Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Faculty of Veterinary Medicine and Animal Science

A field study on rabies in dogs in Lao PDR

The overall knowledge about rabies amongst dog owners

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SAMMANFATTNING

Rabies orsakas av ett virus, rabiesvirus som tillhör familjen Lyssavirus. Viruset sprids vanligen med bett från ett infekterat djur och alla däggdjur kan infekteras. Dock står hunden för smittspridning i 99 % av alla mänskliga fall. Viruset utsöndras via saliven och infekterar perifera nervceller. Det migrerar sedan från perifera nervceller till centrala nervsystemet för att sedan nå hjärnstammen och spottkörtlarna. Inkubationstiden kan variera från 2 veckor till 3 månader. Så fort symptom utvecklats är utfallet nästan 100 % döden på grund av andnings- och hjärtstopp. De vanligaste symptomen som rabies orsakar är i tidigt skede ångest, förvirring och huvudvärk, som sedan utvecklas till hydrofobi (”vattuskräck”), hyperaktivitet, kraftig salivering, hallucinationer, balansproblem och aggression. Likartade symptom drabbar även andra däggdjur

Det finns intramuskulärt och intradermalt administrerade förebyggande vaccin som skyddar mot sjukdomen för människa samt hund och katt. Det finns även ett oralt vaccin som har använts för vilda djur. Om en människa skulle bli biten av ett misstänkt rabiesdrabbat djur så ges post-exponerings behandling (PEP). Det innebär ett flertal vaccinationer, noggrann rengöring av såret samt eventuellt injektioner med antikroppar kring exponeringsplatsen.

Rabies orsakar ungefär 59 000 mänskliga dödsfall per år globalt sett och värst drabbade är utvecklingsländer. Nästan 60 % av dödsfallen sker i Asien, där Indien står för den högsta andelen fall. Laos är ett av de länder där rabies är endemiskt förekommande bland hundar. En grupp experter på rabies har samlats från flera stora organisationer, bland annat WHO och OIE, och bildat ”United Against Rabies Collaboration”. De har som mål att det inte ska ske några mänskliga dödsfall i rabies efter år 2030. För att klara detta mål krävs att minst 70 % av alla hundar i endemiska länder är vaccinerade mot sjukdomen.

I den här studien undersöktes kunskapen kring rabies hos hundägare i Lao PDR och jämförelser mellan hundägarens geografiska distrikt, kön och utbildningsnivå och vaccinationsstatus hos hunden gjordes. Data samlades med hjälp av en enkätundersökning i fyra distrikt i provinsen Vientiane Capital. Totalt deltog 359 hundägare i studien. Resultaten visade att 62,4 % av hundägarna tycker sig veta vad rabies är och 59 % vet att sjukdomen sprids via bett. Endast 24,1 % sa att de visste att rabies kan vara dödligt medan 68,2 % svarade att det vet om att det finns ett rabiesvaccin. Det fanns en signifikant skillnad i kunskap om rabies mellan kvinnor och män, där män hade högre kunskap än kvinnor. De deltagare som tidigare hade vaccinerat sin hund hade signifikant högre kunskap om rabies än de som inte hade gjort det. Kunskapen var signifikant högre hos de deltagare med längre skolutbildning än de som hade kortare.

Studien indikerar områden där kunskapen om rabies brister. Det är viktigt att informationen om rabies och dess prevention sprids till befolkningen så att vaccinationsstatusen hos hundar i landet ökar. Om alla personer som har kunskapen om rabiesvaccinet faktiskt vaccinerar sina hundar uppnår troligen Laos nästan målet av ”United Against Rabies Collaboration” och antalet mänskliga dödsfall skulle minska drastiskt.

SUMMARY

Rabies is caused by a virus, the rabies virus, which belongs to the family Lyssavirus. The virus is most commonly spread through bites by an infected animal. All mammals are receptive for this disease, however dogs are responsible for 99% of all human rabies cases. The virus infects the peripheral nerves and migrates from peripheral nerves to the central nervous system to finally reach the brainstem and salivary glands after which it is excreted in the saliva. The incubation period can vary from 2 weeks to 3 months. As soon as symptoms start showing, the outcome is almost 100% mortality due to respiratory and cardiac arrest. The most common symptoms shown in early stage of clinical infection are anxiety, confusion and headaches. Symptoms shown later on are hydrophobia, hyperactivity, excessive salivation, hallucinations, staggering and aggression. Similar symptoms are shown in other mammals.

There are intramuscular and intradermal administered pre-exposure vaccinations available for humans, dogs and cats. There is also an oral vaccine that is used for wild animals. If a human would get bitten by a suspected rabies infected animal, post-exposure prophylaxis (PEP) should be given. PEP includes several vaccinations, thorough cleaning of the wound and in some cases antibodies administered around the exposure site.

Rabies causes approximately 59 000 human deaths per year around the world and worst affected are developing countries. Almost 60% of all human deaths occur in Asia, where India has the highest portion. Laos is a country where rabies is an endemic disease among dogs. A group of experts has been gathered from several large organisations such as WHO and OIE, and have formed “United Against Rabies Collaboration”. Their goal is to end all human deaths related to canine rabies in 2030. To reach this goal, approximately 70% of all dogs in endemic countries must be vaccinated.

In this study the knowledge about rabies amongst dog owners in Lao PDR was evaluated. Comparisons in knowledge between the dog owners geographic district, gender and educational level as well as vaccination status of the dog were made. Data collections was made by a questionnaire in four districts in Vientiane Capital, the province. In total 359 dog owners participated in the study. The results showed that 62.4% of the dog owners claim to know what rabies is and approximately 59% know that rabies is transmitted through bites. Only 24.1% knew that rabies can be fatal and 68.2% said that they know about the rabies vaccine. There is a significant difference in knowledge between gender, where males had a higher knowledge than females. The participants that had vaccinated their dog before had significantly higher knowledge than those who had not. The knowledge about rabies was significantly higher among the participants who had higher educational level than those who had lower.

The study has identified existing knowledge gaps. It is important that knowledge about rabies, especially regarding prevention, is spread to the population so that higher vaccination coverage is reached. If all people that knows about the rabies vaccine actually vaccinates their dog, the goal of “United Against Rabies Collaboration” could possibly almost be reached in Lao PDR and the number of human deaths would decrease drastically.

CONTENT

ABBREVIATIONS

PrEP - Preexposure prophylaxis

PEP - Postexposure prophylaxis

RIG - Rabies immunoglobulins

INTRODUCTION

Rabies is a disease that kills an estimated 59 000 people worldwide every year (CDC, 2019b). It is considered to be a neglected tropical disease. The knowledge about the virus that causes the illness and the preventive possibilities through vaccination exists but the disease is yet not controlled. Several efforts to control the transmission of this horrific disease has been made in Southeast Asia and since the preventive vaccine has existed for over hundred years, rabies should no longer be neglected.

"United Against Rabies" is a collaboration between several important organization, which have set a goal to eliminate human rabies deaths in 2030. Mass dog vaccination, engaging government in endemic countries and educating both medical staff and local population about the disease and the ways to prevent it, are the main targets to reach the goal (WHO, 2019d: Wilde *et al.,* 2005).

Rabies is caused by a rhabdovirus which can spread to all mammals and the most common way to get infected is through bites from infected animals (WHO, 2014). Rabies causes human deaths in more than 150 countries yearly and the main source is rabid dogs. 95% of all the rabies cases are reported in Asia and Africa (CDC, 2019b: WHO, 2019b). One of the reasons why this disease is so difficult to control is not because we do not have the medical technology, but because the knowledge about this fatal disease and its prevention and the political engagement is too low (FAO, 2019). Knowledge about rabies has been shown to be low in previous studies in Asia (Dodet *et al*., 2008: Thongyuan *et al*., 2016: *Sor et al*., 2018)

The aim of this study was to determine the knowledge about rabies among dog owners in a country where rabies is endemic – Lao PDR. The study compares the dog owners geographic district, gender, level of education and sources of knowledge as well as known vaccination status of the dog in four districts in the province Vientiane Capital.

LITERATURE REVIEW

Rabies

Rabies is a viral disease that can cause illness in all mammals. However, in a global perspective the most common host is the domestic dog which causes approximately 99% of all human rabies cases (WHO, 2019a). The rabies virus is a RNA-virus which is part of the genus Rhabdovirus and family Lyssavirus (CDC, 2019d).

Transmission and pathogenesis

The most common way of contracting rabies is being bitten by a rabid animal. The virus is shred through the salivary glands and can therefore infect another animal by biting but also by licking an open wound. There has also been reported cases of rabies with "non-bite" exposure such as scratching, saliva from rabid animals that comes in contact with a mucous membrane, organ donation and consumption of raw meat from rabid animal (CDC, 2019a: Srinivasar *et al*., 2005: Shuilian *et al*., 2017: Wallerstein, 1999: Wertheim *et al*., 2009). However, according to WHO there has not been a proven case of rabies due to consumption of raw meat but that transmission has occurred while preparing the animal, for example when pulling out the teeth (WHO, 2019a). Aerosol transmission of bat rabies virus has been discussed since three human cases with claimed aerosol transmission have been presented; two persons had been in caves where bats were present and where later diagnosed with rabies without recollection of getting bitten. The third case was infected by the bat rabies virus in laboratory environment. According to Gibbons (2002), infection by the bat rabies virus through aerosol transmission can occur in artificial conditions, however in natural environment another hypothesis is more likely. For example, it can be very difficult to discover a bat bite considering bats in many countries are small and bites can heal quickly (Gibbons, 2002). According to CDC, infection through "non-bite" exposure is unlikely but seeking medical help is still recommended (CDC, 2019a: CDC, 2011b).

When the virus has reached the new host it first infects nervous tissue and replicates through the peripheral nervous system and finally reaches the central nervous system and the salivary glands where it starts to secrete the virus via the saliva. The time until the virus has reached the brain differs, however most studied cases start shredding virus through the saliva about 1-4 weeks after infection (CDC, 2017).

Symptoms presented by humans and dogs

The incubation period can vary from 5 days to a year, but in most cases the infected animal starts showing symptoms within 1-3 months (CDC, 2019c). Factors affecting the incubation period are the virus dose, how far the infection site is from the central nervous system, the type of the virus and if the infected animal/person has pre- or postexposure immunization (CDC, 2019a: Shim *et al*., 2009: Cleaveland *et al*., 2002). Some animals start shredding the rabies virus in their saliva already during the incubation period and the shredding may be intermittent (CDC, 2017).

The first symptoms of rabies are anxiety, headache, fever, tingling and itching at the wound site, and general weakness. The progression of the disease then varies depending on what type

of rabies the animal/person will develop. There are two forms of rabies; furious (also known as classical or encephalitic) rabies and paralytic rabies. If the animal or person develops furious rabies, symptoms include hyperactivity, confusion, hypersalivation, aggression, staggering, hydrophobia, dilated pupils and hallucinations. After a few days a progressive paralysis with sudden convulsions develops and the rabid animal/person finally becomes comatose. Death by cardio-respiratory arrest usually occurs within 2 weeks after showing symptoms of furious rabies (WHO, 2019c). The paralytic form is less acute and starts with muscle weakness at the infection site. The weakness then progresses to paralysis that spreads until the animal/person enters a state of coma. Death by cardio-respiratory arrest eventually occurs (Hemachudha *et al*., 2005).

As soon as any of these symptoms are present, it is very unlikely that the patient survives. Only seven cases have been documented of people diagnosed with rabies that has survived. In six of these cases prior vaccinations had been given, and in two cases survival was only temporary. These two children died after a few years. (Porras *et al*., 1976: Tillotson *et al*., 1977: Alvarez *et al*., 1994: Madhusudana *et al*., 2002: Willoughby *et al*., 2005).

Preventing infection with rabies

Preexposure prophylaxis (PrEP)

The first vaccine against rabies was developed 1885 by Louis Pasteur and Émile Roux (The History of Vaccines, 2019). The early vaccines were made from brain tissue from rabid animals. The vaccines today contain either a killed virus or an attenuated live virus made by cell culture or embryonated eggs and are considered safe. The vaccine is given 2-3 times for humans and 1-2 times for dogs for full immunization preexposure depending on the manufacturer (WHO, 2014: Evidensia, 2016). It then takes 2-4 weeks after the last dose before obtaining adequate protection against the disease (CDC, 2016). The vaccine is given by an intramuscular or intradermal injection and the recommendations for most vaccines are to re-iterate the vaccination every third year. There is also an oral vaccine that has been successful in eradicating rabies in wild animals in parts of Europe and North America. Studies by Stöhr & Meslin (1996) shows that the frequency of rabies declined after the administration of the baits with oral vaccine. However, it not yet fully studied how long the period of immunization is (Macinnes *et al*., 2001).

Postexposure prophylaxis (PEP)

In April 2018 SAGE (WHO's Strategic Advisory Group of Experts) published a new position paper on rabies with a simplification on the pre- and postexposure prophylaxis. What type of PEP you get depends on the category of exposure and previous vaccinations against rabies. There are three categories of exposure depending on the contact with an animal with suspected rabies;

1. Touching or feeding animal, licked by animal on intact skin

2. Nibbling by animal on uncovered skin, getting minor abrasions or scratches but no bleeding

3. Single or multiple wounds from bite or scratch by animal that causes bleeding, contact with saliva from animal and mucous membrane or non-intact skin

Category 1 is considered a non-exposure contact, whereas category 2 and 3 in considered exposure and severe exposure, respectively. Since category 1 is not considered an exposure of the virus, PEP in not required, however wound care is recommended.

The schedule of PEP always includes thorough washing of the wound, wound care and multiple rabies vaccinations. There are three different vaccination schedules depending on previous vaccinations and which schedule the country has chosen to use.

- The Institute Pasteur du Cambodge (IPC) regimen recommends 2 intradermal (ID) injection at 2 sites on days 0, 3 and 7 if immunologically naive, and a single ID injection on days 0 and 3 if vaccinated before

- The 4-dose Essen regimen recommends a single intramuscular (IM) injection on days 0, 3, 7 and between day 14-28 if immunologically naive, and 4 ID injections on day 0 if vaccinated before

- The Zagreb regimen recommends 2 IM injections on days 0 and a single IM injection on days 7, 21 if immunologically naive, and a single IM injection on days 0 and 3 if vaccinated before

The intradermal and intramuscular injections are the same as the ones used in pre-exposure vaccinations. Studies has concluded that intradermal injections have the efficacy equivalent to or higher than the same vaccine administered intramuscular. However, this study also points out that more studies on the survival of the patients receiving intradermal vaccination is required to make a full conclusion (WHO, 2018e).

If the exposure is considered severe, category 3, and no prior rabies vaccination has been given, he/she will not only receive wound care and multiple vaccines according to schedule, but also rabies immunoglobulins (RIG). The immunoglobulins come from human or equine blood which have proven to have the same clinical effects.

RIG is given locally and around the wound to infiltrate and neutralize the virus. It is not recommended to give RIG without rabies vaccinations first, however it is possible to give RIG up to seven days after day 0 and still have a satisfactory result (WHO, 2014).

Diagnostic methods for rabies

To confirm a rabies case either in animals and humans can be of great importance not only for the individual but also for others that might have been exposed to it. It can prevent unnecessary medical treatments and guide the treatment of port-exposure treatment. It is also important to diagnose and report rabies cases for official purposes.

In animals, the diagnosis should be made post-mortem (after death). To confirm the diagnosis, virus should be isolated from two locations of the brain. The tissue samples should then be kept frozen or put in glycerol-saline solution during shipment to a veterinary diagnostic laboratory.

The analysis takes approximately 2 hours, exclusive shipment and preparation of the samples. The result will be given as positive or negative (CDC, 2011a: Duong *et al*., 2016).

Diagnosing rabies in humans requires several tests and can be performed ante-mortem (before death). Samples are taken from saliva, serum, spinal fluid and hair follicles by a skin punch from the neck to test nerve tissue. When analysing saliva, the virus can be isolated or tested by reverse transcriptase-PCR. Reverse transcriptase-PCR detects RNA of the rabies virus. Testing for rabies RNA of rabies antigens can be used when testing hair follicles. Serum and spinal fluids are analysed for rabies antibodies. This test should be interpreted cautiously since the immunological response of the individual can vary (Duong *et al*., 2016: CDC, 2011a).

Treatment of animals and people with confirmed rabies

As mentioned in earlier paragraphs there is no cure for rabies, only preventive measures before onset of symptoms. If an animal is suspected to have rabies it should be euthanized immediately and sent to a qualified lab for analysis (WHO, 2018b). If a person is diagnosed with rabies, he/she should be offered palliative care. However, in many development countries where rabies is endemic, medical care is not provided and the patient will be left untreated or sent home.

The palliative care can be provided even if drugs and medical equipment is limited, since the important aspect is to ease the suffering. The focus should be on keeping the patient hydrated to reduce the feeling of extreme thirst. To manage anxiety, fear, convulsions and agitation, sedative drugs such as Benzodiazepines can be given. If the patient has a fever, the use of non-steroid anti-inflammatory drugs will be efficient. Another just as important measure to take is to make the room comfortable. The patient should lie in a quiet, calm, draught-free, single-bed room with low lighting to prevent hydrophobic and/or aerophobic spasms (Warrell *et al*., 2017: Tarantola *et al*., 2016)

It is important that medical staff and family members of patients diagnosed with rabies are well informed of the prognosis and how to alleviate the suffering of the patient, especially in developing countries. These helpful measures will provide a more comfortable end of life for the patient without putting medical staff or family members at risk (Tarantola *et al*., 2016).

Global burden of canine rabies

Rabies is an endemic disease in over 150 countries. With the treatments presented earlier given in time, rabies is considered completely preventable. However approximately 59 000 people die every year of rabies (CDC, 2019b), which results in about 3.7 million disability-adjusted life years (DALY's) (Hampson *et al*., 2015). Since the symptoms of rabies are not specific for the disease and countries with most cases are developing countries where treatment is hard to receive due to cost and availability, the mortality is believed to be higher (Taylor & Knopf, 2015: WHO, 2018c). Only 2% of individuals that requires RIG has access and the means to purchase it (WHO, 2018c).

Economic burden of canine rabies

Rabies is not only a disease that costs thousands of people's lives, it also has an economic impact. Globally, canine rabies has been calculated to cost approximately 8.6 billion US dollars

annually. The major percentage of the total economic loss is due to early death. Approximately 40-60% of people getting bitten by suspected rabid dogs are under 15 years of age (WHO, 2019a: WHO, 2001). Approximately 1.7 billion US dollars is from direct expenditure of rabies post-exposure prophylaxis and only 129 million, meaning 1.5% of the total amount, is due to dog vaccination. There are thus much less investments in preventing disease transmission.

Vaccination of dogs costs about 1 USD per dose in Asia, whereas human PEP costs 11-150 USD per dose (Hampson *et al*., 2015). This means that dog vaccination is likely to be a more cost-effective way to decrease the number of rabies cases.

Other ways to decrease the cost of rabies is to use intradermal injections instead of intramuscular when giving PrEP and PEP. In Pakistan the reduction of costs for treatment went down by up to 80% by giving the WHO approved intradermal treatment, the Thai Red Cross-intradermal 4-dose regimen (Salahuddin et al., 2016: WHO, 2017a: Rahim *et al*, 2010). This vaccination regime has been successfully introduced in 2017 in many Asian countries such as India, Sri Lanka, Philippines and Nepal (WHO, 2018d).

Rabies in Asia

Asia is the continent with the highest number of human deaths due to canine rabies. 59.6% of all deaths, meaning over 37 000 individuals die annually in Asia due to canine rabies. As mentioned earlier the number is believed to be much higher as a result of under-reporting (Hampson *et al*., 2015). India has the most reported rabies cases globally. This could be a result of the increased number of dogs due to the unfortunate poisoning of vultures by the anti-inflammatory drug diclofenac (Evans, 2004). Diclofenac is a drug frequently used to treat livestock. If a cow newly treated with this drug dies and is eaten by a vulture, the bird can develop kidney failure and die. The population size of vultures decreased due to the consumption of the drug-contaminated carcasses. The reduced number of vultures led to carcasses becoming food for stray dogs. This led to a larger number of stray puppies to survive and reproduce, hence the increased dog population (Wikipedia, 2019: Birdlife international, 2013). However, whether this incident is a reason for the high number of rabies cases in India has not scientifically been determined.

There has been some success in eliminating rabies in some Asian countries and areas, such as Japan and Malaysia (WHO, 2013). However, Malaysia is one example where rabies is once again prevalent (Gongal & Wright, 2011: ARACON, 2018).

Regardless of WHO's recommendation to discontinue the use of nerve tissue vaccines, over 1 million people in Asia are vaccinated with this type of vaccine every year (WHO, 2001). A study by Buchy *et al.* shows that a homogeneous vaccination regime is of great importance to prevent and treat human rabies in Asia (Buchy *et al*., 2017).

In 2015, the dog vaccination coverage for rabies in Asia was estimated to be around 16% (Taylor & Knopf, 2015).

Rabies in Laos

Rabies is considered one of the top five priority diseases in the Lao PDR national strategy for zoonotic disease control program. This strategy has been developed by the Ministry of Agriculture and Forestry and Ministry of Public Health of Lao PDR (ASEAN, 2015).

The country borders to 7 other rabies endemic countries and is considered to be "land-locked". The Lao government visions to change that into "land-linked" to improve trading and communication with neighboring countries. However, the trading of for example dogs for dog meat could complicate the surveillance and control of canine rabies. The annual number of reported dog bites in Laos in approximately 8500. Of these, 99% are treated with vaccinations according to a PEP schedule and wound care. However, only a third of these individuals receive the full treatment consistent with the vaccination program. Neither human nor equine RIG is available in Laos (Kamsing *et al*., 2012).

A study where 415 samples were taken from dogs that was suspected to have rabies during 2010 to 2016, found that 284 dogs tested positive. The study also demonstrated a statistically significant difference in prevalence of rabies between dry season and wet season. There was a higher number of rabies cases during dry season (p=0.004) which starts in November and ends in April (Douangngeun *et al*., 2017). There has also been a study that showed an increased number of canine rabies cases from 2004 to 2011. 2004 the percentage of positive tests were 40.5%, in 2009 62.1% and in 2011 it was 59.4%. Whether this increase is a result of higher knowledge and awareness among the Laotian population or in fact an increase of rabies in the dog population is not clear (Ahmed e*t al*., 2015).

In Lao PDR, most documented cases of rabies occur in Vientiane Capital, a large province. A study by Douangngeun *et al*. (2017), showed that 90.5% of all reported cases in 2010-2017 occurred in Vientiane Capital. There are several districts in Vientiane Capital and the number of rabies cases in the four districts studied in this rapport was 22 in Naxaythong, 2 in Parknguem, 43 in Xaysetha and 105 in Xaytany (Douangngeun *et al*., 2017). The percentage of vaccinated dogs increased from 48% in 2006 to 64% in 2011 in Lao PDR. According to Kamsing *et al*., 74% of the dogs that were tested came from Vientiane Capital which is estimated to cover only 6% of the country's dog population (Kamsing *et al*., 2012). The national dog rabies vaccination coverage is estimated to be very low (ASEAN, 2015). It is unknown how many actual cases there are, but 17 cases of human rabies were recorded in Lao PDR from 2004-2011 (ASEAN, 2015).

Control of rabies

In 2015 the World Health Organization (WHO), the Food and Agriculture Organization of the United Nations (FAO), the World Organization for Animal Health (OIE) and the Global Alliance for Rabies Control (GARC) collaborated and determined a goal to end human deaths due to canine rabies in 2030. They formed United Against Rabies Collaboration, a group of experts that works to support rabies endemic countries to save human lives from the disease (WHO, 2018f).

In order to reach the goal, a global strategic plan, "Zero by 30", was made which includes engaging communities, increasing the awareness about rabies, increasing the access to affordable vaccines and PEP with guaranteed high quality. Mass vaccination programs for dogs plays a crucial role to target the disease at the source (WHO, 2018a). The goal is to eliminate human deaths due to rabies and not the disease itself and the required dog vaccination coverage is therefore assumed to be 70%. A study Coleman and Dye shows that if the rabies vaccination coverage would increase to 70% in dog populations, it would prevent and control outbreaks on 96.5% of occasions (Coleman & Dye, 1996).

Since the rabies virus has a very low basic reproductive number, it is easier to control the disease and even a low vaccinations coverage is effective. The basic reproductive number, R_0, for rabies is <2 which means that there are usually less than 2 secondary infected individuals produced by the primary infected individual in a susceptible population (Hampson *et al*., 2009). This means that the spreading of the disease is comparatively slow.

In order to remain a high vaccination coverage, it is important to establish coherent guidelines for vaccination programs in endemic countries. If a mass vaccination for dogs is implemented it is important to follow up with a booster vaccination 1-3 month after the first shot for full coverage (Sihvonen *et al*., 1999).

In addition to vaccinations, there are studies that also uses sterilization and culling of dogs to control the free-roaming dog populations to reduce the number of rabies cases (Reece & Chawa, 2006). Whether these methods are efficient to control and reduce the cases of human rabies is debated (Cleaveland *et al*., 2014: Rowan *et al*., 2014: WHO, 1990).

Successful control of rabies

There are several examples of areas such as Bali, Philippines, a province in South-Africa and islands of the Caribbean where rabies has been eradicated or controlled in a way that human fatal cases has strongly decreased (Taylor & Nel, 2015: Putra *et al*., 2013: Lapiz, *et al*., 2012: Vigilato *et al*., 2013: WHO, 2017c: WHO, 2017b). Some of these areas are however islands which makes it geographically easier to control and eradicate. The methods that these programs use include mass dog vaccination, training medical staff in treatment of bite wounds, opening animal bite treatment centers to make treatment accessible and affordable, improving public rabies awareness and data collection to have a record of rabies cases to look over the results of vaccination campaigns.

Bangladesh is considered a role model in controlling rabies. In 2011, a pilot study was started to evaluate the effectiveness of mass dog vaccination programs. The result was promising which lead to setting a goal to eliminate rabies in 2020. Through several mass vaccination programs, support and multisectoral coordination from developing partners and providing centers for free patient care post dog bites in all 65 districts, the annual incidence of rabies decreased from 2000 in 2011 to 200 in 2015 (WHO, 2017d).

Knowledge about rabies

In order to reach the goal of zero human deaths due to canine rabies, it is important to raise awareness about the disease and the ways to prevent illness. It is not unusual that patients with bite wounds do not seek treatment or leave the hospital against medical advice because they believe that there is no treatment or cure. Patients may also leave because treatment cannot be offered (Knobel *et al*., 2005: Sudarshan *et al*., 2007: WHO, 2016). As mentioned in earlier paragraph, there are countries that offers vaccinations for dogs and humans, and in some cases even treatment, without expenses for the individual. Knowledge about the vaccine, where to receive it and when to seek medical care is key to reduce the number of rabies cases.

Information about knowledge about rabies among the Lao population is difficult to find. Studies in other countries in Southeast Asia have showed that the general knowledge about rabies is relatively low in the population (Dodet *et al*., 2008: Thongyuan *et al*., 2016).

In Siem Reap Province, Cambodia, a country with rather high prevalence of rabies, a survey was conducted with 360 participants. The percentage of households with adequate knowledge regarding rabies was 9.7% (Sor *et al*., 2018). However, the study by Sor *et al.* showed that 98.6% of the participants knew that rabies could be transmitted through a dog bite and 66.6% knew that rabies could be prevented. A study in northern Vietnam gave a similar result with high knowledge of the animal reservoir, transmission route and prevention measures (Mai *et al*., 2011). *Sor et al*. could also make the conclusion that people with higher education (higher than secondary) are more likely to have adequate knowledge about rabies. In a study about rabies awareness in eight Asian countries, only 15% of the respondents said that their knowledge came from school and 2.6% from government authorities (Dodet *et al*., 2008).

A more recent pilot study in Sri Lanka gave a more promising result. 75% of the participants knew that dogs were the main reservoir, that the disease could be transmitted through bites and knew that it could be prevented by vaccinations and PEP. This study used outpatients in the National Hospital of Sri Lanka as participants which might not give an accurate overview of the knowledge about rabies in the entire population. People with less knowledge about diseases might not seek medical care in the same extent (Muthunuwan *et al*., 2017).

MATERIALS AND METHODS

Study design

The study was conducted in 4 districts of Vientiane Capital, a province in Laos. The districts were chosen purposively since there had been several rabies cases reported from these areas and were therefore areas of interest. It was also assumed that dog owners would be very likely want to participate, because of recent cases.

The districts Xaysetha and Xaytany is considered mostly urban (100% respective 67%). Naxaythong is considered both urban and rural (48% urban) and Parknguem is considered rural (Laos, 2019). Data was collected during 1 month, from September 25th to October 25th 2019.

Before data collection, teachers from the Faculty of Agriculture from the National University of Lao PDR had contacted a representative from the public health department of the district to ask if there was an interest to participate in the study. They thereby asked the village chief if we could carry out the study in their village. The village chief received a paper about the study and was asked not to inform the dog owners about the rabies vaccine until after the study.

The data collection was often made in a government building, usually an office of the village chief. The village chief informed the public that we were there for a study and that dog owners with their dogs could come and get an injection/vaccination to prevent diseases for free if they participated in the study. The announcement was made by a speaker. Four days of the data sampling a speaker was not available, and we therefore had to travel to the dog owners' homes.

Participants

As mentioned earlier, participants were informed about the study and made a choice to participate or not on their own. The participants signed a consent form before entering the study. This informed them that it was completely voluntary and that we could stop at any time. It also informed them that it is possible to participate only in one part of the study (answerer questionnaire and/or blood sample to test antibodies) and that all personal information would be confidential.

We received 77-95 participants from each district, and 359 in total from Vientiane Capital.

There was an issue with some participants being informed about rabies vaccinations beforehand. On one day of sampling, 19 participants were recruited during a rabies vaccination campaign. In addition, the village chief announced that rabies vaccinations would be given to the dogs during sampling one day in Xaytany. meaning that the 13 participants from this particular day were told that there is a vaccine against rabies. Four participants were recruited in an animal hospital. Information about these participants with different circumstances will be presented.

Data collection

A structured questionnaire was developed and discussed at the Faculty of Agriculture, National University of Lao. The questions were thereafter modified to better suit the target group. The questionnaire was translated from English to Lao. The questionnaire included items such as:

dog owner information (1-2) (gender, age, level of education and dog meat consumption), dog information (3) (age, use, caregiver, living situation), health status of the dog (4) (vaccination status, history of illness), general disease questions (diseases that could be transmitted from dogs to humans) and knowledge regarding rabies (6) (transmission route, symptoms, and possible disease hosts). One question about the vaccination status of the dog was added to the questionnaire after 4 days of data collection (question 4.4, see appendix 1 "Questionnaire")

Blood sample were collected from the dogs whose owner had chosen to participate in the study. This blood was later analysed for antibodies against rabies for another project.

After answering the questionnaire and blood sample was collected, the dog was given rabies vaccine and a deworming injection (ivermectin). If the owner had more than one dog, blood sample was collected from the other dog as well. The same injections were given to the second dog. If the owner had more than two dogs, only rabies vaccine and deworming injection was given to the other dogs and no blood sample was collected. If the dog was younger than 3 months, we did not take a blood sample but the dog was given rabies vaccine and deworming if the owner had answered the questionnaire. If the dog owner had not answered the questionnaire and/or the dog was younger than 2 months, the dog was only given a deworming injection.

A research assistant from the Faculty of Agriculture interviewed the dog owners. The interviewer had good knowledge in Lao and English.

Data entry and analysis

The answers from the questionnaire were transferred into an Excel file. The variables gender, recruitment during vaccination campaign and previous vaccination status of the dog were categorized into two levels. Geographic district was categorized into four levels, educational level into five categories and previous vaccination status into three levels. The knowledge score was calculated for each dog owner, ranging from 0 to 10. Descriptive statistics were calculated. Investigating if there was a difference in knowledge score due to i) gender, ii) recruitment during vaccination campaign or not, and iii) information about free rabies vaccination or not, was performed using a two tailed t-test, one per independent variable. The difference between average knowledge score as dependent variable and educational level, geographic district and vaccination status of the dog was investigated using an ANOVA, one analysis per independent variable. The p-value for statistical significance was set to <0.05 for all analyses. All statistical analyses were performed in Minitab.

Ethical clearance

The study was approved by the Faculty of Agriculture, National University of Lao.

RESULTS

If including only the questions asked to every participant (not the follow up questions “If yes”- or “If no”-questions) the response rate was 99.1% for all questions. Meaning, with 23 questions asked all 359 participants, 8257 questions in total could be answered and 8183 were answered.

Information about participants

The total number of participants was 359. Divided into districts we received 95 answers from Parknguem, 90 from Xaytany, 78 from Xaysetha, 77 from Naxaythong, 10 from Sikhottabong, 6 from Chanthabouly and 3 from Sisattanak. The last three mentioned have been grouped together as “Other”. The gender distribution was 56% female, 43.2% male and 0.8% unknown. The age of the participants varied from 14 years to 80 years old which resulted in an average age of approximately 43 years old.

The level of education was divided into 5 categories; No education, Primary School, Class 5-10, Higher Secondary School and Graduation and above. The number of participants in each category was 9 (2.5%), 95 (26.7%), 81 (22.8%), 107 (30.1%), 64 (18.0%) respectively with a total of 356 respondents.

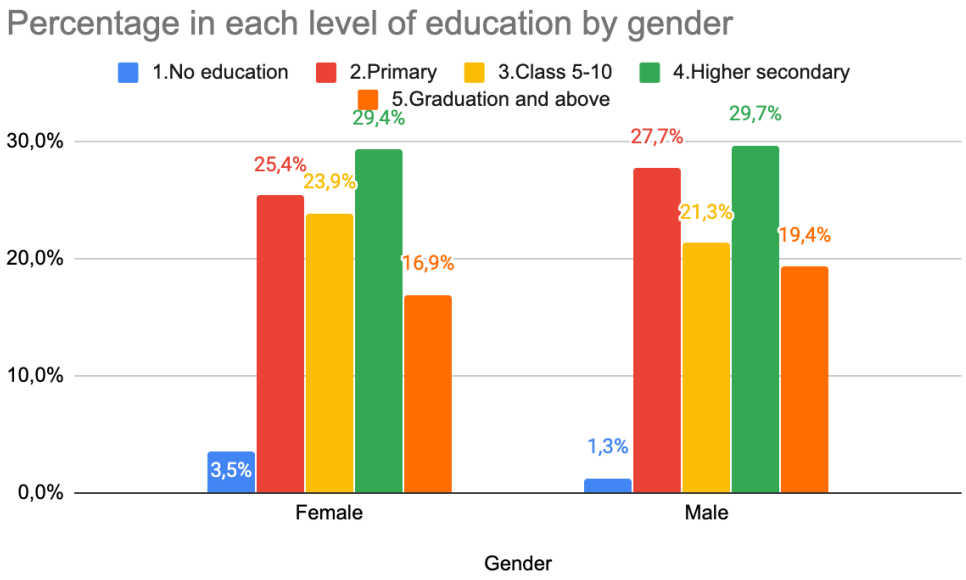

Figure 1. *Percentage in each level of education by gender*.

Figure 1 illustrates the percentage in each level of education between the two genders of the dog owners. This to illustrate if there was an apparent difference in level of education between genders, for example if men had a significantly higher percentage in the higher level of education.

To study if the level of education differed between the districts a diagram was made; figure 2.

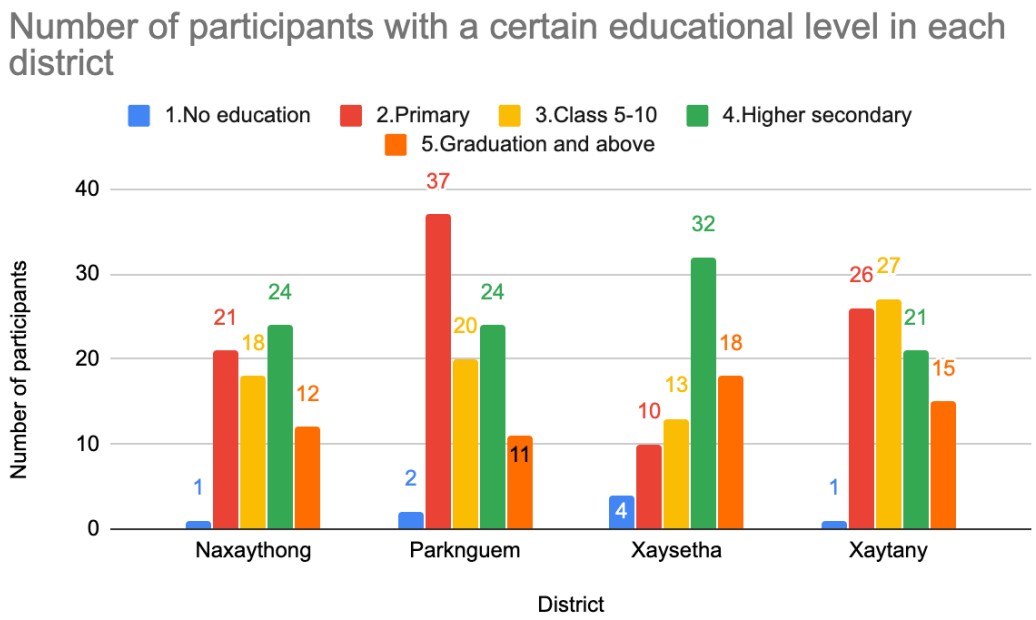

Figure 2. *Number of participants with a certain level of education in the districts that were studied.*

Information about the dogs

The age of the dogs varied from 2 months to 12 years which results in an average age of approximately 2 years. 96.9% used the dog as a guard dog and 13.6% as company. Nearly ¾ had received the dog as a gift.

A majority, 68.2%, of the dogs had never gotten vaccinated or had an owner that did not know whether it had been vaccinated or not. If distributed between the four districts, Xaysetha seems to have a higher vaccination rate as shown in figure 3.

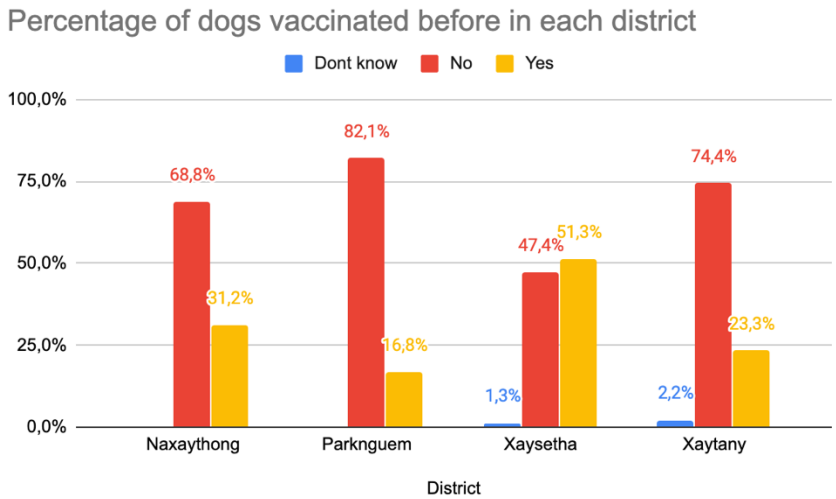

Figure 3. *Percentage dogs vaccinated in each district.*

In total 358 participants answered the question of how the dog was being held. The most common way was “only outside loose”, which 243 (67.8%) answered. 65 (18.2%) said they kept the dog outside but in a fenced area and 30 (8.4%) that the dog was living both indoor and outside and was loose when outside. 11 (3.1%) said that the dog was only living indoors, 7

(1.2%) that the dog was kept in a leash outside and only 1 (0.3%) participant held the dog both indoor and outside but in a leash when outside. To study if it was more or less common to vaccinate a dog that was being held outside or indoors a comparison was made as shown in figure 4.

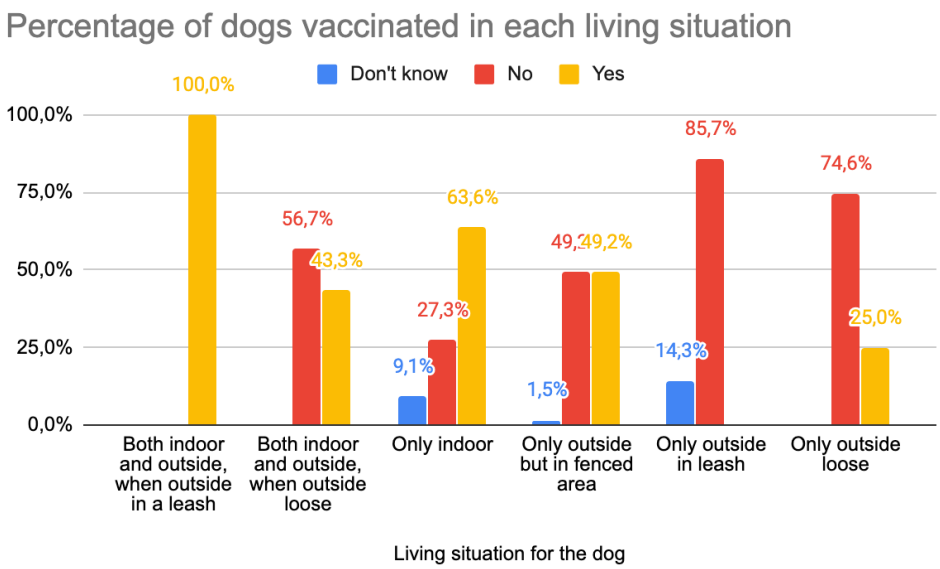

Figure 4. *Percentage of dogs previously vaccinated in each living situation.*

Ninety nine out of 358 participants answered the question which illness the dog had been vaccinated against. Forty nine (49.5%) answered that their dog had been vaccinated against rabies and 18 (19.1%) did not know which illness.

When studying the number of dogs in the four districts that were studied and which illness the dog had been vaccinated against, the distribution presents like following (figure 5):

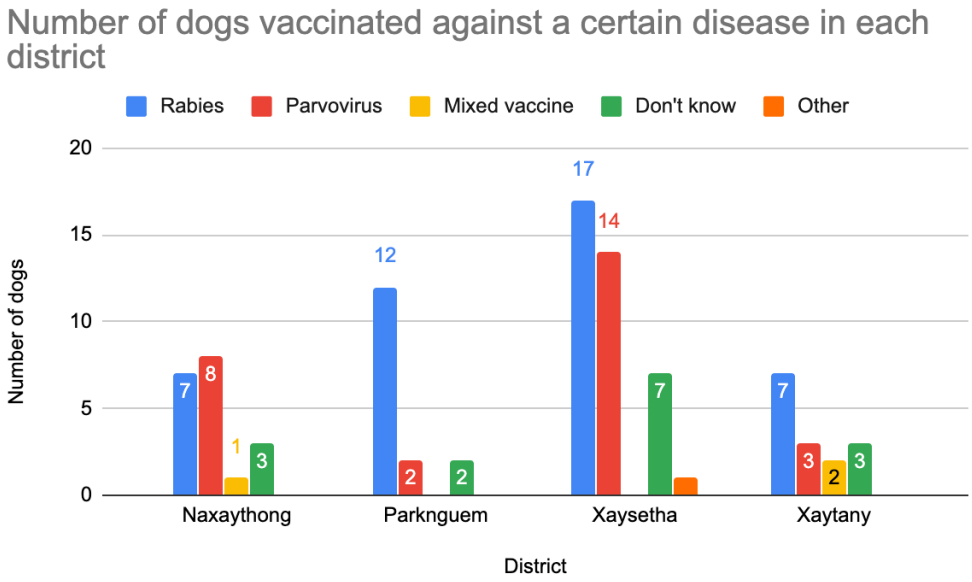

Figure 5. *Which illness the dog had gotten vaccinated against in each district.*

Knowledge about rabies

In total, 62.4% (224 out of 359) answered that they know what rabies is, 60.2% (216 out of 359) said they know how rabies is transmitted and 98.1% (212 out of 216) of these respondents answered that rabies is transmitted by bites. This means that approximately 59% of all participants knew that rabies is transmitted by bites.

When asked who can get rabies 357 respondents answered. More than one alternative could be chosen. The results are shown in figure 6.

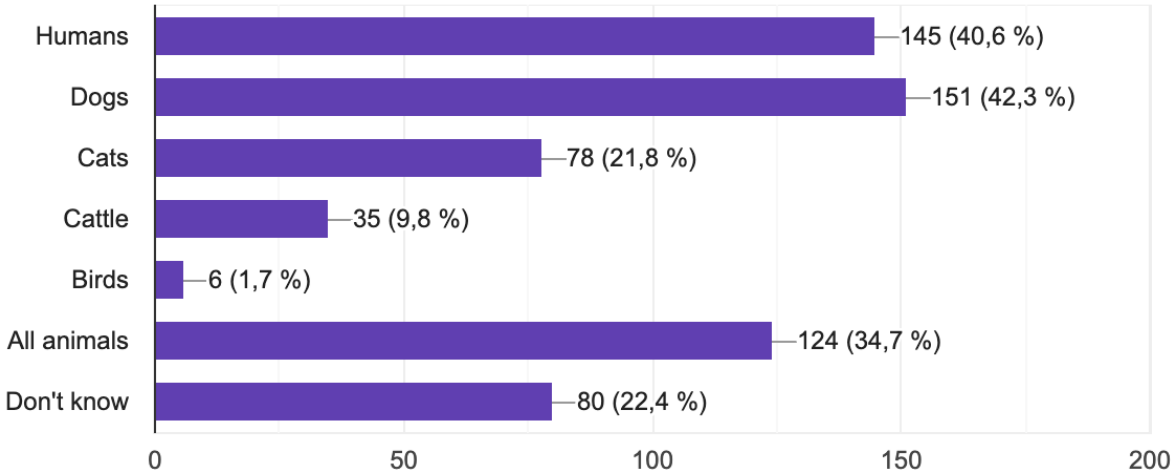

Figure 6. *Number of participants that answered who can get rabies.*

When asked to mention symptoms rabies can give an infected person or dog, all 359 respondents answered, of which 27% said that they did not know (see figure 7). Participants could mention more than one symptom.

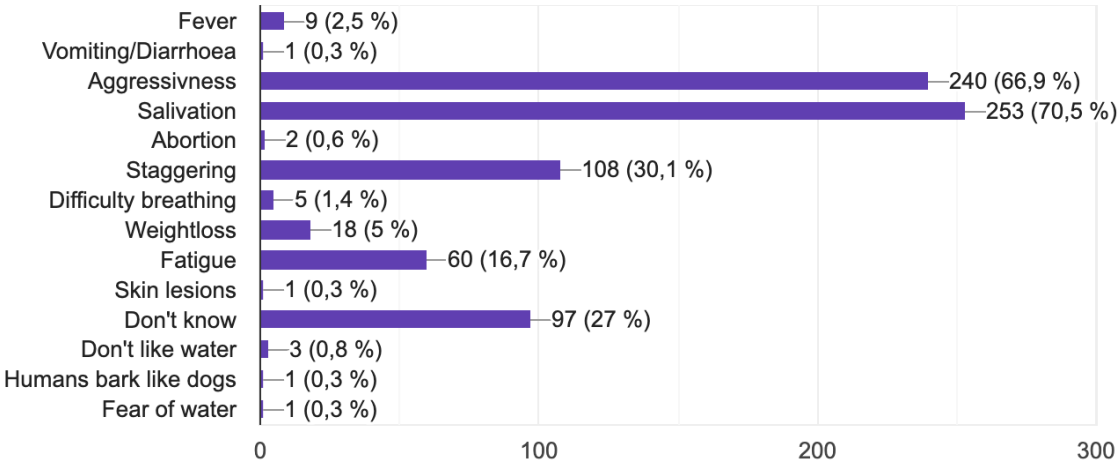

Figure 7. *Number of participants with their answer to mention symptoms of rabies.*

Overall, 352 people answered the question whether rabies can be fatal or not; 24.1% answered "Yes", 17.9% answered "No" and 58% answered "Don't know".

Just over 2/3 (68.2%) knew that there is a vaccine against rabies. The main source of knowledge about rabies was from a friend or someone from the older generation (58.6%). A fifth, 19.7%, of the respondents answered that they received information about rabies from government rabies vaccination campaigns whereas 18.3% had gotten information from the veterinarian, 10.7% had gotten information through school and 15.5% had knowledge about the disease because they had seen a rabies case. Out of the 38 people that said that some knowledge came from school, 5 had primary education, 1 had attended class 5-10, 14 had attended higher secondary school and 18 had a graduation or above.

The knowledge about rabies was evaluated by a scoring system based on the questions asked. Question 6.1, 6.6 and 6.7 gave the respondent 1 point each if she/he answered "Yes". Question 6.3 gave the respondent 1 point if she/he answered "Bites" or "Contact with dog saliva" and 2 points if both alternatives were chosen. Question 6.4 gave the respondent 1 point if she/he answered "Humans", "Dogs" or "All animals", 2 points if "Humans" and "Dogs" were chosen. Question 6.5 gave the respondent 1 point if she/he answered "Aggressiveness", "Salivation" or "Staggering", 2 points if two of the alternatives were chosen and 3 points if all three alternatives were chosen. No points were subtracted if the wrong answer had been chosen. The maximum points possible were 10. In table 1 the number of participants with a certain total score is presented.

Table 1. *Number of participants with a total score 1-10*

Total score	0	1	2	3	4	5	6	7	8	9	10
Number of participants	41	26	11	21	25	31	48	69	50	31	6

The average score of all participants was 5.23 and the median score was 6.

To evaluate if the knowledge about rabies increased with higher level of education, the number of participants in each category with a certain score was described and illustrated in figure 8, table 2 and figure 9.

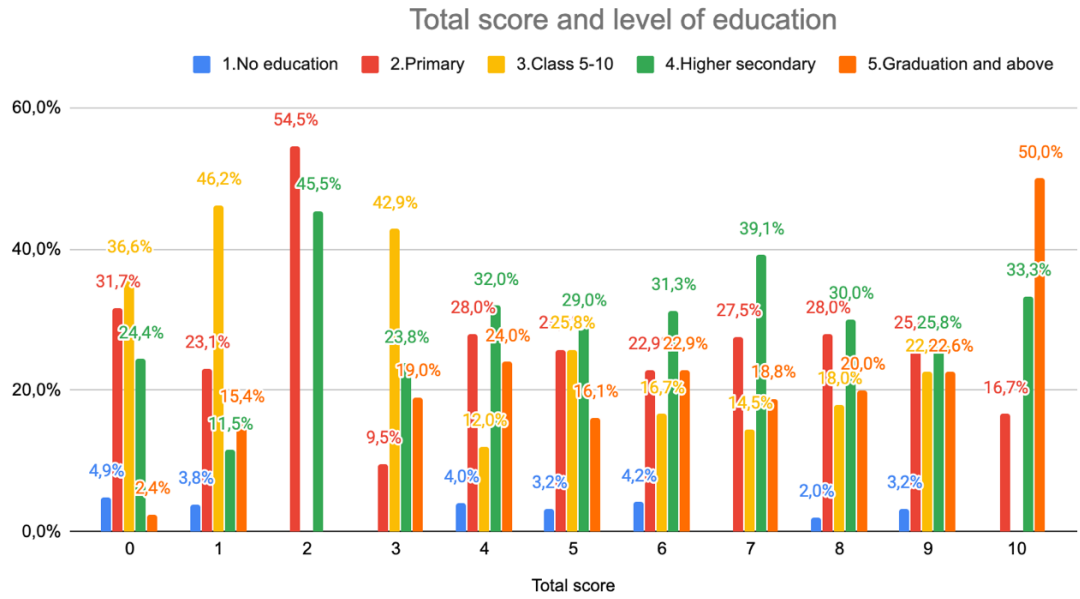

Figure 8. *Percentage that got a certain total score divided by the level of education.*

Table 2. *Number of participants from each level of education with a certain total score*

	Total score										
Level of education	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
No education	2	1	0	0	1	1	2	0	1	1	0
Primary	13	6	6	2	7	8	11	19	14	8	1
Class 5-10	15	12	0	9	3	8	8	10	9	7	0
Higher Secondary	10	3	5	5	8	9	15	27	15	8	2
Graduation and above	1	4	0	4	6	5	11	13	10	7	3

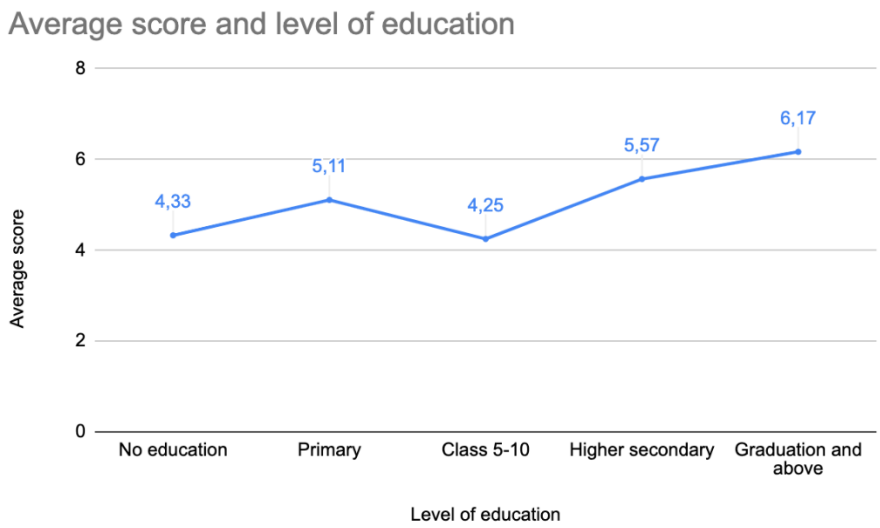

Figure 9. *Average total score in each level of education.*

When investigating if there was a difference in average score for the different educational groups the result showed that the difference in mean value between the educational groups was statistically significant (p-value = 0.0010).

A stratification of gender was made to evaluate if there was a difference between genders regarding knowledge about rabies. This is illustrated in table 3.

Table 3. *Number of participants divided by gender with a certain total score*

	Total score										
Gender	0	1	2	3	4	5	6	7	8	9	10
Female	29	13	8	9	17	17	30	39	22	14	3
Male	12	13	3	12	7	14	18	28	28	17	3

The mean score for females was 4.95 and the mean score for males was 5.57. When using two-tailed t-test to study the average scores between gender, the result showed that the difference in mean value was statistically significant (p-value = 0.04).

One hypothesis is that the people that vaccinates their dogs have more knowledge about diseases in general. An evaluation between knowledge about rabies and if the owners knows if the dog had been vaccinated was made, as shown in figure 10 and table 4.

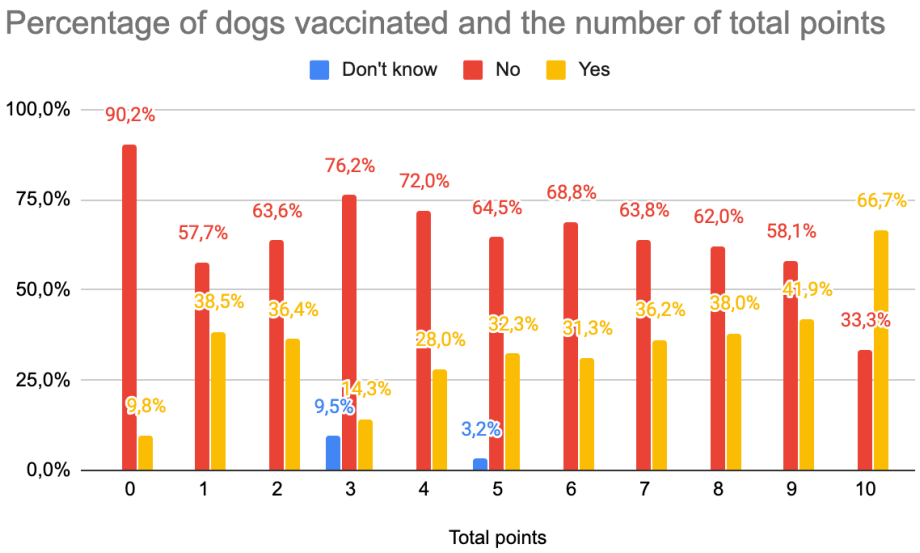

Figure 10. *Percentage of participants that had or had not vaccinated their dog and their total score.*

Table 4. *Number of participants with a certain total score that had or had not vaccinated their dog*

	Total score										
Vaccinated dog	0	1	2	3	4	5	6	7	8	9	10
Yes	4	10	4	3	7	10	15	25	19	13	4
No	37	15	7	16	18	20	33	44	31	18	2
Don’t know	0	0	0	2	0	1	0	0	0	0	0

The average score for participants that had vaccinated their dog was 5.96 and the average score for those who had not vaccinated their dog was 4.92. The average score for the participants who did not know if their dog had been vaccinated was 3.67. When testing whether there was a difference in average scores between the categories of vaccination status, the result showed that the difference in mean value was statistically significant (p-value = 0.004).

To study if there was a difference in knowledge about rabies between the districts a comparison was made (see figure 11).

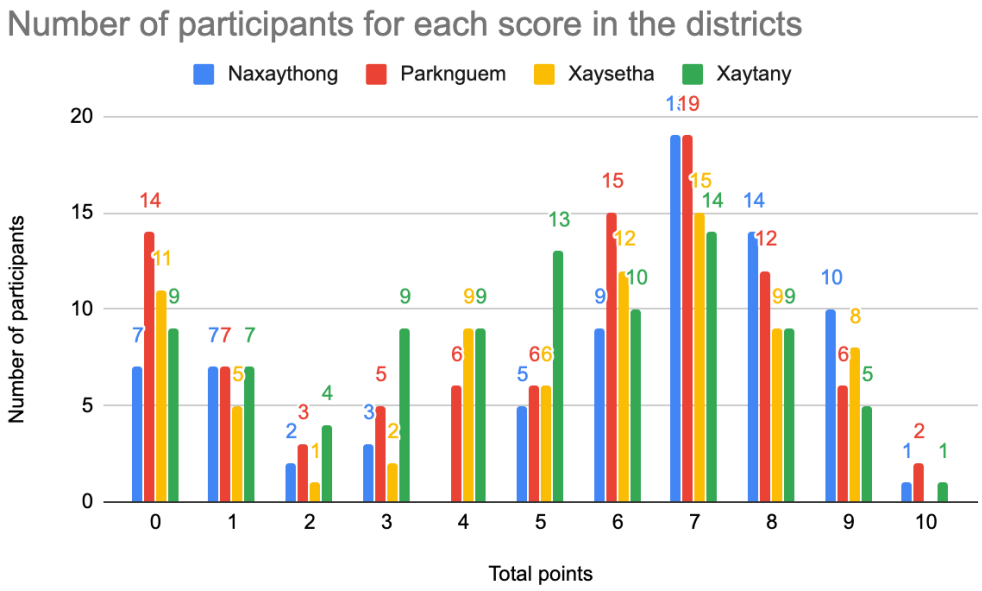

Figure 11. *The number of participants with a certain total score divided by the district.*

The average score for each district was 5.77 in Naxaythong, 5.00 in Parknguem, 5.13 in Xaysetha and 4.76 in Xaytany. When used One-way ANOVA-test to study the average scores between the groups, the result showed that the difference in mean value was not statistically significant (p-value = 0.15).

In total, 159 (of 359) participants said that they know dogs can transmit diseases to humans. Of these, 147 participants, meaning approximately 92.5%, of these participants answered “Rabies” when asked to mention a disease that could be transmitted from dogs to humans. This means that approximately 40.9% out of all participants mentioned rabies on their own initiative. The percentage of participants answering “Yes” when asked if they know what rabies is, was 62.4%. Two hundred and eight participants said that they know what rabies is and answered “dog” and “humans” or “all animals” when asked who can get rabies, which results in 57.9%.

Nineteen participants were recruited during a rabies vaccination campaign. The average score on knowledge in this sample group was 7 and the average score of the participants not taking part of the rabies vaccination campaign was 5.13. When used a two-tailed t-test with the significant level of 0.05 the results showed that the difference between the two groups are statistically significant (p-value = 0.006).

One of the days of sampling the village chief unfortunately announced that rabies vaccination was offered if participating in the study. The average score on knowledge from this group was 6.85. The remaining group had an average score of 5.16. When used a two-tailed t-test the result showed that the difference between the two groups are statistically significant (p-value = 0.04).

Not vaccinating when having the knowledge

To receive an overview on why dog owners have not vaccinated their dog against rabies if they know that there is a vaccine, an open question was asked to a subset of participants: 14 people in Naxaythong, 3 people in Parknguem, 8 in Xaysetha and 5 in Xaytany. The majority answered

that there was no veterinarian to give the vaccine, that they do not have time, that the clinic is too far away or that it is too expensive. A few different reasons given were that the dog always got sick after an injection, that their dog is never angry towards other people and therefore does not need rabies vaccine and that it was believed that one previous vaccination protected the dog from rabies its whole life.

DISCUSSION

Vaccination rate

Xaysetha had a higher vaccination rate compared to the other districts. There were even more participants that had vaccinated their dog before than participants that had not, which was unique. One possible reason for the high vaccination rate could be because the district is considered 100% urban and the population might have better access to veterinary clinics that offers vaccination services. It could also have been due to pervious vaccination campaigns, since these are often held in cities. Xaysetha also had the highest number of participants in the two highest levels of education ("Higher secondary school" and "Graduation and above") and the difference in knowledge about rabies were higher with more advanced education, which means that this could also be a potential factor for the high vaccination rate. However, Xaysetha did not have the highest average score in knowledge about rabies. Baumgaertner *et al*. (2018) suggest that it is not just a matter of knowledge that increase the willingness to vaccinate, but also about trust in the source (Baumgaertner *et al*., 2018). Areas with high rabies vaccination coverage might not necessarily have knowledge that correlates. It is possible that dog owners simply trust their source, meaning the veterinarians, the school system and their government when information about rabies and vaccination recommendations are given.

It was unfortunate to see that the percentage of vaccinated dogs that were living only outside loose was as low as the results show. To decrease the number of rabies cases the free roaming dogs are probably the ones that are the most important to vaccinate, since they also interact with dogs and humans other than from their family.

Knowledge about rabies

Over 60% claimed to know what rabies is, however it does not necessarily mean that the participants actually have that knowledge. The question "Do you know what rabies is?" can also be interpreted in several ways. Some might answer "Yes" if they know that it is an illness, some might have lied and some might answer "No" because they do not feel as though they know exactly what causes the illness etc. A better way to ask the question could have been "Have you heard about rabies?". 40.9% mentioned rabies when asked to state an illness that dogs can transmit to humans (as an open question). It is possible that this percentage is closer to the actual number of people knowing what rabies is. Although, 57.9% said that they know what rabies is and received 1 or 2 points on who can be infected, which is rather close to the percentage of people claiming to know what rabies is, thus the number could very well be correct.

Since bites by rabid dogs are by far the most common cause of human rabies, information about transmission should be well spread in endemic countries (WHO, 2019a). In the present study, 59% of the participants knew that rabies is transmitted by bites. If this is representative for the entire Laotian population, this means that 2/5 would not know that you can get rabies if bitten by a dog and might not seek medical care.

Only 24.1% were aware that rabies can be fatal which is close to the result in a study in Sri Lank that showed that only 22.5% knew rabies is fatal (Muthunuwan *et al*., 2017). This could

be a reason why fewer humans and dogs are vaccinated against the disease than desired. If people knew that rabies is nearly 100% fatal if not prevented in time, it would probably be of higher priority, more vaccinations would be given which would result in fewer human deaths. Therefore, the lack of knowledge about its mortality could be one of the reasons why so few answered that their dog had been vaccinated against rabies. One of the more frequent reasons why dog owners did not vaccinate against rabies was that there was no veterinarian to give the vaccine or that they simply did not have the time. It is possible that they do not know were vaccinations can be given.

The finding that 68.2% knows about the rabies vaccine, although only 62.4% claimed to know what rabies is reinforces my previous argument that the question "Do you know what rabies is?" can be interpreted differently since it is not quite reasonable that more people know about the rabies vaccine than people knowing what rabies is. It is of course also imaginable that some people may have lied when answering the question about the vaccine. 68.2% is a rather high level of knowledge about the vaccine. However, previous studies about knowledge of the rabies vaccine in other Asian countries have shown both lower and significantly higher result (Kapoor *et al*., 2019: Matibag *et al*., 2007: Mog *et al*., 2019: Hossain, 2017). If all dog owners that know about the vaccine in Lao PDR actually vaccinates their dog against rabies, it would almost reach the vaccination coverage goal of "Zero by 2030" which would have a positive effect on the number of human rabies cases.

To study if people with higher school education had more knowledge about rabies, the average scores was compared (figure 9). There was a significant difference in knowledge between the groups, just as shown in the study by Sor *et al*. (2018). However, in this study the average score did not increase linearly with increased level of education. As mentioned earlier only 10.7%, meaning 38 out of 355 participants said that their knowledge about rabies came from school. The study by Dodet *et al*. (2008), had a similarly low result. That knowledge does not increase linearly with higher education probably means that knowledge about rabies does not necessarily increase with increased level of education because of information taught in school. It could simply be because a person with a higher school education is more educated in general. Although, out of the 38 participants that chose school as a source of knowledge about rabies, 14 had attended higher secondary and 18 had a graduation or above. This means that approximately 84% of the participants that chose school as a source of knowledge about rabies, had a more advanced level of education.

The average knowledge in the four districts that were studied had a noticeable difference as shown in figure 11, however it was not statistically significant. Possible reasons for the difference could be that rabies is more common in one district thus resulting in higher knowledge among the population, animal clinics and rabies vaccination could also be accessible more easily in some districts or there could have been a rabies vaccination campaign in some areas that lead to higher knowledge.

As mentioned, it is possible that dog owners that vaccinates their dog is more interested and invested in the dogs' health and thus know more about diseases that they can contract. The result showed a significant difference in knowledge about rabies between people that had

vaccinated their dog and people that had not. This hypothesis could therefore be correct when it comes to the Laotian population.

Limitations with the study and sources of error

It was not possible to randomly select the participants in this study which can be a source of error. The participants chose themselves to be a part of it and had heard that they would be offered an injection for the dog as compensation. This could result in the sample group being more interested and aware of diseases in dogs in general which could have given us a higher average knowledge about rabies than the population of Laos.

As mentioned earlier, 19 participants had just taken part of a rabies vaccination campaign and when comparing their average knowledge to the rest of the sample group it was significantly higher. This could also make the total average knowledge about rabies in the group that was studied slightly higher than in the population of Laos. The same conclusion can be drawn with the participants from the day the village chief announced that rabies vaccine would be given. These participants had better knowledge than the rest of the sampling group, possibly because they know of the severity of the disease.

Some linguistic misunderstanding might also have happened during the data collection. The questionnaire was translated from English to Lao and the assistant interviewing the participants asked all the questions in Lao. The questions had been discussed before starting the study however it is inevitable that some misunderstanding have happened.

CONCLUSION

In this study it has not been established if the knowledge about rabies in the Laotian population is adequate or not. However, the results show important and interesting gaps in knowledge regarding rabies and its prevention. For example, the percentage of people knowing that rabies is fatal is relatively low which points out what information vaccination campaigns, veterinarians, doctors and other sources of information should focus on.

To be able to reach the goal of “Zero by 2030” it is important to increase the knowledge about rabies. If knowledge about this terrible disease would increase, more dog owners would probably get their dog vaccinated and the number of cases would decrease. It is also important to inform the population on where rabies vaccination for humans and dogs can be obtained and if possible, make vaccinations more accessible, since this seems to be one of the main reasons for not getting the dog vaccinated.

POPULAR SCIENTIFIC SUMMARY

Rabies is caused by a virus called rabies virus. The disease can affect all mammals, meaning almost all warm-blooded animals. The most common way to contract rabies is by getting bitten by a rabid animal. More unusual ways are if an infected animal licks an open wound, getting saliva from a rabid animal on a mucous membrane for example in your eye or by receiving organ donation from a person with rabies. The virus is excreted in the saliva so if an animal with rabies bites a person, the saliva gets in contact with nerves in the wound which is what the virus infects. The virus infects the nerves and travel to the central nervous system and the brain stem and finally the salivary glands. The virus is therefore not present in the blood. When the virus has infected the brainstem, symptoms start to arise. The period from exposure of the virus to the time where the infected person/animal start showing symptoms is called the incubation period, which for rabies can vary from 2 weeks up to 3 months. When symptoms have started to show, the outcome is almost always death within a couple of weeks.

There are two forms of rabies; the furious type, which is the most common one, and the paralytic type. Symptoms when contracting the furious form is aggression, excessive salivation, staggering and hallucinations. Symptoms for the paralytic form is paralysis at the exposure site that progresses slowly to the entire body until a state of coma.

There is a vaccine that can give a good protection against the disease. If bitten by a rabid animal post-exposure treatment (PEP) is given. PEP includes several vaccination and wound cleaning and, if not vaccinated before also injections with antibodies around the wound. Antibodies are proteins that attacks a certain virus or bacteria.

If an animal is diagnosed with rabies it is euthanized immediately. If a person is diagnosed, the only treatment given is supportive and symptomatic care. This often includes fluids, medication to treat anxiety, pain and muscle spasms.

There are approximately 59 000 people dying of rabies in the worlds every year and almost 60% of these deaths occur in Asian. Only 2% of the people in need of the PEP antibodies is actually given the treatment after exposure. The economic burden of rabies is also great. It is estimated to cost 8.6 billion USD per year and the largest cost is due to early death. 1.7 billion USD goes to PEP treatment.

Information about rabies in Lao PDR is scarce, however it is an endemic country which means that rabies cases occur every now and then. A study in 2017 showed that half of all dogs with suspected rabies from 2010 to 2016 actually had the disease. The number of confirmed cases were 284. Roughly 8000 dog bites are reported annually in Lao PDR. Nearly all patients start treatment of PEP, but only 1/3 are treated with the full vaccination programme.

The vaccination coverage in Lao PDR is estimated to be low and studies have shown that if 70% of all dogs are vaccinated, the number of human deaths due to rabies will decrease.

Several studies have shown that the overall knowledge about rabies is low in many Asian countries. This could be one of the reasons why the vaccination coverage is low and why this preventable disease still kills thousands of people every year. The lack of knowledge is also the

reason why many people in need of medical care are not seeking it or leaving the hospital before full treatment. Since the preventive treatments have existed for many years there is no reason for human deaths to continue in this rate. Thus, it is very important to inform the population about the preventive options for both dog and human.

In this study a translated questionnaire was answered by dog owners in four districts in Vientiane Capital, Lao PDR. The districts where the study was carried out in was Naxaythong, Parknguem, Xaysetha and Xaytany. The questionnaire included questions about the owner, the dog and knowledge about rabies. 359 people participated in the study and as compensations the dog was offered a de-worming injection and rabies vaccination. The knowledge was evaluated by a scoring system where the participant could get 1-10 points. For example, if the responded answered "Yes" on question "Can rabies be fatal?" he/she would receive 1 point. The average knowledge, meaning the mean total score, was then compared between genders, districts, level of school education and if the dog had been vaccinated before.

The result showed that 62.4% knew what rabies is and approximately 60% knew that rabies is transmitted by bites. The knowledge about symptoms of rabies was quite high. 70.5% answered salivation and 66.9% answered aggression, however only 30.1% said that staggering is a symptom of rabies. Only 24.1% know that rabies can be fatal. 68.2% knew that there is a rabies vaccine.

When comparing the mean score in knowledge about rabies, men had a higher score than women, participants with higher school education had higher total score in general and those who had vaccinated their dog before had a significantly higher average score that those who had not. There was a difference in mean total score between the four districts. Naxaythong had the higher mean and Xaytany had the lowest, however this difference was not statistically significant when analysed.

In conclusion, the study points out some interesting and important gaps in knowledge about rabies amongst dog owners in Lao PDR. It is very important that the number of rabies vaccinated dogs increases in the country and in order to get that result the population needs to be informed about the severity of this disease and the vaccination options. If all the people who knew about the rabies vaccine when to an animal clinic and vaccinated their dog, Lao PDR almost reaches the goal of "Zero by 2030", which would save so many lives.

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REFERENCES

Ahmed, K., Phommachanh, P., Vorachith, P., Matsumoto, T., Lamaningao, P., Mori, D., Takaki, M., Douangngeun, B., Khambounheuang, B., Nishizono, A., (2015). Molecular epidemiology of rabies viruses circulating in two rabies endemic provinces of Laos, 2011-2012: Regional diversity in Southeast Asia. *PLoS Neglected Tropical Diseases*, 9(3): e0003645 doi: 10.1371/journal.pntd.0003645

Alvarez, L., Fajardo R., Lopez, E., Pedroza R., Hemachudha, T., Kamolvarin, N., Cortes, G., Baer, G., (1994). Partial recovery from rabies in a nine-year-old boy. *The Pediatric Infectious Disease Journal*, 13: 1154-1155.

Asian Rabies Control Network (ARACON) (2018). *Rabies Malaysia*. https://rabiesalliance.org/resource/lessons-learned-malaysia [2019-09-06].

Baumgaertner, B., Carlisle, J.E., Justwan, F., (2018). The influence of political ideology and trust on willingness to vaccinate. *PLoS One*, 13(1): e0191728 doi: 10.1371/journal.pone.0191728

Birdlife international (2013). *Vultures are under threat from the veterinary drug diclofenac.* http://datazone.birdlife.org/sowb/casestudy/vultures-are-under-threat-from-the-veterinary-drug-diclofenac [2019-09-06].

Buchy, P., Preiss, S., Singh, V., Mukherjee, P., (2017). Heterogeneity of rabies vaccination recommendations across Asia. *Tropical Medicine and Infectious Disease*, 2(3): 23.

Centers for Disease Control and Prevention (CDC) (2011a). *Diagnosis in animals and humans*. https://www.cdc.gov/rabies/diagnosis/animals-humans.html [2019-10-01].

Centers for Disease Control and Prevention (CDC) (2011b). *What type of exposure occurred?* https://www.cdc.gov/rabies/exposure/type.html [2019-08-12].

Centers for Disease Control and Prevention (CDC) (2016). *Rabies serology*. https://www.cdc.gov/rabies/specific_groups/doctors/serology.html [2019-10-01].

Centers for Disease Control and Prevention (CDC) (2017). *The virus reaches the brain*. https://www.cdc.gov/rabies/transmission/body.html [2019-10-27].

Centers for Disease Control and Prevention (CDC) (2019a). *How is rabies transmitted?* https://www.cdc.gov/rabies/transmission/index.html [2019-08-13].

Centers for Disease Control and Prevention (CDC) (2019b). *Rabies around the world*. https://www.cdc.gov/rabies/location/world/index.html [2019-08-15].

Centers for Disease Control and Prevention (CDC) (2019c). *What are the signs and symptoms of rabies?* https://www.cdc.gov/rabies/symptoms/index.html [2019-08-14].

Centers for Disease Control and Prevention (CDC) (2019d). *What is rabies?* https://www.cdc.gov/rabies/about.html [2019-08-12].

Cleaveland, S., Fèvre, E.M., Kaare, M., Coleman, P.G., (2002). Estimating human rabies mortality in the United Republic of Tanzania from dog bite injuries. *Bulletin of the World Health Organization*, 80(4): 304-310.

Cleaveland, S., Hampsson, K., Lembo, T., Townsend, S., Lankester, F., (2014). Role of dog sterilization and vaccination in rabies control programmes. *Veterinary Record*, 175(16): 409-410.

Coleman, P.G., Dye, C., (1996). Immunization coverage required to prevent outbreaks of dog rabies. *Vaccine*, 14(3): 185-186.

Dodet, B., Goswami, A., Gunasekera, A., Guzman, F., Jamali, S., Montalban, C., Purba, W., Quiambao, B., Salahuddin, N., Sampath, G., Tang, Q., Tantawichien, T., Wimalaratne, O., Ziauddin, A., (2008). Rabies awareness in eight Asian countries. *Vaccine*, 26(50): 6344-6348.

Douangngeun, B., Theppangna, W., Phommachanh, P., Chomdara, K., Phiphakhavong, S., Khounsy, S., Mukaka, M., Dance, D.A.B., Blacksell, S., (2017). Rabies surveillance in dogs in Lao PDR from 2010-2016. *PLoS Neglected Tropical Diseases*, 11(6): e0005609 doi: https://doi.org/10.1371/journal.pntd.0005609

Doung, V., Tarantola, A., Ong, S., Mey, C., Choeung, R., Ly, S., Bourhy, H., Dussart, P., Buchy, P., (2016). Laboratory diagnostics in dog-mediated rabies: an overview of performance and a proposed strategy for various settings. *International Journal of Infectious Diseases*, 46: 107-114.

Evans, P., (2004). India fears public health catastrophe as vultures head for extinction. *The Guardian*, 6 September.

Evidensia (2016). *Vaccination hund*. https://evidensia.se/vara-tjanster/vaccination/ [2019-08-12].

Food and Agriculture Organization of the United Nations (FAO) (2019). *FAO, OIE and WHO unite for World Rabies Day to call for elimination of disease*. http://www.fao.org/news/story/en/item/198087/icode/ [2019-10-27].

Gibbons, R.V., (2002). Cryptogenic rabies, bats, and the question of aerosol transmission. *Annals of Emergency Medicine*, 39(5): 528-536.

Gongal, G., Wright, A.E., (2011). Human rabies in the WHO Southeast Asian region: Forward steps for elimination. *Advances in Preventive Medicine*, 2011: e383870 doi:10.4061/2011/383870

Hampson, K., Coudeville, L., Lembo, T., Sambo, M., Kieffer, A., Attlan, M., Barrat, J., Blanton, J.D., Briggs, D.J., Cleaveland, S., Costa, P., Freuling, C.M., Hiby, E., Knopf, L., Leanes, F., Meslin, F., Metlin, A., Miranda, M.E., Müller, T., Nel, L.H., Recuenco, S., Rupprecht, C.E., Schumacher, C., Taylor, L., Vigilato, M.A.N., Zinsstag, J., Dushoff, J., (2015). Estimating the global burden of endemic canine rabies. *PloS Neglected Tropical Diseases*, 9(5); e0003786 doi: 10.1371/journal.pntd.0003709

Hampson, K., Dushoff, J., Cleaveland, S., Haydon, D.T., Kaare, M., Packer, C., Dobson, A., (2009). Transmission dynamics and prospects for the elimination of canine rabies. *PLoS Biology*, 7(3): e1000053 doi: https://doi.org/10.1371/journal.pbio.1000053

Hemachudha, T., Wacharapluesadee, S., Mitrabhakdi, E., Wilde, H., Morimoto, K., Lewis, R., (2005). Pathophysiology of human paralytic rabies. *Journal of NeuroVirology*, 11(1): 93-100.

Hossain, M., (2017). Study on knowledge, attitude & practice about rabies & pet animals among school children in Bangladesh. *Journal of Microbiology and Experimentation*, 4(1): e00103 doi: 10.15406/jmen.2017.04.00103

Kamsing, A., Nasipaseuth, P., Archkhawong, S., Southalack, K., Theppangna, W., Khamphaphongphane, B., Phounphenghaek, K., Kounnavong, B., Phengxay, M., Dusan, F., (2012). A review of rabies surveillance and response activities in Lao PDR to 2011. *Zoonoses and Infections in Animals*, 57(14): 454.

Kapoor, P., Baig, V.N., Kacker, S., Sharma, M., Sharma M., (2019). A cross-sectional study of knowledge regarding rabies among attendees of anti-rabies clinic of a teaching hospital, Jaipur. *Journal of Family Medicine and Primary Care*, 8(1): 194-198.

Knobel, D.L., Cleaveland, S., Coleman, P.G., Fèvre, E.M., Meltzer, M.I., Miranda, M.E., Shaw, A., Zinsstag, J., Meslin, F.X., (2005). Re-evaluating the burden of rabies in Africa and Asia. *Bulletin of the World Health Organization*, 83(5): 360-368.

Laos (2019). *Lao People's Democratic Republic – Provinces*. https://www.citypopulation.de/en/laos/cities/?cityid=35581 [2019-09-28].

Lapiz, S.M., Miranda, M.E., Garcia, R.G., Daguro, L.I., Paman, M.D., Madrinan, F.P., Rances P.A., Briggs, D.J., (2012). Implementation of an intersectoral program to eliminate human and canine rabies: the Bohol rabies prevention and elimination project. *PLoS Neglected Tropical Diseases*, 6(12): e1891 doi: 10.1371/journal.pntd.0001891

Macinnes, C.D., Smith, S.M., Tinline, R.R., Ayers, N.R., Bachmann, P., Ball, D.G.A., Calder, L.A., Crosgrey, S.J., Fielding, C., Hauschildt, P., Honig, J.M., Johnston, D.H., Lawson, K.F., Nunan, C.P., Pedde, M.A., Pond, B., Stewart, R.B., Voigt, D.R., (2001). Elimination of rabies from red foxes in eastern Ontario. *Journal of Wildlife Diseases*, 37: 119-132.

Madhusudana, S.N., Nagaraj, D., Uday, M., Ratnavalli, E., Kumar, M.V., (2002). Partial recovery from rabies in a six-year-old girl. *International Journal of Infectious Diseases*, 6(1): 85-86.

Mai, L.T.P., Mai, N.D.C., Dung, L.P., Thuy, N.T.T., Tho, N.T.T., Lien, N.T.P., Quyet, N.T.,, Dung, N,A., Than, P.D., (2011). Community knowledge, attitude and practices toward rabies prevention in north Vietnam. *International Quarterly of Community Health Education*, 31(1): 21-31.

Matibag, G.C., Kamigaki, T., Kumarasiri, P.V., Wijewardana, T.G., Kalupahana, A.W., Dissanayake, D.R., De Silva, D.D., Gunawardena, G.S., Obayashi, Y., Kanda, K., Tamashiro, H., (2007). Knowledge, attitudes, and practices survey of rabies in a community in Sri Lanka. *Environmental Health and Preventive Medicine*, 12(2): 84-89.

Mog, C., Roy, A., Choudhuri, P., (2019). Knowledge about rabies among adult residents, Agartala, West Tripura: a cross sectional study. *International Journal of Community Medicine and Public Health*, 6(8): 3548-3553.

Muthunuwan, J.T., Ganhewa, A.G.K.H., Perera, H.D.S.G., Hishaam, M., Bandara, W.M.M.S., Gunasekera, H.A.K.M., (2017). Preliminary survey on knowledge, attitudes and practices regarding rabies. *Sri Lankan Journal of Infectious Diseases*, 7(1): 38-46.

Porras, C., Barboza, J.J., Fuenzalida E., Adaros H.L., Oviedo, A.M., Furst, J., (1976). Recovery from rabies in a man. *Annals of Internal Medicine*, 85: 44-48.

Putra, A.A., Hampson K., Girardi, J., Hiby, E., Knobel, D., Mardiana, I.W., Townsend, S., Scott-Orr, H., (2013). Response to a rabies epidemic, Bali, Indonesia, 2008-2011. *Emerging Infectious Diseases*, 19(4): 648-651.

Rahim, A., Kuppuswamy, K., Thomas, B., Raphael, L., (2010). Intradermal cell culture rabies vaccine: A cost effective option in antirabies treatment. *Indian Journal of Community Medicine*, 35(3): 443-444.

Reece, J.F., Chawa, S.K., (2006). Control of rabies in Jaipur, India, by sterilization and vaccination of neighborhood dogs. *Veterinary Record*, 159: 379-383.

Rowan, A.N., Lindenmayer, J.M., Reece, J.F., (2014). Role of dog sterilisation and vaccination in rabies control programmes. *Veterinary Record*, 175(16): 409.

Salahuddin, N., Gohar, M.A., Baig-Ansari, N., (2016). Reducing cost of rabies post exposure prophylaxis: Experience of a tertiary care hospital in Pakistan. *PLoS Neglected Tropical Diseases*, 10(2): e0004448. doi:10.1371/journal.pntd.0004448

Shim, E., Hampson, K., Cleavland, S., Galvani, A.P., (2009). Evaluating the cost-effectiveness of rabies post-exposure prophylaxis: a case study in Tanzania. *Vaccine*, 27(51): 7167-7172.

Shuilian, C., Heng, Z., Meiling, L., Jingfang, C., Dong, Y., Faming, C., Ruchun, L., Tianmu, C., (2017). Rabies virus transmission in solid organ transplantation, China, 2015-2016. *Emerging Infectious Diseases*, 23(9): 1600-1602.

Sihvonen, L., Kulonen, K., Neuvonen, E., Pekkanen, K., (1999). Rabies antibodies in vaccinated dogs. *Acta Veterinaria Scandinavica*, 35(1): 87-91.

Sor, S., Higuchi, M., Sarker, M.A.B., Hamajima, N., (2018). Knowledge of rabies and dog-related behaviors among people in Siem Reap Province, Cambodia. *Tropical Medicine and Health*, 46(20) doi:10.1186/s41182-018-0102-0

Srinivasan, A., Burton, E., Kuehnert, M., Rupprecht, C., Sutker, W., Ksiazek, T., Paddock, C., Guarner, J., Shieh, W., Goldsmith, C., Hanlon, C., Zoretic, J., Fischbach, B., Niezgoda, M., El-Feky, W., Orciari, L., Sanchez, E., Likos, A., Klintmalm, G., Cardo, D., LeDuc, J., Chamberland, M., Jernigan, D., Zaki, S., (2005). Transmission of rabies virus from an organ donor to four transplant recipients. *The New England Journal of Medicine*, 352: 1103-1111.

Stöhr, K., Meslin, F.M., (1996). Progress and setbacks in the oral immunisation of foxes against rabies in Europe. *Veterinary Record*, 139: 32-35.

Sudarshan, M.K., Madhusudana, S.N., Mahendra, B.J., Rao, N,S,N., Ashwath Narayana, D,H., Abdul Rahman, A., Meslin, F-X., Lobo, D., Ravikumar, K., Gangaboraiah, (2007). Assessing the burden of human rabies in India: results of a national multi-center epidemiological survey. *Internal Journal of Infectious Diseases*, 11(1): 29-35.

Tarantola, A., Crabol, Y., Mahendra, B.J., In, S., Barennes, H., Bourhy, H, Peng, Y., Ly, S., Buchy, P., (2016). Caring for patients with rabies in developing countries – the neglected importance of palliative care. *Tropical Medicine and International Health*, 21(4): 564-567.

Taylor, L.H., Knopf, L., (2015). Surveillance of human rabies by national authorities – A global survey. *Zoonoses and Public Health*, 62: 543-552.

Taylor, L.H., Nel, L.H., (2015). Global epidemiology of canine rabies: past, present and future prospects. *Veterinary Medicine: Research and Reports*, 6: 361-371.

The History of Vaccines (2019). *Rabies vaccine used in human*. https://www.historyofvaccines.org/content/rabies-vaccine-used-human [2019-10-01].

Thongyuang, S., Pinyopummintr, T., Sithisarn, P., Sinthusing, C., Phetudomsinsuk, K., Sangmalee, A., Sukmak, M., Phimpraphai, W., Suprasert, A., (2016). Knowledge and practices regarding rabies in urban and rural communities in Thailand and Cambodia. *International Journal of Infectious Diseases*, 53: 120.

Tillotson, J.R., Axelrod, D., Lyman, D.O., (1977). Follow up on rabies – New York. *Morbidity and Mortality Weekly Report*, 26(31): 249-250.

Vigilato, M.A., Clavijo, A., Knobl, T., Silva, H.M.T., Cosivi, O., Schneider, M.C., Leanes, L.F., Belotto, A.J., Espinal, M.A., (2013). Progress towards eliminating canine rabies: policies and perspectives from Latin America and the Caribbean. *Philosophical Transactions of the Royal Society of London. Series B, Biological sciences*, 368(1623): 20120143 doi: 10.1098/rstb.2012.0143

Wallerstein, C., (1999). Rabies cases increase in the Philippines. *British Medical Journal*, 318(7194): 1306.

Warrell, M.J., Warrell, D.A., Tarantola, A., (2017). The imperative of palliation in the management of rabies encephalomyelitis. *Tropical Medicine and Infectious Disease*, 2(4): 52.

Wertheim H.F.L., Nguyen, T.Q., Nguyen, K.A.T., de Jong, M.D., Taylor, W.R.J., Le, T.V., Nguyen, H.H., Nguyen, H.T.H., Farrar, J., Horby, P., Nguyen, H.D., (2009). Furious rabies after an atypical exposure. *PLoS Medicine*, 6(3): e1000044. doi: https://doi.org/10.1371/journal.pmed.1000044

Wikipedia (2019). *Indian vulture crisis*. https://en.wikipedia.org/wiki/Indian_vulture_crisis [2019-09-06].

Willoughby, R.E. Jr., Tieves, K.S., Hoffman, G.M., Ghanayem, N.S., Amlie-Lefond, C.M., Schwabe M.J., Chusid, M.J., Rupprecht, C.E., (2005). Survival after treatment of rabies with induction of coma. *The New England Journal of Medicine*, 352(24): 2508-2514.

Wilde, H., Khawplod, P., Khamotham, T., Hemachudha, T., Tepsumethanon, V., Lumlerdacha, B., Mitmoonpitak, C., Sitprija, V., (2005). Rabies control in South and Southeast Asia. *Vaccine*, 23(17-18): 2284-2289.

World Health Organization (WHO) (2001). Rabies,Asia. *Weekly Epidemiological Record*, 41(76): 320-323. https://www.who.int/docstore/wer/pdf/2001/wer7641.pdf?ua=1 [2019-08-16].

World Health Organization (WHO) (2013). *WHO – Expert consultation on rabies.* https://apps.who.int/iris/bitstream/handle/10665/85346/9789241209823_eng.pdf?sequence=1 [2019-08-15].

World Health Organization (WHO) (2014). *International travel and health - Rabies*. https://www.who.int/ith/vaccines/rabies/en/ [2019-10-18].

World Health Organization (WHO) (2016). Human rabies transmitted by dog: current status of global data, 2015. *Weekly Epidemiological Record*, 91(2): 13-20. https://www.who.int/wer/2016/wer9102.pdf?ua=1 [2019-10-12].

World Health Organization (WHO) (2017a). *Immunological basis for immunization series.* https://apps.who.int/iris/bitstream/handle/10665/259511/9789241513371-eng.pdf?sequence=1 [2019-08-15].

World Health Organization (WHO) (2017b). *Rabies elimination in KwaZulu-Natal, South Africa*. https://www.who.int/rabies/control/KZN_Project_Summary_150317.pdf?ua=1 [2019-10-06].

World Health Organization (WHO) (2017c). *Rabies elimination in the Visayas, the Philippines*. https://www.who.int/rabies/control/Philippines_Project_Summary_300317.pdf?ua=1 [2019-10-06].

World Health Organization (WHO) (2017d). *The rabies elimination program of Bangladesh.* https://www.who.int/neglected_diseases/news/Bangladesh-rabies-elimination-program/en/ [2019-09-16].

World Health Organization (WHO) (2018a). *New global strategic plan to eliminate dog-mediated rabies by 2030*. https://www.who.int/news-room/commentaries/detail/new-global-strategic-plan-to-eliminate-dog-mediated-rabies-by-2030 [2019-09-15].

World Health Organization (WHO) (2018b). *Rabies – Treatment*. https://www.who.int/rabies/about/home_treatment/en/ [2019-10-01].

World Health Organization (WHO) (2018c). *Rabies vaccines position paper – Evidence to Recommendation Table 2: Simplified administration of RIG as a part of PEP*. https://www.who.int/immunization/policy/position_papers/rabies_simple_admin_rig_pep.pdf?ua=1 [2019-08-14].

World Health Organization (WHO) (2018d). *Rabies – WHO recommends the intradermal route for rabies post-exposure prophylaxis*. https://www.who.int/rabies/rabies_post_immunization/en/ [2019-08-15].

World Health Organization (WHO) (2018e). *WHO position paper on rabies vaccine, February 2018.* https://www.who.int/immunization/policy/position_papers/pp_Rabies_Presentation_2018.pdf?ua=1 [2019-08-15].

World Health Organization (WHO) (2018f). *Zero by 2030: the global strategic plan to end human deaths from dog-mediated rabies by 2030*. https://www.who.int/rabies/resources/9789241513838/en/ [2019-09-17].

World Health Organization (WHO) (2019a). *Rabies.* https://www.who.int/news-room/fact-sheets/detail/rabies [2019-08-25].

World Health Organization (WHO) (2019b). *Rabies – Prevalence*. https://www.who.int/health-topics/rabies#tab=tab_3 [2019-10-27].

World Health Organization (WHO) (2019c). *Rabies – Symptoms*. https://www.who.int/rabies/about/home_symptoms/en/ [2019-08-14].

World Health Organization (WHO) (2019d). *United Against Rabies – collaboration celebrates one year of progress towards zero human deaths by 2030*. https://www.who.int/news-room/detail/28-09-2019-united-against-rabies-collaboration-celebrates-one-year-of-progress-towards-zero-human-rabies-deaths-by-2030 [2019-10-27].

World Health Organization (WHO) & World Society for the Protection of Animals (WSPA) (1990). *Guidelines for dog population management*. https://apps.who.int/iris/bitstream/handle/10665/61417/WHO_ZOON_90.166.pdf?sequence=1&isAllowed=y [2019-10-06].

APPENDIX

Questionnaire

1. Which district or province do you live in:

2. Information about the dog owner

2.1 Gender: Female Male

2.2 Age (years):

2.3 Education level: No education Primary Class 5-10 Higher secondary Graduation and above

2.4 Are you the owner of the dog: Yes No

2.5 Do you consume dog meat: Yes No

2.6 If yes, how often: Every day Once a week Once a month Less often

2.7 If no, why not:

3. Dog information:

3.1 Age of the dog:

3.2 Breed:

3.3 The dogs' main use: Guard Company Meat Other:

3.4 Main caregiver: Adult in family Child in family Other:

3.5 Living situation: Only outside loose Only outside in a leash Only outside loose but in a fenced area
Only indoor Booth indoor and outside, when outside in a leash
Booth indoor and outside, when outside loose

3.6 How did you come to own the dog: Bought A gift Puppy from previous dog Other:

4. Health status of the dog:

4.1 Has the dog ever gotten vaccinated: Yes No (continue to 4.5) Don't know

4.2 How often does the dog get vaccinated: One time 1 time/year 1 time/3 years Other:

4.3 Against which illness:

4.4 How long ago was the dog vaccinated:

4.5 History of illness: Bite wounds Vomiting/diarrhoea Parasites Lameness
Other:

5. General questions:

5.1 Do you know if dogs can transmit diseases to humans: Yes No

5.2 If yes, which illness do you know of that dogs can transmit to humans:

6. Rabies:

6.1 Do you know what rabies is: Yes No

6.2 Do you know how rabies is transmitted: Yes No

6.3 If yes, how is rabies transmitted: Mosquitoes Faeces Bites Blood contact Food Contact with dog saliva

6.4 Who can get rabies: Humans Dogs Cats Cattle Birds All animals Don't know

6.5 Symptoms of rabies: Fever Vomiting/diarrhoea Aggressiveness Salivation Abortion Staggering Difficulty breathing Weight loss Fatigue Skin lesions Don't know

6.6 Can rabies be fatal: Yes No Don't know

6.7 Do you know if there is a vaccine against rabies: Yes No

6.8 Where does your knowledge about rabies come from: School Government rabies vaccination campaigns Newspaper/TV/radio Old generation/friend Other: