

ORIGINAL RESEARCH ARTICLE

Do open garbage dumps play a role in canine rabies transmission in Biyem-Assi health district in Cameroon?

Tabue N. Raymond, Msc^{1,2*}, Madgan E. Roland, Bsc³,
Kenfack M. M. Françoise, Msc¹, Zeukeng Francis, Msc²,
Esemu F. Livo, Msc² and Seumen T. H. Clovis, Msc²

¹Ministry of Public Health, Yaoundé, Cameroon; ²National Reference Unit for Vector Control, The Biotechnology Center, University of Yaoundé, Yaoundé, Cameroon; ³School of Health Technicians and Sanitary Engineering of Yaoundé, Yaoundé, Cameroon

Background: Rabies is a neglected zoonotic disease which represents a serious public health problem. In Cameroon, efforts to prevent human deaths caused by rabies are often thwarted by the lack of community awareness. The community knowledge, as well as attitudes and perception on rabies, is therefore important for both prevention of human deaths and control in animals.

Methods: A cross-sectional study was carried out to evaluate the level of community knowledge as well as the role of open garbage dumps (OGDs) in the epidemiology of human rabies. Overall 420 heads of household were interviewed in the Biyem-Assi health district of Yaoundé. OGDs were identified through a systematic check, and household wastes they contained were characterized.

Results: Although 66.9% of respondents have knowledge on stray dogs, only 35% of respondents knew the role of OGDs in the increase of stray dog population. Overall OGDs consisted of fermentable wastes. Nutrition places for stray dogs were wild garbage dumps (68.1%), markets (18.3%), and houses (13.6%). The feeding behavior of stray dogs correlated significantly with the human rabies transmission ($\chi^2 = 154.12$, $df = 4$, $p < 0.05$).

Conclusion: Most participants knew that rabies could be transmitted by a dog bite as well as the measures to be taken in this type of situation. Increased knowledge of respondents on rabies showed OGDs and stray dogs as significant risk factors for canine rabies in Biyem-Assi health district.

Keywords: *rabies; stray dog; open garbage dumps; Cameroon*

Responsible Editor: Samad Amini-Bavil-Olyaei, University of Southern California, United States.

*Correspondence to: Tabue N. Raymond, Ministry of Public Health, PNLP, P.O. Box 14386 Yaoundé, Cameroon, Email: tnraymon@yahoo.fr

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Rabies is a viral zoonosis caused by negative-stranded RNA viruses from the *Lyssavirus* genus. Although rabies can infect and be transmitted by a wide range of mammals, dogs remain the main reservoir (1, 2). The highest rabies burden is attributable to dog-mediated transmission and human rabies cases (>90%) resulting from bites of rabid dogs (3, 4). Nowadays, most human deaths caused by canine rabies occur in Asia and Africa with about 30,000 and 23,800 cases per year, respectively (4). Estimates of rabies burden in Africa have always been uncertain due to a lack of reliable data. Successful rabies control has been observed in many parts of Central and South America through large-scale and synchronized mass dog vaccination campaigns (5). However, few large-scale dog vaccination programs were implemented in sub-Saharan Africa. Furthermore, the

incidence of rabies might be underestimated by more than 100-fold because most deaths occur in communities rather than in hospitals (6, 7), and those that occur in hospitals are frequently misdiagnosed as forms of encephalitis (8). Moreover, people are not aware of WHO guidelines on rabies postexposure prophylaxis (PEP) (9). Consequently, in developing countries, dog bite victims fail to receive PEP due to lack of awareness on rabies or because of high treatment cost (4, 7, 10). Most expenditure for PEP is borne by those who can least afford it. As a result, many patients do not complete their treatment.

Most cities in Cameroon are facing increasing populations. This situation coupled with extreme poverty leads to promiscuity and insalubrity in streets and neighborhoods (11). Cameroonian cities produce large quantities of household wastes, and their transport to the collection

sites remains problematic. The average production of household wastes in Yaounde increases from 850 g/capita/day in 1998 (12) to 6.5 kg/capita/day in 2007 (13). Out of the 1,023 tonnes of household wastes produce each day, only 70% (about 700 tonnes) could be collected every day by the municipality (14–16). The remaining 30% represent household wastes that could not be collected mainly from suburbs with poor road infrastructures. Therefore, it is more likely to find open garbage dumps (OGDs) near residential houses due to the difficulty for the municipality vehicles to drive inside and the distance of houses to the collection points. In suburbs, wastes are dumped directly to OGDs and sometimes into drains leading to flooding during the rainy season. The proximity of these OGDs to households could increase the frequency of man-stray dog contact, thus the risk of rabies transmission. Nonetheless, it is clear that rabies disproportionately affects poor communities and particularly children. The situation is exacerbated because household wastes are mostly transported to dumps by children who present the highest risks for rabies (17). Therefore, the disability-adjusted life years (DALYs) burden for rabies is particularly high and a greater number of life years are lost (18, 19).

Various cases of rabies recorded in Yaounde were attributed to dog bites. Between January and September 2013, there were 137 human cases of dog bites which contributed to 19 deaths in Cameroon (20). These animals are kept essentially as pets and for guarding. In Cameroon like in other developing countries, dogs are intimately dependent on humans for food and shelter (21). This association means that dogs' population can be correlated in size as well as in distribution, with human populations (22, 23). Furthermore, social changes such as urbanization resulted in an increase in human and dog movements

(24). In cities, the human population, as well as the dog population, has expanded enormously. Unfortunately, low population income in Cameroonian cities does not always allow dogs owners to properly feed their pets. As a consequence, unrestricted dogs scavenge for food and roam the streets in search of sex mates (25–27).

In Cameroon, no data actually exist about the distribution of pet animals in Yaounde. Available statistics are only based on people who brought their animal for vaccination. One of the principal factors contributing to low prioritization of rabies control has been the lack of information on the burden and impact of the disease (28).

To fill the gap and provide baseline data on rabies, a survey was conducted in Biyem-Assi health district of Yaounde to evaluate the level of knowledge and perception of the population on rabies and the role of OGDs in the transmission of this disease. This was carried out in order to contribute to a better understanding of rabies' epidemiology in Cameroonian cities and to recommend new integrated rabies control methods.

Methods

Ethical considerations

Prior to the study, an administrative authorization was obtained from the Divisional Officer of the Biyem-Assi health district. Participation was strictly voluntary and was dependent on oral consent by the participants. Respondents were informed of the study and the confidentiality of the data to be collected.

Study site

The study was carried out from October 2013 to March 2014 in the Biyem-Assi health district (03°84'N, 11°49'E)

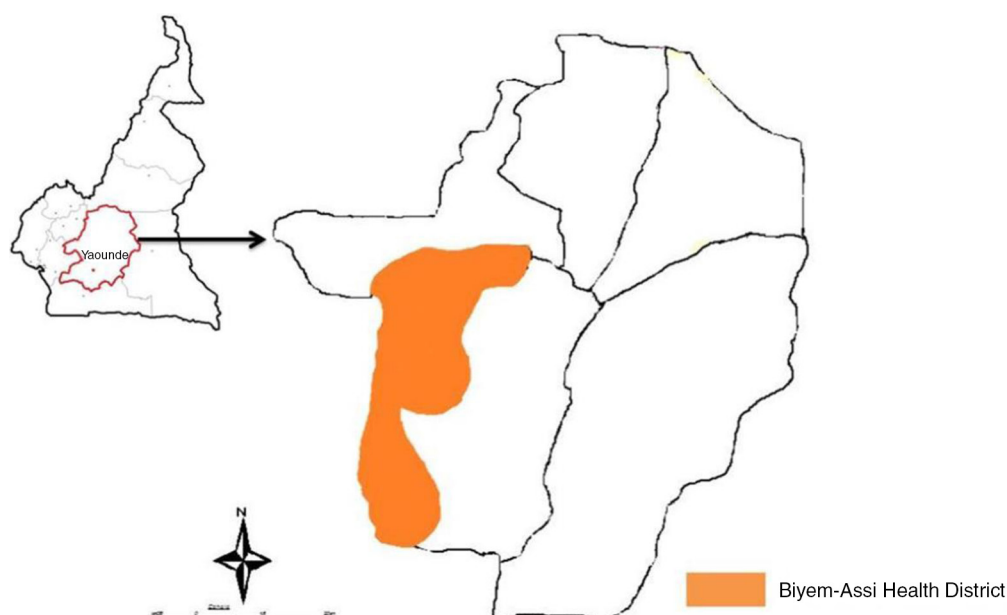


Fig. 1. Map of Yaounde Health District showing the location of the study sites.

which is located in the South West of Yaoundé, the capital of Cameroon (Fig. 1). Its population is estimated at 310,000 (29) and is characterized by increasing numbers of stray dogs in the streets and the large number of wild garbage dumps positioned closely to households.

Sampling procedure

A community-based cross-sectional study was conducted. Overall, 420 households were surveyed using a systematic random sampling method. The head of each household or its substitute (> 18 years old) was interviewed in French for 10–15 min using a structured questionnaire.

Questionnaire design

The questionnaire designed for this study consisted of closed and a few open-ended questions. It had four parts: anthropometric and socio-demographic information, risk factors of rabies transmission (stray dogs and OGDs), knowledge/attitude/perception of rabies, and its measures of control. The questionnaire was pretested in a neighborhood quarter with the similar socio-demographic characteristic prior to the survey and was modified to improve its clarity and analysis.

Characterization of OGDs

An observational method was considered more appropriate to characterize household wastes in OGDs. Through a systematic check, OGDs were identified and solid wastes were characterized as fermentable, hazardous, or non-hazardous wastes. The approximate distance of each OGD to the nearest house was evaluated and reported.

Statistical analysis

Vaccinated dogs were defined as those that had been immunized (oral or parenteral) 1 year before the survey. Data were analyzed using Epi-Info version 7.0. The Chi-square test was used to set the difference in proportions or frequencies. $P < 0.05$ was considered as statistically significant.

Results

Demographic and socio-demographic characteristics of respondents

Overall 420 respondents were interviewed in this study. Most respondents were female (66%) and single (51.9%). Respondents' median age was 35 years and ranged from 18 to 73 years. The main education levels of participants were primary (39.8%) and secondary (34.3%) schools. Slightly under a quarter (22.1%) had attended higher education institutions (Table 1). Approximately 32.14% of respondents had at least one dog and 67% of them had vaccinated dogs.

OGDs characterization

A total of 134 OGDs were numbered in the Biyem-Assi health district and the average distance between these

Table 1. Demographic and socio-demographic characteristics

	Male	Female	Total
Gender	143 (34.0%)	277 (66.0%)	420 (100%)
Marital status			
Married	59 (14.0%)	143 (34.0%)	202 (48.1%)
Single	84 (20.0%)	134 (31.9%)	218 (51.9%)
Educational level			
Primary school	43 (10.2%)	124 (29.5%)	167 (39.8%)
Secondary school	68 (16.2%)	76 (18.1%)	144 (34.3%)
Higher institution	29 (6.9%)	64 (15.2%)	93 (22.1%)
Never attended school	3 (0.7%)	13 (3.1%)	16 (3.8%)
Age			
18–29	43 (10.2%)	96 (22.9%)	215 (51.2%)
30–41	81 (19.3%)	134 (31.9%)	139 (33.1%)
> 42	19 (4.5%)	47 (11.2%)	66 (15.7%)

OGDs and the nearest households ranged from 5 to 15 m with a median distance of 10 m. Some solid wastes including plastic, textile, paper, paperboard, and food wastes were steadily found in every OGD (Table 2).

Risk factors of rabies transmission

Risks factors associated with OGDs

Questioned about risks of closed dumps to households, 35 and 28.1% of respondents estimated that this predominantly leads to an increase of stray dog density and

Table 2. Solid wastes characterization

Typology of solid household waste	Number (N = 143)	Frequency (%)
Fermentable wastes		
Food waste	143	100
Plant waste	41	28.67
Dead animals	26	18.18
Non-hazardous wastes		
Wood waste	68	47.55
Inert waste (paved, gravel, bricks, tiles)	86	60.14
Scrap metal (ferrous and non-ferrous metals)	102	71.33
Paper and paperboard	143	100
Textile	143	100
Glass (cups, jars, bottles, jars)	123	86.01
Hazardous wastes		
Waste plastics (water, juice bottles . . .)	143	100
Tires	54	37.76
End of life vehicles	5	3.50
Batteries and fluorescent tube	8	5.59
Electrical and electronic waste	79	55.24

Table 3. Stray dogs and risk linked to feeding behavior

Feeding behavior	Risk factors			
	Killing	Rabies transmission	Pest transmission	Total
Open garbage dump	45 (10.71%)	241 (57.38%)	0	286 (68.10%)
House	25 (5.95%)	18 (4.29%)	14 (3.33%)	57 (13.57%)
Market	36 (8.57%)	19 (4.52%)	22 (5.24%)	77 (18.33%)
Total	106 (25.24%)	278 (66.19%)	36 (8.57%)	420 (100%)

mosquitoes, respectively. OGDs were considered as the source of unhealthy environment and disease at 21.9 and 15%, respectively. Regarding the definition of stray dog, 66.9% of heads of households knew what a stray dog is while for 14.76% stray dogs are domestic dogs, pet dogs for 8.81%, or guard dogs for 6.90%. Feeding places for stray dogs were wild garbage dumps (68.1%), markets (18.3%), and houses (13.6%). The Chi-square test analysis of feeding behavior of stray dogs as well as risk they incur revealed that 42% of respondents consider the feeding behavior of stray dogs as a potential risk for rabies transmission (Table 3). There was a direct association between feeding behavior of stray dogs and rabies transmission at a significant level ($\chi^2 = 154.12$, $df = 4$, $p < 0.05$). Only 18% of respondents considered OGDs as a risk factor for rabies.

Knowledge, attitudes, and practices with regard to rabies All participants involved in the study have full knowledge concerning rabies transmission by dog bites. In contrast, only 32% of respondents attribute rabies transmission to scratching and licking of a rabid dog. Concerning transmission of rabies by bites of animals other than dogs, 21 and 15% of respondents attributed rabies to cats and cows, respectively.

Concerning the perception of rabies symptoms in humans, rabies was characterized by fever (10%), wound infection (51.43%), and diarrhea (6.67%). A total of 31.90% of respondents were unable to state the symptoms of rabies in humans (Fig. 2). Concerning the perception of rabies symptoms in dogs, rabies was characterized by irritability (49%), skin lesions (26.9%), and alopecia (11%). A total of 13.1% of respondents had no idea about the symptoms of rabies in dogs (Fig. 3). As measures to be taken in the case of dog bites, 56% of participants accepted that they would disinfect the wound after washing with water, 35% reported that they would go to hospital, and 9% did not know what to do in this situation (Table 4). Concerning control measures, participants recommended the destruction of OGDs to reduce stray dog population (36%), the regulation of stray dog density in the district (48%), and the vaccination of dogs (16%).

Discussion

Instead of its preventive possibility, rabies remains a public health problem of major concern. The situation is alarming in rural Africa and Asia where canine rabies has been severely neglected (30). Moreover, the periodicity of epidemics leads to only intermittently perceiving rabies as a problem (31). In these rural areas, the disease persistence is due to poverty and the increase of wild carnivore populations (32). Regarding canine rabies in Africa, most studies focus on dog vaccinations while little is known about the origin and factors that favor the free roaming of dogs and human rabies transmission. Thus, transmission and identification of risk factors are the most important processes underlying infectious disease dynamics (33), but it is also the least understood. Therefore, knowledge and attitudes of the population, perception of rabies, and the impact of OGDs on the transmission of rabies were investigated in Biyem-Assi health district of Yaounde through a cross-sectional study. To the best of our knowledge, this study stands as the first conducted to highlight the public health threat of rabies in Cameroon.

Findings of this study indicate that rabies is an important public health problem in the Biyem-Assi health district and that community awareness, knowledge, and perception of rabies were high among the respondents.

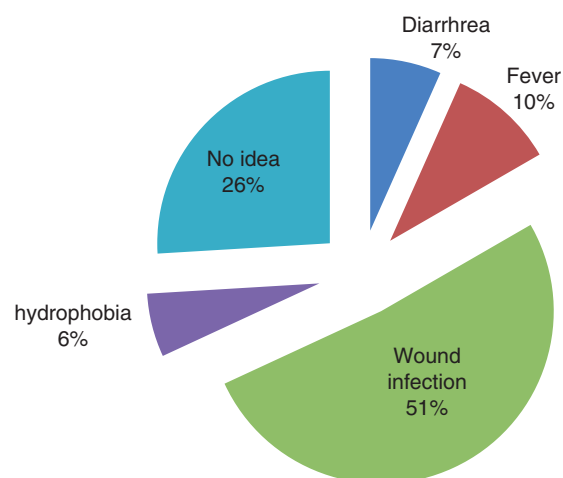


Fig. 2. Perception of rabies symptoms in humans.

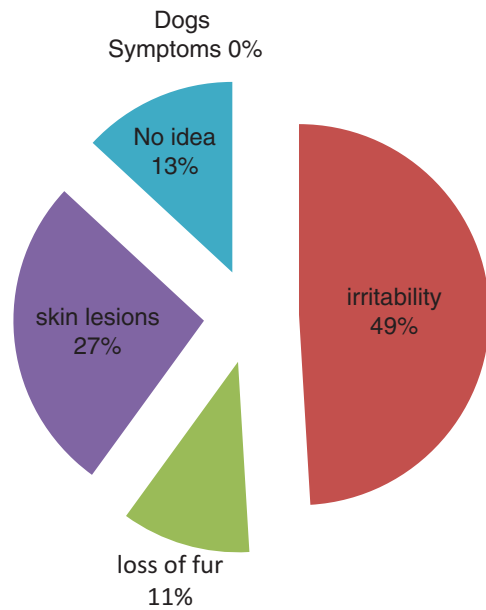


Fig. 3. Perception of rabies symptoms in dogs.

These data corroborate with those obtained in some endemic countries of South Asia that revealed a high level of knowledge on rabies transmission. In fact, about 98.6% of the population knew that rabies is transmitted by rabid dogs (34–36).

This high level of awareness among the respondents may be attributed to their level of education. In fact, 96% of the respondents had attended, at least, primary school (Table 1).

Nevertheless, this study has shown some knowledge gaps among the study population. About 31% of respondents did not know what stray dogs were, 32% of dogs were not vaccinated and 31.90% of respondents did not know the symptoms of rabies in humans. This indicates that there is a need for rabies awareness education in this community. Educating the population on rabies and the risk factors associated with its transmission could fill this knowledge gap. The study also showed that within dogs' owners, there is a good coverage of vaccination (>67%) and the rabies PEP behaviors in the population are considerable. This was confirmed by the fact that 56% of participants would disinfect their wounds and 35% would go to hospital for treatment after a dog bite. Unfortunately, poor households are facing increasing financial difficulties, resulting in substantial delays in PEP delivery (7).

Moreover, the current results indicate that respondents believe that OGDs are a public health problem in the community and lead to stray dogs proliferation. Most wastes had a household origin and stray dogs were mostly attracted by fermentable wastes from cooking or lapsed foods. This corroborates previous studies conducted on solid waste management in India (37). Participants there-

Table 4. Knowledge, attitudes, and practices responds frequency

Questions on knowledge, attitudes, and practices with regard to rabies	Answers (N = 240)	Frequency (%)
Definition of stray dog		
Domestic dogs	62	14.76
Roaming dog	281	66.90
Pet dog	37	8.81
Guard dogs	29	6.90
Others	11	2.62
Risks of closed dumps to households		
Source of disease	63	15.0
Increase of stray dogs density	147	35.0
Mosquitoes	118	28.1
Source of unhealthy environment	92	21.9
Rabies transmission mode		
Dog bites	420	100
Scratching and licking of rabid dogs	135	32.1
Scratching cats	89	21.2
Licking of cow	63	15.00
Others	12	2.86
Perception of human symptoms		
Diarrhea	28	6.67
Fever	42	10.00
Wound infection	216	51.43
Hydrophobia	25	5.95
No idea	109	25.95
Perception of dogs symptoms		
Irritability	206	49.05
Loss of fur	46	10.95
Skin lesions	113	26.90
No idea	55	13.10
Measures to be taken in case of dog bites		
Disinfect the wound after water washing	235	55.95
Go to the hospital	147	35.00
Did not know what to do	37	8.81
Others	1	0.24
Rabies control measures		
Reduce stray dog population	202	48.10
Vaccination of dogs	67	15.95
Destruction of OGDs	151	35.95
Others	0	0.00

fore recommended control programs for both OGDs and dogs populations. These measures should be implemented by the Cameroonian government, which took the initiative to increase the number of veterinary vaccination centers all over the country. This decision is facing some discrepancies as many dogs in this country, like elsewhere in Africa, had no owner. This situation therefore renders parenteral vaccination inaccessible (38). An integrated rabies control measure coupling dog vaccination, elimination of factors

that contribute to dog free-roaming and proliferation must be implemented. These integrated measures can lead to rabies elimination for the reason that in Cameroon like elsewhere in Central and West Africa, domestic dogs are the only rabies vectors (39). Studies in other countries have shown that children are more frequently bitten (6). Therefore, awareness education should be planned, targeting children who are usually responsible for the transport of garbage to dumps; that is, they are more likely to meet stray dogs scavenging for food around dumps.

Conclusion

This study reveals that OGDs near residential houses and stray dogs increase the risk factor for canine rabies transmission in Biyem-Assi health district. Therefore, if a sustainable effort to maintain sufficient vaccination coverage in the domestic dog populations is a crucial step towards global elimination of canine rabies (32), an integrated control method including environmental cleaning up through the improvement of solid waste management to avoid the proliferation of OGDs is therefore necessary.

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