



## Socio-economic factors associated with voluntary rabies control measures in Vietnam



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### ABSTRACT

Rabies is a fatal zoonosis, and in Vietnam, it remains problematic despite the availability of dog rabies vaccination. The purpose of this study was to clarify the socio-economic factors associated with voluntary rabies control measures among the general population using a “Knowledge, Attitudes, and Practice” framework to provide health and veterinary authorities in Vietnam with baseline information for better planning of policy supports.

A questionnaire survey with interviews was conducted in 495 households (64 mountainous and 431 plain-area households) in Thai Nguyen Province in September 2016. After the survey, uni- and multivariable analyses were performed to detect factors associated with the practices of dog rabies vaccination and tethering dogs. Structural equation modelling (SEM) was performed to understand the structures associated with practice decisions. Contingent valuation was performed to calculate willingness-to-pay for vaccination.

Vaccination coverage was 77.4% (724/935 dogs), and was significantly lower in mountainous areas dominated by ethnic minorities (63.8%, 67/105) than in plains (79.2%, 657/830,  $\chi^2 = 11.7$ ,  $df = 1$ ,  $p < 0.001$ ). Mean estimation of willingness-to-pay for a vaccination was 2.30 USD (51,959 Vietnamese dong), which was more than double the current price. The willingness-to-pay in mountainous areas was 2.16 USD, while that in plain areas was 2.32 USD. The proportion that never confined dogs was significantly higher in mountainous areas (65.6%, 42/64 households) than in plain areas (26.5%, 114/430,  $\chi^2 = 37.7$ ,  $df = 1$ ,  $p < 0.001$ ). Despite the low proportion of households tethering dogs, the majority answered that they would confine (479/489, 98.0%) or leash while walking (482/491, 98.2%) if such orders were enforced. SEM result showed that higher social status promoted better knowledge ( $\beta$ , the coefficient, = 0.75,  $se = 0.05$ ,  $p < 0.001$ ), better knowledge positive attitudes ( $\beta = 1.0$ ,  $se = 0.0$ ,  $p$  value not calculated), and positive attitudes better practices of confinement ( $\beta = 0.4$ ,  $se = 0.05$ ,  $p < 0.001$ ), vaccination ( $\beta = 0.52$ ,  $se = 0.06$ ,  $p < 0.001$ ), and sterilization ( $\beta = 0.11$ ,  $se = 0.04$ ,  $p < 0.001$ ).

Our study suggested that rabies education targeted to mountainous areas using local languages for ethnic minority groups as well as the national language, and higher subsidies on dog rabies vaccination for poor households may improve vaccination coverage. Dog management may be improved by promotion campaigns.

### 1. Introduction

Rabies is a fatal zoonosis caused by rabies virus (RABV) categorized to the *Lyssavirus* genus of the *Rhabdoviridae* family (Troupin et al.,

2016). Mammals are affected by RABV and almost 100% of infected animals die after showing fatal encephalitis (Knobel, 2013). In Asia and Africa, transmission of RABV is maintained by dogs, rather than by wild animals as seen in Europe and America (Rupprecht et al., 2002). Every

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year, over 60,000 individuals die due to rabies globally and over 99% of victims are infected by domestic dogs (WHO, 2013; Hampson et al., 2015). Although clinical human rabies can be prevented by post-exposure prophylaxis (PEP), high cost and shortage of PEP are often challenges in developing countries (Sambo et al., 2013). Dog population management offers a desirable long-term goal for rabies control by reducing the risk, while improving animal welfare and community participation (Taylor et al., 2017). However, a combination between PEP and mass dog vaccination currently remains the most cost-effective approach in rabies control (Zinsstag et al., 2009; Fitzpatrick et al., 2016; Cleaveland and Hampson, 2017).

In many countries in South and Southeast Asia, including Vietnam, rabies is endemic. Annual human rabies cases in Vietnam recently declined from 410 cases in 1995 to 34 in 2003 after the implementation of rabies control measures (Rabies in Asia Foundation, 2013). However, human rabies cases unfortunately started to gradually increase from 2004, and 91 rabies cases were confirmed in 2016, despite the availability of dog rabies vaccination. Between 2011 and 2015, 380,000 people on average received PEP at city/provincial/district health care units (MARD and MoU, 2016). PEP requires a rabies resistant sera (31.0 United States Dollar (USD), 700,000 Vietnamese Dong (VD), as of 2017 November 27, 1 USD = 22,605 VD) and five shots of vaccine (a product with lower price 8.8 USD (200,000 VD) or another product with higher price 22.6 USD (510,000 VD) per shot) (National Hospital of Tropical Diseases, 2018). Moreover, a medical doctor will usually receive 3.1 USD (70,000 VD) per shot from a single patient (personal communication). The price of PEP is high, and according to personal communications, many bite victims do not complete the course. Rabies has not been eliminated from Vietnam and human deaths mainly occurred in northern and central northern mountainous provinces between 2011 and 2015 (MARD and MoU, 2016). In animals, there were 16,800 deaths due to rabies, with 97% of these animals being dogs, were recorded in 1996. The annual number of dogs died or destroyed declined after that, and on average 159 dogs died or were destroyed between 2011 and 2015 (MARD and MoU, 2016).

Two commercial dog rabies vaccines are available in Vietnam, namely Rabies and Rabisin (Rabies in Asia Foundation, 2009r). Vaccination campaigns for dogs in district/town clusters and household visits in rural communes have been conducted two times a year: main campaign in March and April, and additional one for those missed it in September and October between 2011 and 2015 under ‘National rabies prevention and elimination program’ (MARD and MoU, 2016). The Ministry of Agriculture and Rural Development (MARD) is requesting the people’s committees of all levels (province, district, and commune) to consider providing dog rabies vaccine from local budget until 2021 (MARD and MoU, 2016), and the cost of vaccination per dog is 0.93 USD (21,000 VND) in Thai Nguyen Province at present in May 2018. Veterinary officers in provincial offices manage dog vaccination, in collaboration with districts and communes. The vaccination coverage on dog population exceeded 70% in cities and 17 of 63 provinces; however, the overall coverage in 2015 in Vietnam was 42.9% (3.89 million dogs), and still remains low (MARD and MoU, 2016). Limited capacity in dog rabies diagnosis has been a big challenge, and three regional diagnostic laboratories were recently built (MARD and MoU, 2016).

Other effective rabies control measures include dog population control and confinement of dogs (Kurosawa et al., 2017). Vietnam has a large dog population of about 7.7 million and most dogs are kept in a free roaming manner in rural areas (MARD and MoU, 2016). In 2016, MARD conducted a trial on dog management in Thai Nguyen province, in cooperation with FAO (MARD and MoU, 2016). Detailed report from this trial is not publicly available, but such experience and lessons helped to design the national program on rabies 2017–2021 (FAO, 2017), and the program describes about capturing free-roaming and unhealthy dogs (MARD and MoU, 2016). To improve dog rabies vaccination coverage and dog management, it is essential to understand

socio-economic factors associated with the poor practices.

Knowledge, Attitudes, and Practice (KAP) studies have been used to collect baseline information on what respondents know and what they actually do, and to identify knowledge gaps, cultural beliefs, or behavioral patterns that may represent obstacles to the control of infectious diseases (Launiala, 2009). The KAP survey model assumes that practices for control and prevention are motivated by knowledge and attitudes – this has also been applied in rabies studies (Sambo et al., 2014; Digafe et al., 2015). Although key factors influencing levels of knowledge, attitudes, and practices related to rabies and its prevention and control have been revealed in the previous study using uni- and multivariable linear analyses (Sambo et al., 2014; Digafe et al., 2015), it is still unclear as to how these factors influence implementation of the practices related to rabies control. A behavioral economics analysis on British cattle and sheep farmers employed structural equation modeling (SEM) in understanding the determinant structure and factors influencing their biosecurity behavior (Toma et al., 2013). This study showed that knowledge, awareness, and attitude determined biosecurity behavior. SEM is a statistical technique used to test and estimate causal relationships between variables, some of which may be latent (Bollen, 1989; Toma et al., 2013). Latent variables are variables not directly observed, but are inferred from observed and directly measurable variables (Bollen, 1989; Toma et al., 2013). For example, ‘attitude’ may be measured using representative questions such as attendance to an educational workshop; however, it cannot be directly measured. SEM can evaluate the complex relationship between multiple factors at once, including latent variables (Qiu et al., 2014). There are the other approaches used to understand the determination of preventive health behavior called Health Belief Model (HBM) and Protection Motivation Theory (PMT) (Prentice-Dunn and Rogers, 1986). HBM consists of four perceptions: susceptibility, severity, benefits, and barriers, and the first two components to mobilize the individual to act (Prentice-Dunn and Rogers, 1986). PMT outlines two cognitive mediating processes forming a threat and a coping appraisal, respectively, and these two processes combine to form protection motivation or an intention to perform a protective behavior (Prentice-Dunn and Rogers, 1986; Schemann et al., 2013).

The objectives of this study were to understand the socio-economic factors associated with the practices of household voluntary dog vaccination and dog confinement using KAP framework in Thai Nguyen Province, Vietnam, and to estimate the structure that determines the conduct of voluntary rabies control practices using SEM. In addition, the willingness-to-pay for the dog rabies vaccination was evaluated. This information will be critically important in planning dog rabies control programs in Vietnam.

## 2. Materials and methods

### 2.1. Study sites and sampling framework

Thai Nguyen Province was selected through discussions with the health authorities in Vietnam, because elevated incidences of rabies cases were perceived during the first three months of 2016 (Viet Nam News, 2016). Thai Nguyen is a province in the northeast region of Vietnam (Fig. 1). This mountainous, midland province has a natural land area of 3534.5 km<sup>2</sup> and a human population of 1,149,100. According to the sub-Department of Animal Health (DAH), Thai Nguyen Province, the estimated number of domestic dogs and the number of dogs vaccinated in 2017 were approximately 300,000 and 158,000, respectively (note that the estimated number of dogs includes puppies).

The sampling framework employed multistage cluster sampling to estimate the proportion of households conducting vaccination and dog tethering in the first sampling unit district, the second commune, and the third household. First, sample size was calculated using C-Survey software (CSurvey, 2008). The expected vaccination coverage was assigned a value of 0.754, based on a previous study in Vietnam (Mai le

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