


Factors associated with owned-dogs' vaccination against rabies: A household survey in Bobo Dioulasso, Burkina Faso

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Abstract

Canine vaccination is an effective means for rabies control, a minimum of 70% dog rabies vaccination coverage is required in endemic areas. According to previous investigations, this recommended coverage is always not achieved in Burkina Faso. This study was carried out to investigate reasons for poor vaccination coverage in canine population. Using a structured questionnaires, a cross-sectional survey was conducted in the city of Bobo Dioulasso to capture data on drivers that affect dog owners' individual decision to vaccinate or not their dogs. Through a house-to-house approach, 239 questionnaires were administrated to dog owners during face to face interviews. The results indicated dog rabies vaccination coverage of 25.9%. Dog breed, origin and confinement status had a significant association with vaccination status ($p < 0.05$). Owners of exotic and cross-bred dogs were more likely to adopt vaccination compared to owners of local-bred dogs. Dogs of bought origin were significantly more likely to be vaccinated among all dogs. Household characteristics including age of owners, level of education, employment status, means of transportation, perception of vaccination cost and level of knowledge about rabies were significantly associated with the vaccination status ($p < 0.05$). The oldest dog owners, the owners having high level of education, having a car as means of transportation, having good knowledge of rabies and dog rabies vaccination, being employed and perceiving vaccination cost as affordable were more likely to vaccinate their dogs. Combining community awareness and free dog rabies vaccination approaches could improve the vaccination coverage.

KEYWORDS

Burkina Faso, households survey, owned-dog, rabies control, socio-economic drivers, vaccination

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1 | INTRODUCTION

Human rabies transmitted by dogs is a serious public health threat as it is responsible for more than 59,000 globally and annually (Hampson et al., 2015). Asian and African countries have the highest rabies-related deaths (Hampson et al., 2015; Knobel et al., 2005). For example, annually, rabies kills approximately 7,000 people in Central Africa, 2,000 in North Africa, 6,000 in Southern Africa, 6,000 in West Africa (Hampson et al., 2015). This major zoonosis that affect domestic animals, wildlife and human, is 100% preventable disease if postexposure prophylaxis is adequately provided to exposed victims and if dogs are vaccinated appropriately (Zinsstag et al., 2017). However, in most of rabies endemic countries, the vaccination coverage in dogs is low and dogs are mostly roaming (Jibat et al., 2015; Savadogo et al., 2020).

Burkina Faso, a low-income country located in West Africa, is known to be rabies endemic during recent decades (Dodet et al., 2009; Kabore, 2014; Kouliati, 1989; Nitcheman, 1983; Savadogo, 2015; Savadogo et Boushan, 2015; Savadogo et al., 2020; Sondo et al., 2015; Sondo et al., 2018). Many deaths and exposures to rabid animals occurs regularly in the country (Ouermi et al., 2018; Savadogo et al., 2016, 2017, 2020; Savadogo et Boushan, 2015; Sondo et al., 2018). In Burkina Faso, laboratory diagnosis of animal rabies is made by testing, through fluorescent antibody test (FAT), brain samples from suspect dogs, ruminants, equine, pigs, primates, cats and wild animals including bats. The highest prevalences (up to 70%) were obtained in dogs (Kouliati, 1989; Nitcheman, 1983; Savadogo et al., 2020; Sondo et al., 2018). Moreover 90% of reported bite cases in Burkina Faso are caused by dogs (Savadogo et al., 2020; Sondo et al., 2018).

However, dog-keeping has important socio-economic and cultural functions in Burkinabe communities (Kouliati, 1989). People keep dogs for various purposes, including house or herd guarding, hunting, sacrifices during traditional funerals against conspiracy of misfortune, companionship especially for children, human consumption as source of protein and consumption (by dogs) of family leftover meal which, in some Burkinabe culture, is prohibited from being put into garbage. Since the 1960s, national animal health policies have prohibited animal roaming and made compulsory the rabies vaccination for domestic carnivores including dogs (Burkina Faso, 1989). Primary rabies vaccination is required from three months of age, followed annually by booster shots (Burkina Faso, 2018; Savadogo et al., 2020). Dog vaccination is known to be an effective pathway to achieve the break in the epidemiological cycle that could lead to control rabies in animal and eliminate human dog-mediated rabies (Cleaveland et al. 2006; WHO, 2004). For this purpose, a minimum of dog rabies vaccination coverage of 70% is required (Beran, 1991; Cleaveland et al. 2006; Zinsstag et al., 2017).

In the context of Burkina Faso, where there is lack of free mass rabies vaccination campaigns, direct and indirect costs associated with dog vaccination seeking are charged to dog-owners. Studies showed dog vaccination coverages ranging from 13% to 40% in the country (Savadogo et al., 2020; Sondo et al., 2018). In addition, a

household survey indicated 49.4% vaccination coverage in the country administrative capital, Ouagadougou (Savadogo et al., 2020). Effective adoption of rabies vaccination requires that their formulation take into consideration the social, cultural and economic context of local communities regarding dog management and rabies prevention. The present study was conducted with the aim of capturing data on factors associated with dog rabies vaccination status in Bobo Dioulasso, Burkina Faso.

2 | MATERIAL AND METHODS

2.1 | Study areas

Bobo Dioulasso is located in the western part of the Burkina Faso (11°11'00" North latitude and 4°17'00" West longitude) (Figure 1). In 2012, according to the Institut National de la Statistique et de la Démographie (INSD), the population of the city was estimated at nearly 813,000 inhabitants (Burkina Faso, 2017). The city is subdivided into 33 administrative areas grouped within seven administrative districts. As the former capital of Burkina Faso, Bobo Dioulasso has had public health and veterinary infrastructures that are in charge of rabies surveillance and control for several decades (Nitcheman, 1983). Individual rabies vaccination of dog is provided by private veterinary clinics. Also, during the annual celebration of the World Rabies Day, public veterinary services organize mass rabies vaccination campaigns. However, feedback information from field officers have regularly reported unsatisfactory dog vaccination coverage.

2.2 | Sampling and data collection

A cross-sectional household survey was conducted from September to November, 2018 with the objective of describing the factors associated with dog rabies vaccination. One administrative area was randomly selected from all areas in each administrative district. The study included only dog-owning households and the survey was carried out through a house-to-house approach, using a respondent-driven sampling method. The interviewers were accompanied by a local veterinary officer who helped to identify the first dog-owning household and to provide introduction remarks. Then, each respondent was asked to introduce interviewers to another dog-owning household in the same area (Camara et al., 2019; Govoeyi et al., 2019). On the basis of logistic convenience (Aiyedun & Olugasa, 2012), a total of 239 households were surveyed. In each selected administrative area, a minimum of 30 households were visited and interviewed. A questionnaire with both closed-ended and open questions (Data S1) were used to collect the data through face to face interview. Questions were asked to households' heads or other household members in the absence of the household's head. The interview was conducted in a language understandable to respondents (French, Mooré or Dioula). Household's socio-economic characteristics included age, sex, religion, education

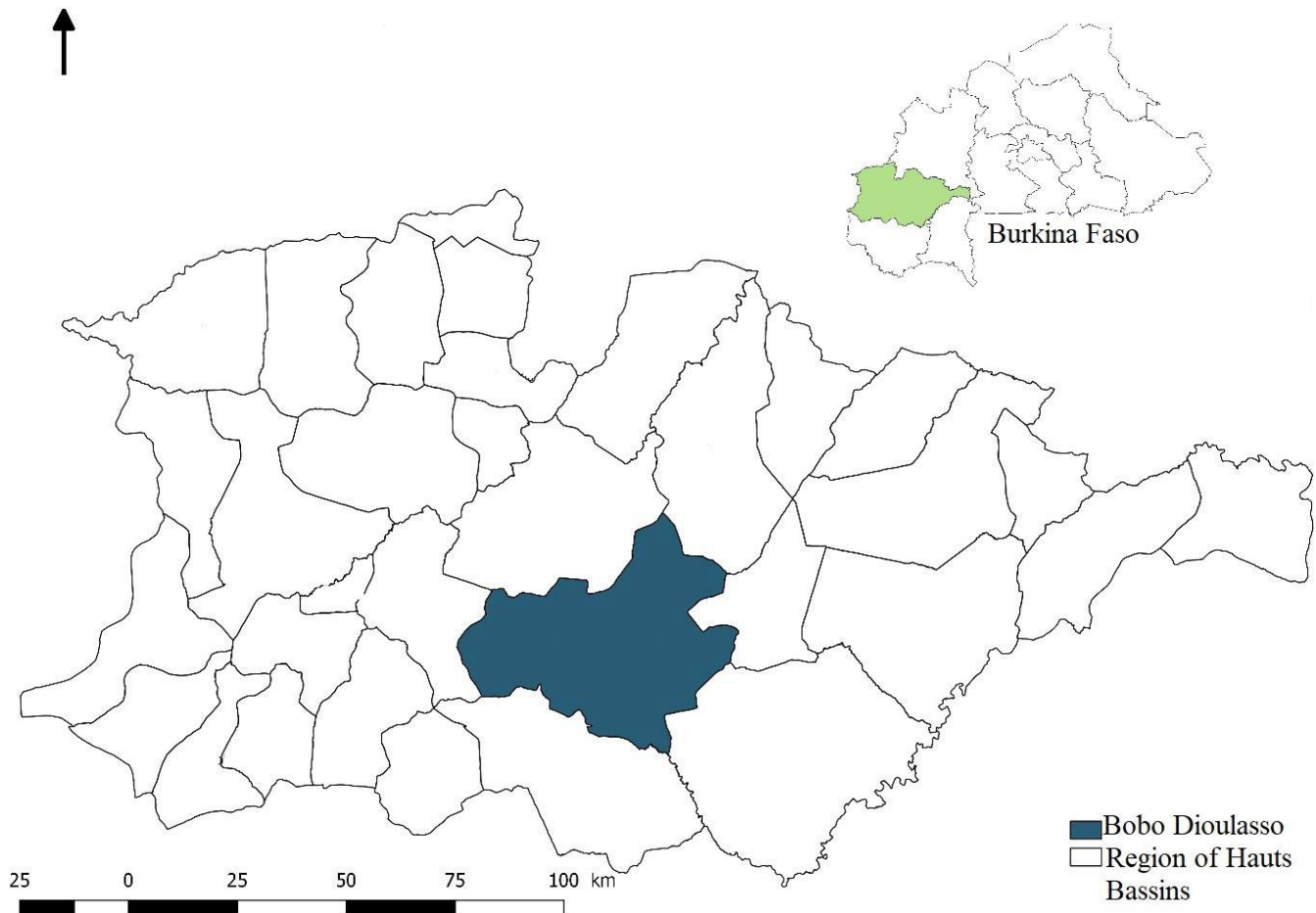


FIGURE 1 Geographical situation of the study area in Burkina Faso (Source of shapefiles: DIVA-GIS) Blue : Bobo Dioulasso White : Region of Hauts Bassins

level, employment status of the respondent, number of persons living in the household and means of transportation were registered. The estimated distance between households and nearest known veterinary clinic (on the basis of respondent estimation), the respondent's knowledge of rabies and dog vaccination were also considered. Three questions were used to assess knowledge of rabies covering vector animals, modes of transmission and prevention methods. Two questions were used to assess knowledge of dog vaccination covering required age of dogs for primary vaccination and frequency of booster shots. Data collected on dogs included sex, breed, origin, number per household, purpose of being kept, confinement status and rabies vaccination status.

2.3 | Analysis of collected data

2.3.1 | Assessment of participant's knowledge of rabies

For the three questions on the knowledge of rabies, scores were given according to the completeness and accuracy of answers to each question, ranging from zero to three (Sambo et al., 2014) (Table 1):

- Vector animals : zero if incorrect answer, one if only one vector animal named, two if two vector animals named and three if at least three vector animals named.
- Modes of transmission : zero if incorrect answer, one if only one mode of transmission named, two if two modes of transmission named and three if at least three modes of transmission named.
- Preventive practices in case of exposure : zero if incorrect response, one if one good practice named, two if two good practices named and three if at least three good practices named.

Adding up the scores given to questions thus made it possible to rank the level of knowledge of rabies on a scale ranging from zero to nine : unsatisfactory if total scores ranks from zero to two, satisfactory if total scores from three to five and very satisfactory if total scores between six and nine (Table 4).

2.4 | Assessment of participant's knowledge of dog rabies vaccination

For the knowledge of dog rabies vaccination of dogs, according to the completeness and accuracy of answers to each of asked

TABLE 1 Scoring of participants knowledge of rabies

Knowledge variables	Given score	N° observed	Frequency (%)	Example of answers
Vector animals				
Incorrect answer	0	44	18.4	Don't know, poultry, reptiles
One vector animal named	1	138	57.7	Dog, cat, monkey, rodent, sheep, goat
Two vector animals named	2	52	21.8	Dog, cat, monkey, rodent, sheep, goat
Three vector animals named and over	3	5	2.1	Dog, cat, monkey, rodent, sheep, goat
Modes of transmission				
Incorrect answer	0	11	4.6	Don't know, contaminated food, garbage
One mode of transmission named	1	67	28.0	Bite, scratch, saliva, licking
Two modes of transmission named	2	150	62.8	Bite, scratch, saliva, licking
Three modes of transmission named and over	3	11	4.6	Bite, scratch, saliva, licking
Preventive methods in case of exposure				
Incorrect answer	0	2	0.8	Don't know, nothing, bandage, application of biting animal hair to the wound, tourniquet, disinfection with alcohol, visiting traditional practitioner
One good practice named	1	141	59.0	Washing with soapy water, consultation of doctor or veterinarian, post-exposure treatment (vaccination)
Two good practices named	2	70	29.3	Washing with soapy water, consultation of doctor or veterinarian, post-exposure treatment (vaccination)
Three good practices named and over	3	26	10.9	Washing with soapy water, consultation of doctor or veterinarian, post-exposure treatment (vaccination)

questions, scores zero or one were given (Sambo et al., 2014) : minimal age for primary rabies vaccination (zero if incorrect answer and one if correct answer), frequency of booster shots (zero if incorrect answer and one if correct answer) (Table 2). The total scores allowed the classification of knowledge levels about dog rabies vaccination, using a scale ranging from zero to two : unsatisfactory if total scores were zero, satisfactory if it was one and very satisfactory if it was two (Table 5).

2.5 | Statistical analysis

First, all collected data were put into Microsoft Excel™ 2016 spreadsheet for the qualitative variables scoring process. Then, the database was imported into R software version 3.6.1 and descriptive

statistics were performed for percentage calculation. Finally, we performed univariable chi-square test to assess the association between explicative variables (dog characteristics, husbandry practices, owner and household characteristics) and dog vaccination status (unvaccinated, doubtful and vaccinated). The level of significance of the association was set at $p < 0.05$.

2.6 | Ethical considerations

This study obtained ethics approval from the Research Ethical Committee of the Université Cheikh Anta Diop (Protocole-0322/2018/CER/UCAD). It was conducted with the collaboration and technical support from the National Veterinary Office (Direction Générale des Services Vétérinaires, Burkina Faso) and

Knowledge variables	Given score	N° observed	Frequency (%)	Example of answers
Required age for primary vaccination				
Incorrect answer	0	179	74.9	Don't know, over 3 months, less than 3 months
Correct answer	1	60	25.1	3 months
Frequency of booster shots				
Incorrect answer	0	114	47.7	Don't know, every 6 months, one time
Correct answer	1	125	52.3	Annually

TABLE 2 Scoring of participants knowledge of dog rabies vaccination

Dog characteristics	N° observed (%)	Vaccination status			p-value
		Doubtful (%)	Non-vaccinated (%)	Vaccinated (%)	
Sex					
Female	92 (36.1)	8.9	65.8	25.3	0.815
Male	163 (63.9)	8.0	70.0	22.0	
Breed of dog					
Exotic	3 (1.2)	0.0	0.0	100.0	0.003
Local	242 (94.9)	8.8	67.7	23.5	
Crossbred	10 (3.9)	0.0	40.0	60.0	
Origin of dog					
Bought	165 (64.7)	10.3	55.5	34.2	0.002
Gift	64 (25.1)	5.2	82.8	12.1	
Born in the household	11 (4.3)	10.0	80.0	20.0	
Picked on the street	15 (5.9)	0.0	92.9	7.1	
Purpose of being kept					
Companionship	29 (11.4)	7.4	70.4	22.2	0.243
Guard	173 (67.8)	9.9	60.9	29.2	
Both	53 (20.8)	4.0	78.0	18.0	
Dog number per household					
One	239 (93.7)	8.0	65.6	26.4	0.714
Two	15 (5.9)	14.3	64.9	21.4	
Three	1 (0.4)	0.0	100.0	0.0	
Confinement status					
Confined	85 (33.3)	10.0	51.2	38.8	0.007
Roaming	107 (41.9)	10.1	71.7	18.2	
Both	63 (24.7)	3.4	74.6	22.0	

TABLE 3 Dog characteristics and vaccination status ($n = 255$)

the Regional Livestock Office (Direction Régionale des Ressources Animales et Halieutiques des Hauts Bassins, Bobo Dioulasso). Prior to administration of any questionnaire, participants were informed about the background and purpose of the study, highlighting that their participation was voluntary and their answers would be kept confidential. Only people of 18 years and older were included and participants who verbally agreed were interviewed.

3 | RESULTS

3.1 | Dog ownership and demographics

Within 239 households that were surveyed, 255 dogs were counted, 63.9% of dogs were male. We also counted a total of 2,400 persons living in these households. The human per dog ratio was 9.4:1. From

TABLE 4 Characteristics of respondents and their levels of knowledge regarding rabies ($n = 239$)

Respondent characteristic	Knowledge levels of rabies			p-value
	Unsatisfactory (%)	Satisfactory (%)	Very Satisfactory (%)	
Sex				
Female ($n = 124$)	14.5	66.1	19.4	0.457
Male ($n = 115$)	13.9	60.0	26.1	
Age (years)				
18 to 35 ($n = 71$)	21.1	73.2	5.7	0.000
36 to 50 ($n = 117$)	13.7	59.0	27.3	
Over 50 ($n = 51$)	5.9	58.8	35.3	
Levels of education				
Primary ($n = 24$)	33.3	58.3	8.4	0.000
Secondary ($n = 68$)	19.0	81.0	0.0	
High school ($n = 81$)	9.9	67.9	22.2	
University ($n = 55$)	3.6	52.8	43.6	
Others ^a ($n = 11$)	45.5	54.5	0.0	
Estimated distance from household to veterinary clinic (Km)				
Less than 5 ($n = 12$)	8.3	75.0	16.7	0.003
5 to 10 ($n = 57$)	10.5	47.4	42.1	
Over 10 ($n = 170$)	15.9	67.6	16.5	

^aFrench-Arabic instruction, local language instruction, illiterate.

TABLE 5 Characteristics of respondents and their levels of knowledge regarding dog vaccination ($n = 239$)

Characteristics variables	Knowledge levels of dog vaccination			p-value
	Unsatisfactory (%)	Satisfactory (%)	Very Satisfactory (%)	
Sex				
Female ($n = 124$)	48.4	28.2	23.4	0.884
Male ($n = 115$)	45.2	29.6	25.2	
Age (years)				
18 to 35 ($n = 71$)	64.8	22.5	12.7	0.001
36 to 50 ($n = 117$)	45.3	28.2	26.5	
Over 50 ($n = 51$)	25.5	39.2	35.3	
Levels of education				
Primary ($n = 24$)	79.2	12.5	8.3	0.000
Secondary ($n = 68$)	55.9	23.5	20.6	
High school ($n = 81$)	42.0	32.1	25.9	
University ($n = 55$)	21.8	40.0	38.2	
Others ^a ($n = 11$)	81.8	0.0	18.2	
Estimated distance from household to veterinary clinic (Km)				
Less than 5 ($n = 12$)	8.4	58.3	33.3	0.000
5 to 10 ($n = 57$)	21.1	26.3	52.6	
Over 10 ($n = 170$)	58.2	27.6	14.2	

^aFrench-Arabic instruction, local language instruction, illiterate.

255 dogs counted, 34.3% were declared vaccinated. Only 25.9% of dogs that were declared as vaccinated had an up-to-date vaccination certificate. The vaccination status of other dogs was either

unvaccinated (65.7%: declared non-vaccinated or vaccination certificate not up to date) or doubtful (8.4%: declared vaccinated but vaccination certificate was not seen by interviewers). Table 3 describes

Socioeconomic characteristics	N° observed (%)	Vaccination status			p-value
		Doubtful (%)	Non-vaccinated (%)	Vaccinated (%)	
Sex					
Female (n = 124)	124 (51.9)	9.7	66.9	23.4	0.539
Male (n = 115)	115 (48.1)	7.0	64.3	28.7	
Age (years)					
18 to 35	71 (29.7)	11.3	74.6	14.1	0.001
36 to 50	117 (48.9)	8.5	67.6	23.9	
Over 50	51 (21.4)	3.9	49.0	47.1	
Religion					
Animism	2 (0.8)	0.0	50.0	50.0	0.082
Christianity	86 (36.0)	10.5	54.7	34.8	
Islam	151 (63.2)	7.3	72.2	20.5	
Levels of education					
Primary	24 (10.0)	8.3	75.0	16.7	0.005
Secondary	68 (28.5)	13.2	69.1	17.7	
High school	81 (33.9)	7.4	66.7	25.9	
University	55 (23.0)	5.5	49.0	45.5	
Others ^a	11 (4.6)	0.0	100.0	0.0	
Professional status					
Student	12 (5.0)	0.0	83.3	16.7	0.000
Retired	14 (5.8)	7.1	35.7	57.2	
Employed	114 (47.7)	9.6	55.3	35.1	
Not employed	99 (41.5)	8.1	79.8	12.1	
Estimated distance between household and veterinary clinic (Km)					
Less than 5	12 (5.0)	8.3	58.3	33.4	0.000
5 to 10	57 (23.8)	6.5	74.7	18.8	
Over 10	170 (71.2)	14.0	40.4	45.6	
Main means of transportation of household					
Bicycle	2 (0.8)	0.0	100.0	0.0	0.001
Motorbike	147 (61.5)	10.9	72.1	17.0	
Car	90 (37.7)	4.4	54.4	41.2	
Levels of knowledge of rabies (vector animals, modes of transmission, prevention practices)					
Unsatisfactory	34 (14.2)	11.8	73.5	14.7	0.000
Satisfactory	151 (63.2)	8.6	74.2	17.2	
Very satisfactory	54 (22.6)	5.6	37.0	57.4	
Levels of knowledge of dog vaccination (required age for primary vaccination, frequency of booster shots)					
Unsatisfactory	112 (46.9)	8.0	83.1	8.9	0.000
Satisfactory	69 (28.9)	7.2	65.2	27.6	
Very satisfactory	58 (24.2)	10.3	32.8	56.9	
Perception on vaccination cost					
Affordable	72 (30.1)	8.3	54.2	37.5	0.025
Expensive	167 (69.9)	8.4	70.6	21.0	

^aFrench-Arabic instruction, local language instruction, illiterate.**TABLE 6** Influence of socioeconomic characteristics on the dog vaccination status (n = 239)

ownership of the dogs. According to 67.8% of interviewees, dogs were kept for guard. Dog origin was varied: bought (64.9%), gift (25.0%), picked on the street (5.9%) or born in the household (4.2%). The local breed dog was most represented (94.6%) and 33.5% of dogs were confined day and night (24 hr a day) within households.

3.2 | Respondents' Characteristics

Data regarding respondents' characteristics are described in Table 6. The majority of respondents were female (51.9%) and between 36 and 50 years old. Respondent religions were animism (0.8%), Christian (36%) and Islam (63.2%). Most of interviewed participants have studied and were employed persons, working for public or private services. In the studied city, the most employed means of transportation was motorbike.

3.3 | Participant knowledge level of rabies and dog rabies vaccination

Tables 4 and 5 present levels of knowledge (both of rabies and dog rabies vaccination) by sex, age, education level and distance from household to the nearest veterinary clinic. Levels of knowledge of rabies (animal vectors, modes of transmission, prevention practices) and dog rabies vaccination (required age for primary vaccination, frequency of booster shots) were associated with education level, age and distance to the nearest veterinary clinic ($p < 0.05$). Among dog owners, those who had very satisfactory levels of knowledge regarding rabies and dog rabies vaccination were more likely to vaccinate their dogs.

3.4 | Influence of dog characteristics on their rabies vaccination status

Dog vaccination coverage varied according to the number of dogs per household, the breed of dog, dog sex, purpose of being kept, dog origin and confinement status (Table 3). Owners of exotic and crossbred dogs were more likely to adopt vaccination compared to owners of local breed dogs ($p < 0.05$). In addition, dogs of bought origin were significantly more likely to be vaccinated ($p < 0.05$). Rabies vaccination coverage was also higher in confined dogs ($p < 0.05$).

3.5 | Influence of socio-economic characteristics on the dog rabies vaccination status

Only 24.3% of participants had a very satisfactory knowledge level regarding dog rabies vaccination. In most of households, motorbikes were used as main means of transportation (61.5%) while 47.7% of respondents were employees (by government or private agencies). The average cost of rabies vaccination, estimated at 3.8 euros per

dose (2,500 FCFA in veterinary clinics), was perceived to be expensive by the majority of dog owners (69.9%). Among investigated socio-economic characteristics, age, level of education, professional status of dog owners, estimated distance between household and veterinary clinic, means of transportation, perceived cost of vaccination, knowledge of rabies and dog rabies vaccination were significantly associated with dog vaccination status ($p < 0.05$) (Table 6). The oldest dog owners, the owners having high level of education, having a car as main means of transportation, having good knowledge of rabies and dog rabies vaccination, being employed and perceiving vaccination cost as affordable were more likely to vaccinate their dogs.

4 | DISCUSSION

Knowledge of canine population characteristics is a critical step in planning and ensuring the effectiveness of any dog rabies vaccination strategy (Coetzer et al., 2016). The study showed that the number of owned-dogs per household in the study area (approximately 1.1) was lower than that obtained in Ouagadougou, the administrative capital of the country (approximately 1.4; Savadogo et al., 2020) and in Philippines (approximately 1.6; Davlin et al., 2013). However, the obtained owned-dog per household ratio was higher than that reported in Cameroon (approximately 0.7 in Garoua and Ngaoundéré, 0.4 in Yaoundé; Bouli et al., 2020). The male per female sex ratio (1.8:1) reflects dog owners' preference for males due to the fact that dogs are kept primarily for security purpose (Aiyedun & Olugasa, 2012; Bouli et al., 2020; Jibat et al., 2015). Unfortunately, as the dogs are mainly roaming in Burkina Faso (Savadogo et al., 2020), males could travel long distances and fight compared to females. Thus, they contribute in spreading the rabies virus in animal population (Davlin et al., 2013; Flores-Ibarra & Estrella-Valenzuela, 2004). In addition, the findings showed that the human per dog ratio is higher than that described in Ouagadougou, Burkina Faso (8:1) and in KwaZulu-Natal, South Africa (8.25:1) where rabies is also endemic (Hergert et al., 2016; Nitcheman, 1983; Savadogo et al., 2020).

The dog rabies vaccination coverage (25.9%) obtained in this study was lower than the World Health Organization recommended threshold coverage (at least 70%) (Beran, 1991; Cleaveland et al. 2006; Coleman & Dye, 1996; Jibat et al., 2015; Zinsstag et al., 2017). The obtained rabies vaccination coverage may differ from field reality. Indeed, the dog rabies vaccination status was assessed on the basis of the presentation of vaccination certificate or information provided by respondent. Thus, rabies vaccinated dogs might be wrongly classified as non-vaccinated, for example if the person being aware of the dog rabies vaccination status or keeping the dog rabies vaccination certificate was absent from house during the survey time. In contrast, higher vaccination coverage (49.4%) was reported in Ouagadougou (Savadogo et al., 2020), probably due to the greater presence of the veterinary facilities (public and private) that may increase access to dog vaccination services. In addition, Ouagadougou hosts more frequently World Rabies Day

celebrations, during which communication and subsidized short rabies vaccination campaigns are organized by veterinary officials in collaboration with private clinics. This observation confirms that implementation of free-vaccination programs allowed achieving higher levels of vaccination coverage in dogs (up to 70%) as reported in Chad, Mali, Tanzania, Tunisia and Zambia (Hergert et al., 2016; Jibat et al., 2015; Mosimann et al., 2017). In Nigeria, where vaccination is charged to dog owners, Awoyomi et al. (2007) have found a rabies vaccination coverage of 56,6% in fairly balanced study sample of local, exotic and crossbred dogs.

Dog-owning meets communities' socio-economic and cultural needs because of several functions including companionship and guard of houses or warehouses (Jibat et al., 2015; Nitcheman, 1983; Savadogo et al., 2020). A study conducted by Jibat et al., 2015 reported that in most of African countries, people keep dogs for guarding, companionship, income generation and meat purposes. Dog origin was varied and dogs which were bought by owners, were the most likely to be vaccinated ($p < 0.05$). Indeed, this kind of owners may pay more attention to dog healthcare (including rabies vaccination) in regard of their role in insuring security for households. These owners are mostly professionals (employed or retired) whose income has enabled them to invest in building own houses (Awoyomi et al., 2007; Flores-Ibarra & Estrella-Valenzuela, 2004). This attitude of the dog owners would explain that employed owners were more likely to vaccinate dog and that dogs, which were bought by owners, were more likely to be vaccinated ($p < 0.05$).

Local husbandry practices favour dog roaming, owned-dogs going out and coming home freely (Savadogo et al., 2020). Under these conditions, at the time of vaccination, owners are unable to handle and transport dogs to veterinary clinic or mass vaccination campaign fixed sites (Davlin et al., 2013; Mosimann et al., 2017). This constraint might result the lower vaccination coverage in non-confined dogs observed in this study in contrast with confined dogs ($p < 0.05$). Despite higher rabies vaccination coverage in confined dogs (Davlin et al., 2013), some confined-dog owners, who had not vaccinate their pets, might feel that a confined dog is not at risk of rabies infection and then vaccinating is a waste of resources. They are unaware that in households which are not entirely closed, other rabid animals, including cats or monkeys, are capable of coming into contact and transmission of rabies to a confined-dog. In addition, there is a risk that confined dogs meet other dogs when taken out for healthcare including veterinary treatment (Awoyomi et al., 2007).

Regarding household means of transportation, two-wheeled vehicles (bicycles, motorbikes) were mostly used in the study city. Unfortunately, they are not suitable for transporting dogs to vaccination sites and the findings showed that dog owners who had cars were more likely to vaccinate their dogs ($p < 0.05$). Those having cars may also have enough financial resources to pay for dog vaccination, because dog rabies vaccination was not free of charge in Bobo Dioulasso. Moreover in the local context of study city, veterinary clinics, were not many and remain located far from most households. Estimated distance to veterinary clinics was a major barrier to dog vaccination ($p < 0.05$) due to the dog handling issues,

the transportation logistic constraints, transportation costs and lost of working time felt by owners (Mosimann et al., 2017; Savadogo et al., 2020).

The findings also indicated that most of respondents' knowledge levels of rabies and dog rabies vaccination were at least satisfactory. Knowledge levels were significantly higher in oldest dog owners ($p < 0.05$), which makes sense because regarding lack of regular communication and education about the disease in the country, the oldest persons are the more likely to hear about rabies. The significant association of education levels with knowledge of rabies is a warning that risk may be higher in poor communities with low access to education (Ahmed et al., 2014). It highlights the need for innovative awareness approaches (spreading relevant messages through banners, media and social media) to improve communities' perspectives and behaviors in regard of rabies prevention. Awareness should focus particularly on children under 15 years old (e.g., school kids) who represent nearly 40% of rabies victims in Burkina Faso (Sondo et al., 2015). Mobile technologies (including social media) are effective means for reducing the gap due to lack of personnel and thus, the distance-related inaccessibility to vaccination facilities ($p < 0.05$) (Lembo et al., 2010; Mosimann et al., 2017; Sambo et al., 2014). The observed vaccination coverage was higher for owners having 'satisfactory' and 'very satisfactory' levels of knowledge. This further emphasizes the importance of education and training of stakeholders for effective control strategy as described through the Stepwise Approach for Rabies Elimination (Coetzer et al., 2016; Mosimann et al., 2017; Zinsstag et al., 2017).

Characteristics such as dog sex (Davlin et al., 2013), dog number per household, the purpose of being kept (Flores-Ibarra & Estrella-Valenzuela, 2004), the sex and religion of respondents had no significant association with owner's decision to vaccinate or not their dogs. The lack of association between the number of dogs per household and rabies vaccination status could be related to the fact that almost all households had only one dog. Indeed, in the context of the study, where owners did not have enough financial power with respect to the cost of rabies vaccination, it is clear that having a larger number of dogs could encourage non-vaccination of dogs.

The proposed study was carried out to help having an overview on drivers that affect dog rabies vaccination coverage in Bobo Dioulasso. The method focuses on vaccination coverage and kind of drivers according to respondents' reports, but leaves aside the in-depth social processes that accompany or lead to dog owners decision to vaccinate. Therefore, analysis focusing on social processes around pets vaccination would be useful to implement as an additional reflection to the present employed approach (Zinsstag, 2013). The respondent-driven sampling method that we used in the study is due to lack of data on household dog-owning in the study area. This observation calls for in-depth investigation of dog-owning, dog population structure with the objective of providing data for stakeholders' evidence based decision making, especially to support mass rabies vaccination planning and effectiveness monitoring.

5 | CONCLUSION

This study showed a low vaccination coverage in owned-dogs in Bobo Dioulasso. Both canine ownership characteristics and household socio-economic factors were associated with owner individual decisions to vaccinate their dogs. Therefore, we recommend that more in-depth investigation be carried out in larger areas across the country in order to analyse the structure of dog populations and the willingness of owners to pay for pet healthcare, particularly dog vaccination. This could enable national veterinary officials to design and implement dog mass vaccination with respect to local socio-economic context. In addition, considering the study findings, most of people considered the vaccination to be expensive. Therefore, it would be useful that animal health policy and decision-makers allocate resources for free mass vaccination and community awareness.

CONFLICT OF INTERESTS

All authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTION

Madi Savadogo: Conceptualization; Data curation; Formal analysis; Methodology; Resources; Validation; Writing-original draft. Dieudonné Tialla: Conceptualization; Methodology; Validation; Writing-original draft. Boris Ouattara: Conceptualization; Data curation; Formal analysis; Resources; Validation. Laibané Dieudonné Dahourou: Validation; Writing-review & editing. Walter Ossebi: Conceptualization; Validation; Writing-review & editing. Sidwatta Guy Ilboudo: Validation; Writing-review & editing. Alima Hadjia Banyala Combari: Validation; Writing-review & editing. Zékiba Tarnagda: Validation; Writing-review & editing. Rianatou Alambédji-Bada: Conceptualization; Project administration; Supervision; Validation; Writing-review & editing.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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