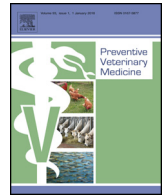




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Size and demography pattern of the domestic dog population in Bhutan: Implications for dog population management and disease control

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ABSTRACT

Understanding the demography of domestic dogs is essential to plan the dog population management and rabies control program. In this study, we estimated the owned and stray dog population and the proportion of owned dogs that are free-roaming in Bhutan. For this, a cross-sectional household surveys were conducted in six districts (both urban and rural areas) and two border towns in southern Bhutan. The population estimation was done by extrapolation of the mean number of dogs per household and dogs per person, whilst mark-resight survey was conducted to estimate the proportion of owned dogs that were free-roaming. A total of 1,301 (rural:585; urban:716) respondents (one per household) were interviewed of which 173 households (24.4%) in urban areas owned 237 dogs whilst 238 households (40.8%) in rural areas owned 353 dogs. The mean number of dogs per dog owning household was estimated to be 1.44 (urban:1.37 dogs; rural:1.48 dogs) and dogs per household was estimated to be 0.45 (urban:0.33; rural:0.60). The dog: human ratio was 1:16.30 (0.06 dogs per person) in urban areas and 1:8.43 (0.12 dogs per person) in rural areas. The total owned dog population based on the mean number of dogs per household and dogs per person were estimated to be 65,312 and 71,245 in the country, respectively. The male: female ratio of the owned dog was 1.31:1 in urban areas and 2.05:1 in rural areas. Majority of the dogs were local non-descript breeds in both urban (60.8%) and rural (78%) areas, and the most common source was acquisition from friends or family (44.7%). The stray dog population in Bhutan was estimated to be 48,379 (urban:22,772; rural:25,607). Of the total estimated owned dog population in the two border towns, the proportion that were found free-roaming was estimated to be 31%. The different dog population estimation methods were compared and discussed in this paper. This study generated baseline data on the demographic patterns of the owned and stray dogs in Bhutan which will be useful for planning and monitoring dog population management and rabies control program in the country.

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1. Introduction

Dogs are the first animal to be domesticated in the world; and since then have performed several useful functions to humans as companion, guide, guard, security, herding and for transport purpose depending on the socio-cultural background of the society (Coppinger and Schneider, 1995; Stafford, 2006). However, when dogs are not given proper care, they would roam the streets and become the main source of stray dogs. Large populations of stray dogs and un-supervised owned dogs can create public health threats through bites, disease transmission such as rabies and other

zoonotic diseases (Robertson and Thompson, 2002; Feldman et al., 2004; WHO, 2004; Keuster et al., 2005; Zinsstag et al., 2009; Tenzin et al., 2011a; Tenzin et al., 2011b), and also pose threats to native wildlife from predation and disease transmission (Butler et al., 2003; Cleaveland et al., 2007).

Dog population control program including vaccination require data on the distribution and numbers of owned and stray dogs in the country. Thus, understanding the size and demography of dogs is a necessary first step for planning rabies prevention and control and also to plan drugs and vaccine requirement for veterinary care (Downes et al., 2013; FAO, 2014). Cross-sectional household surveys has been recommended to study the population demography of owned dogs (Downes et al., 2013). Through such surveys the proportion of households that own dogs and the mean number of dogs owned by these dog owning households can be determined

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to estimate the size of the owned dog population. For instance, the proportion of households that own dogs has been studied in numerous countries, including Sri Lanka (rural 57%) (Matter et al., 2000), Thailand (73.7%) (Kongkaew et al., 2004), Chile (rural 89%, towns 63% and cities 49%) (Acosta-Jamett et al., 2010), Zimbabwe (rural 62%) (Butler and Bingham, 2000) and Mexico (urban 54%) (Flores-Ibarra and Estrella-Valenzuela, 2004). These studies have also estimated the mean number of dogs per dog owning household in the range of 1.2 to 3.2. In other studies, the population of owned dogs has then been estimated by multiplying the mean number of dogs per household (obtained from household surveys) by the total number of households (obtained from national statistics) in the USA (AVMA, 2002), Zimbabwe (Butler and Bingham, 2000), Mexico (Ortega-Pacheco et al., 2007) and Italy (Slater et al., 2008).

However, no studies have been conducted to understand the demographics of owned and stray dogs in Bhutan. Therefore, the objectives of this study were to: (1) describe the pattern of dog ownership in Bhutanese households; (2) describe the demographics and estimate the size of the owned dog population; (3) estimate and compare the proportion of owned dogs that were free-roaming and conversely the proportion of free-roaming dogs that were owned; and (4) estimate the size of the stray dog population in Bhutan from the estimated population of owned dogs. The findings from this study is expected to assist in better planning and implementation of effective population control and welfare of dogs in the country.

2. Materials and Methods

2.1. Study area

The Kingdom of Bhutan is situated in the eastern Himalayas, bordering People's Republic of China to the north and India to the south (Fig. 1). The country is divided into 20 administrative units called Dzongkhags (districts) which are further subdivided into 205 Geogs (sub-districts). There are 127,942 households (HHs) in Bhutan of which 84,427 are rural and 43,515 urban (NSB, 2012). Bhutan has a total human population of 720,680 (rural population 466,017; urban population 254,663) (NSB, 2012). For the purpose of this study, dogs that were fed, cared-for and claimed by a household as being owned were considered as owned dogs.

2.2. Cross-sectional household survey

During January–February 2012, a household survey was conducted in six Dzongkhags (Bumthang, Samtse, Samdrup Jongkhar, Trashigang, Thimphu and Tsirang—Fig. 1) which covered both rural and urban areas. Households from both rural and urban settlements were selected in proportion to the population size in the relevant area/region. In the rural areas a two stage cluster sampling method was used where two villages were randomly selected from each sub-districts of the six Dzongkhags. From each selected village, five households were selected through systematic random sampling. In towns the households were chosen using a rolling sample method in which the first selected households provided information about the next available household in the area or within the building until the required number of household respondents had been interviewed in the respective study areas. The information about the first household that owned dog was provided by the key informant—local veterinary official. One adult member of each selected household was interviewed using a face to face method to collect the information on the number of dogs owned by that particular household and their demographics.

The questionnaires consisted of two parts: a household and an individual dog characteristics. The household level questionnaire was designed to collect information about the respondents and the

dog owning status of that household. For the dog survey, data were collected on the demographic characteristics of the owned dogs including their age, sex, and neuter and vaccination status. The dog owners were also asked about the source and purpose of keeping a dog as well as management aspect of their dogs. All selected households ($n = 1,301$) were interviewed in the household survey, while only 413 households (175 urban and 238 rural) that owned dogs were included in the dog survey.

2.3. Estimation of the dog population

From the household surveys the proportion of dog owning households, the mean number of dogs owned per dog owning household, the mean number of dogs for all households and the mean number of dogs per person were calculated. The size of the owned dog population was estimated by several methods which had been used in other countries (Butler and Bingham, 2000; AVMA, 2002; Slater et al., 2008; Downes et al., 2013). These involved: (1) multiplying the mean number of owned dogs per household by the number of households in the urban and rural areas, and (2) multiplying the mean number of dogs per person by the number of people in the area. We used the national household and human population data to estimate the figures (Table 1) (NSB, 2006). Using these two methods the size of the owned dog population were compared and biases for the two different methods discussed.

In Bhutan, free-roaming dog population are managed through Catch-Neuter-Vaccinate-Release (CNVR) program, wherein the dogs are captured from the street by trained dog catchers and then brought to the clinics for neutering and vaccination. The neutered dogs are given permanent identification marks by ear-notching and then released back to the place of capture. These dogs were categorized as free-roaming or stray dogs. The owned dogs are also brought to the clinic by the owners themselves for neutering and rabies vaccination and were categorized as owned dogs. This program is being implemented in all over the country, both rural and urban areas. In this study, the ratio of stray-to-owned dogs presented to the CNVR clinic from July 2011 to June 2013 was estimated (Table 1). The total number of owned dogs was then multiplied by this ratio to give an estimate of the total stray dog population. CNVR data from Thimphu Dzongkhag was not included in the estimation of the ratio of stray and owned dogs as sterilization and vaccination of the owned dogs in Thimphu city was performed by the National Animal Hospital on a weekly basis and consequently very few owned dogs were brought to the CNVR clinic. Including data of Thimphu would have resulted in an over-estimation of the mean number of stray dogs. The density of dogs in each Dzongkhag was calculated by dividing the estimated dog population (both owned and stray) by the size of the Dzongkhag (km^2).

2.4. Estimation of the proportion of owned dogs that were free-roaming

A one-day free rabies vaccination campaign was organized on 28th September 2012 coinciding with World Rabies Day in two southern border town of Gelephu (Sarpang Dzongkhag) and Phuentsholing (Chukha Dzongkhag) (Fig. 1). This involved setting up of 17 temporary vaccination posts (VP) at strategic locations. Each vaccinated dog was identified by placing a colored synthetic collar around its neck. On the following day, the household surveys were conducted in the vicinity of the VP.

Households closer to the VP were initially visited and then the interview teams radiated outwards until the required number of households to be interviewed was achieved. Dog owners were asked if their dog(s) had been taken to a VP on World Rabies Day and the dogs were also checked for the presence of the identifying collars. This provided an opportunity to estimate the size of the

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