2,930 stray dogs/km², and the ratio of stray dogs to humans was 1:4.7. In Shimotsui, the density was 225 stray dogs/km², and the ratio was 1:5.2. Since the stray dog population in Nepal is very large, one of the measures used to prevent dog bites and dog-acquired infections such as rabies is an effort to capture stray dogs. Another such measure is an effort to decrease the availability of food for stray dogs. We also organized health education programs in both Nepal and Okayama Prefecture, Japan, which involved a course on the prevention of dog bites and subsequent infections. After each course, a questionnaire survey was conducted. The results suggest that the course participants understood these important preventive methods. In addition to the measures mentioned above and the routine vaccination of dogs, this health education course is recommended as a long-term preventive program

KEYWORDS: dog, rabies, dog density, dog bite, health education

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Original Article

Survey of the Stray Dog Population and the Health Education Program on the Prevention of Dog Bites and Dog-Acquired Infections: A Comparative Study in Nepal and Okayama Prefecture, Japan

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We estimated the number of stray dogs in Kathmandu, Nepal, where human rabies cases still occur, and in Shimotsui, Okayama Prefecture, Japan. In Kathmandu, the stray dog density was 2,930 stray dogs/km², and the ratio of stray dogs to humans was 1:4.7. In Shimotsui, the density was 225 stray dogs/km², and the ratio was 1:5.2. Since the stray dog population in Nepal is very large, one of the measures used to prevent dog bites and dog-acquired infections such as rabies is an effort to capture stray dogs. Another such measure is an effort to decrease the availability of food for stray dogs. We also organized health education programs in both Nepal and Okayama Prefecture, Japan, which involved a course on the prevention of dog bites and subsequent infections. After each course, a questionnaire survey was conducted. The results suggest that the course participants understood these important preventive methods. In addition to the measures mentioned above and the routine vaccination of dogs, this health education course is recommended as a long-term preventive program.

Key words: dog, rabies, dog density, dog bite, health education

Rabies is a zoonosis that occurs globally. Almost all cases of human rabies are attributed to dog bites, especially in developing countries where canine rabies is still endemic. Most of the strains of neurotropic viruses that cause rabies belong to the genus *Lyssavirus*, family *Rhabdoviridae* [1]. In humans, the average incubation period lasts for approximately 20–60 days and is followed by the onset of acute neurological symptoms including paralysis, delirium, coma, and finally death [2].

A World Health Organization (WHO) survey report-

ed that 160 to 170 human rabies cases were clinically confirmed in Nepal in 1999, and that approximately 35,000 persons required treatment after exposure to rabies in Nepal in 1999 [3]. Although the prime reason for this situation is a delay in the widespread vaccination of dogs, the presence of a very large number of stray dogs is suspected to be another important reason.

In Bangkok, Thailand, approximately 70% of dogs that bit humans were stray dogs with unidentified owners, and if dogs that were actually homeless but were fed by neighbors were included, the figure was over 80% [4]. Considering the major role played by stray or homeless dogs in dog bites and rabies, tracking their number is essential if dogs are to be controlled. However, there have been few reports on the numbers of stray dogs in

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recent years, and in several studies the number of owning dogs that were not known whether they were free-ranging dogs or not have been surveyed by means of interviews [5-9].

We estimated the stray dog population in Nepal and Okayama Prefecture, Japan, using Beck's method [10]. This method is a modified capture-mark-recapture method for estimating numbers of wild animals. The number of animals that are captured, marked, released and then recaptured is equivalent to the number of animals observed up to the previous day in Beck's modification. Therefore, this is regarded as less labor- and cost-intensive than the original method. In this method, the number of stray dogs is counted early in the morning, a time of day when they are often observed since traffic is light and visibility is good.

In Nepal, the stray dog density was estimated in the capital Kathmandu (Fig. 1), in a survey area made up of the shopping district running approximately 1.5 km in a straight line from the Palace. The number of stray dogs was counted there in October, when it is supposed that stray dogs are most often observed since the weather in October is the mildest of the year. In Okayama Prefecture, Japan, the stray dog density was estimated in Shimotsui (Fig. 2), where the coastline is backed by mountains and the narrow flat land and the mountain slopes are crowded with many houses. This area has a reputation as a home for many stray dogs. The number of stray dogs was counted there in May, when the weather is the mildest of the year.

We also organized a health education program on the prevention of dog bites and dog-acquired infections such as rabies in Nepal and Okayama Prefecture, Japan. The

purpose of this health education was to disseminate knowledge on the prevention of dog bites and these infections. Questionnaires were distributed at the end of each course in order to evaluate this health education program.

Based on the results of the above survey attempts, we examined the measures for preventing dog bites and these infections, focusing on rabies.

Materials and Methods

Estimation of stray dog population.

Beck's method [10] was used to estimate the population density of stray dogs, which included homeless dogs without owners or keepers and free-ranging dogs with owners or keepers. The observer counted while walking the survey areas. When he encountered a stray dog, he numbered it, recorded the location and took a photograph of it. It was identified by several features such as build, fur and tail. This counting procedure was conducted from 5:30 to 6:30 a.m. The number of stray dogs counted on a given day (*M*) was determined.

The number of stray dogs in Kathmandu, Nepal, was counted from October 16 to October 22, 1997. The survey area in Kathmandu was 5,930 m². The same counting procedure was conducted in Shimotsui, Kurashiki City, Okayama Prefecture, Japan, from May 23 to May 28, 2001. The survey area in Shimotsui was 50,700 m², an area which was used so that "M" would not be 0 on any given day. Within each survey area during the survey time, it was confirmed whether traffic was light or not and whether visibility was good or not. The temperature at 6:00 a.m. was measured.

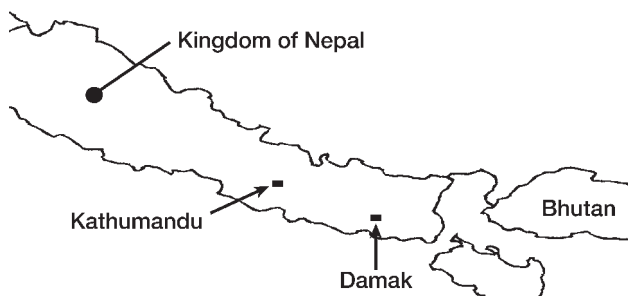


Fig. 1 Location of Kathmandu and Damak

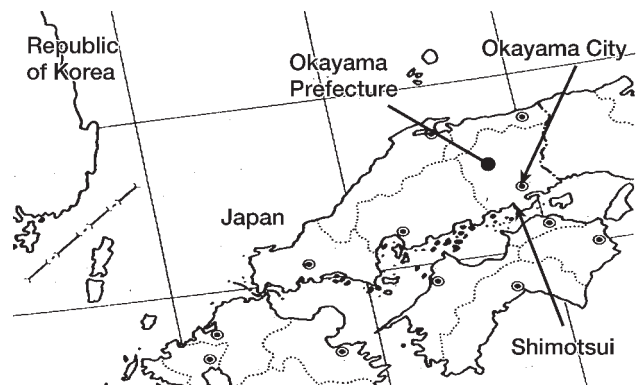


Fig. 2 Location of Okayama and Shimotsui

For the estimation, only the “M”s counted on the 4 days when it was not rainy or windy were used. On the basis of the chosen “M”s, the number of stray dogs that had been observed up to the previous day (m) was determined. “M”s and “m”s were substituted into the following equation to estimate the number of stray dogs (N) observed over the 4 days combined.

$$N = \frac{\sum M(\sum(M - m))}{\sum m}$$

The stray dog density for Kathmandu and Shimotsui was calculated separately from “N”, and the above value of the area was measured using the map. The stray dog-to-human population ratios were also calculated for the 2 districts using the human density of Kathmandu in 2001, 13,800/km², [11] and that of Shimotsui in June 2001, 1,160/km², [12].

Within each survey area, the sites where the stray dogs obtained food and that they used as shelters for sleeping were determined.

Health education program on the prevention of dog bites or dog-acquired infections and questionnaire survey. Courses on the prevention of dog bites and dog-acquired infections were conducted in schools in Kathmandu and Damak (Fig. 1) in Nepal. Similar courses were conducted in a school in Okayama City (Fig. 2), Okayama Prefecture, Japan. Details of the courses are shown in Table 1.

Each course took 50 min. A stuffed toy dog, posters and a blackboard were used during the courses. The

content of the courses included instruction in the proper reaction upon encountering stray dogs [13], the proper way to touch known dogs [14], emergency procedures after being bitten by dogs [15] and the proper methods of keeping dogs with respect to public health. The school teachers and the health care workers such as nurses and radiological technologists were requested to transmit the information to their colleagues, students, and children who visited the hospital.

Questionnaires were distributed to the participants soon after each course. The responses of these questionnaires were analyzed statistically.

Results

Estimation of stray dog population. In Kathmandu, the 4 days used to estimate the stray dog population were October 16, 17, 21 and 22. In Shimotsui, the 4 days were May 24, 25, 26 and 28. Within each survey area during the 4 days of the survey it was confirmed that traffic was light and that visibility was good. The mean temperature during the survey was 16.0 °C in Kathmandu and 17.5 °C in Shimotsui.

Table 2 shows the results of counting and estimating the stray dogs in Kathmandu and Shimotsui.

In the survey area in Kathmandu, piles of garbage, not in containers such as cans or bags, were distributed at 4 sites along the roadside, where stray dogs were seen to feed themselves. The garbage dumps included leftover

Table 1 Courses on the prevention of dog bites and dog-acquired infections conducted in Nepal and Okayama Prefecture, Japan

Date	Place	Participants
October 16, 1997	Kathmandu	29 students (9–17 years old), 1 teacher
October 18, 1997	Damak	58 students (4th grade high school), 7 teachers
October 19, 1997	Damak	50 students (4th grade primary school), 3 teachers
October 19, 1997	Damak	12 health care workers
October 20, 1997	Kathmandu	31 students (11–16 years old), 14 teachers
October 27, 1998 (4 courses)	Okayama	132 students (1st grade high school), 10 teachers

Table 2 Results of counting and estimating stray dogs in Kathmandu and Shimotsui

Area	N ^a	Stray dog density	Ratio of stray dogs to humans
Kathmandu	17.4 dogs	2,930 dogs/km ²	1:4.7
Shimotsui	11.4 dogs	225 dogs/km ²	1:5.2

a, Number of stray dogs estimated within the survey areas by means of Beck's modification[10].

meals such as rice, vegetables and fruits. One household in a housing unit gave food to stray dogs every morning. Stray dogs were seen sleeping under the eaves between houses and in abandoned houses.

In the survey area in Shimotsui, no piles of loose garbage were found; all garbage was contained in cans. Some stray dogs were seen feeding on food set aside for kept dogs. Stray dogs were seen sleeping under the eaves between houses, in garages and under the highway.

Health education program on the prevention of dog bites or dog-acquired infections and questionnaire survey. Table 3 shows the results and statistical analysis of the students' responses to the questionnaire.

In a comparison between students in the capital Kathmandu and the rural city Damak, there were no significant differences at either $P < 0.01$ or $P < 0.05$ in the answers to the 4 questions on personal experience with dogs. Although there was a difference in the rate of correct response to the test questions between the capital and rural city ($P < 0.01$), both were high at 83% (149/

180) and 95% (301/318), respectively.

Table 4 shows the results and statistical analysis of the responses of teachers and health care workers to the questionnaires.

Discussion

The population density of stray dogs, calculated from the estimated number of stray dogs, was 10 times higher in Kathmandu than in Shimotsui. The biggest reason for this difference is that the public health administration in Japan takes measures to capture stray dogs and detain them in public health centers or animal control centers. In the year 2000, a total of 151,574 stray dogs were captured in Japan. Subsequently 15,336 dogs were returned to their owners and the remaining 136,238 dogs were sacrificed [16].

On the other hand, the Nepalese administration takes no active measure to capture stray dogs. In the questionnaire for teachers and health care workers in Nepal, many of the respondents responded "Have experienced seeing a

Table 3 Results of students' responses to the questionnaire

Content of question	Nepal ^a	Okayama ^b	<i>P</i> value
'See a dog everyday'	95% (157/166)	67% (88/132)	0.000 ^c
'Have experienced keeping a dog'	67% (112/166)	58% (77/132)	0.000 ^c
'Have experienced a dog bite'	20% (34/166)	36% (48/132)	0.002 ^c
If 'yes' above, 'have visited hospital'	88% (30/ 34)	13% (6/ 48)	0.000 ^d
Content of the course	90% ^e (450/498)	99% ^e (391/396)	0.000 ^c

a, Rate of responses by the course participants in both Kathmandu and Damak; b, Rate of responses by the course participants in Okayama City; c, *P* value obtained from chi-square test comparing "a" with "b"; d, *P* value obtained from Fisher's exact test comparing "a" with "b"; e, Rate of total correct answers in 3 test questions on the content of the course.

Table 4 Results of responses of school teachers and health care workers to the questionnaire

Content of question	Nepal ^a	Okayama ^b	<i>P</i> value ^d
'Have experienced keeping a dog'	71% (22/31)	83% (5/6)	1.000
'Have experienced a dog bite'	19% (6/31)	50% (3/6)	0.140
'Have experienced seeing a rabid dog'	71% (22/31)	0% (0/6)	0.002
'Have heard a jackal howl in the past year'	61% (19/31)	0% (0/6)	0.008
'Think it necessary to wash hands after touching a dog'	97% (30/31)	100% (6/6)	1.000
'Think that dogs should be leashed'	94% (29/31)	100% (6/6)	1.000
'Did not know what to do after a bite before participating in the course'	39% (12/31)	33% (2/6)	1.000
'Did not know how to touch a dog before participating in the course'	81% (25/31)	100% (6/6)	0.561

a, b, d, See footnotes to Table 3.

rabid dog” or “Have heard a jackal howl.” These results show that rabies is observed close to home in Nepal. Some people think that stray dogs have to be sacrificed, and a non-governmental organization (NGO) that is active in the eradication of homeless dogs without owners or keepers actually exists in Kathmandu. However, in Kathmandu Valley there is a religious rite of adorning dogs [17]. It is likely that there are also some people who have a moral or religious aversion to killing stray dogs. According to a WHO report, there is no clear evidence that capturing and killing dogs has an impact on rabies control [18]. Therefore, with respect to the introduction of the capture and killing of stray dogs, extra caution must be exercised.

Another possible reason for the larger stray dog population in Kathmandu is the availability of food, including the presence of a quantity of garbage scattered on the streets and the tendency of some dog-lovers to feed stray dogs. Dogs that thrive due to the latter practice are known as free-ranging dogs with owners or keepers. In Japan, almost all local governments including the Okayama prefectural government prohibit free-ranging. Through proper garbage disposal and the prohibition of giving feed to stray dogs in Kathmandu, stray dogs could be deprived of nutrition resulting in a reduced life span and lowered reproductive ability. These measures seem to play a role in reducing the number of stray dogs.

Free-ranging dogs with owners or keepers have the same likelihood as homeless dogs without owners or keepers to bite humans, come into contact with rabid dogs or rabid jackals, spread parasitic infections through their excreta and increase the number of stray dogs through free mating. In developing countries, free-ranging with keepers is common [19]. In the health education courses that we taught, the participants were discouraged from allowing free-ranging; that is, they were told to leash their own dogs as one of proper methods of keeping dogs in order to prevent dog bites and dog-acquired infections. The responses to the questionnaire indicated that most of the participants understood the significance of leashing kept dogs. Disseminating the proper methods of dog-keeping is especially important, for, according to the questionnaire, many participants in the courses in Nepal have experienced keeping a dog.

The high proportion of students who responded “See a dog everyday” in the questionnaire and the high density of stray dogs suggested that dogs were closer to people in Nepal. However, the proportion of the participants

who responded “Have experienced a dog bite” was higher in Okayama. Conversely, of those who had been bitten, significantly more students responded “Visited hospital” in Nepal. These results show that dog bites are regarded as a graver situation in Nepal than in Okayama. Since no differences in response rates were found between Kathmandu and Damak, the situation is probably similar in the capital and in the rural city in Nepal.

Though the situation is grave in Nepal, kept dogs are not widely vaccinated. Therefore, education in the emergency procedures to be followed after being bitten by dogs, the proper reactions upon encountering stray dogs in order to prevent stray dogs from biting and the proper way of touching kept dogs in order to prevent them from biting is a simple but necessary step toward reducing rabies in humans. All of these methods were part of the content of this health education program. The emergency procedures to be followed after being bitten, as covered in this course, included vaccination but did not include confirming Negri bodies histopathologically in the hippocampus of the dog that had bitten the victim. The reason for this omission is that no Negri body is formed in the hippocampuses of 30% of rabid dogs [20]. It is essential to disseminate the emergency procedures to be performed after being bitten, for some teachers and health care workers were not aware of them according to the questionnaire. According to the questionnaire, many teachers and health care workers had not known about the ways of touching dogs that do not displease them generally. In the course, a stuffed toy dog was used for demonstration. The rate of correct answers in the test in the questionnaire was very high, suggesting that the course contents were simple and easy to understand. It seems that the contents and methods of the courses were effective.

Dog bites or rabies occur more commonly in children than in adults [4, 21]. Therefore, in countries with a high incidence of rabies, the adoption of this health education program as a part of the formal primary school curriculum may be expected to achieve a preventive effect.

According to our survey, the number of stray dogs in Kathmandu is far higher than in Shimotsui. It is supposed that one of the reasons for this difference is that the Nepalese administration takes no active measures to capture stray dogs. Also, it appears that food is fairly easily available to stray dogs in Kathmandu. Managing garbage properly and prohibiting the free-ranging of dogs may play an indirect role in reducing the number of stray

dogs. Apart from these measures and the widespread vaccination of dogs, the health education program used in this study could be one part of a long-term program to prevent dog bites and dog-acquired infections. The results of the questionnaire suggested that this education was effective. To implement these measures, countries that have successfully reduced human rabies should provide health-related support to countries such as Nepal that still have a high incidence of human rabies.

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