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Estimation of Dog-bite rates and evaluation of Healthcare Seeking Behaviors following dog bite, Haiti

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1 **Title:** Estimation of Dog-bite rates and evaluation of Healthcare Seeking Behaviors following dog bite,
2 Haiti.

3 **Running head:** Healthcare Seeking Behaviors following dog bite, Haiti

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10

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25 **Abstract**

26 **Background:** Haiti has been identified as one of only several countries in the Western Hemisphere in
27 which canine rabies control efforts have succeeded in eliminating dog-mediated human rabies deaths. In
28 2016, a study was conducted to test several alternative vaccination methods that may compliment the
29 current central point vaccination program. During this study, households within the Croix de Bouquet
30 community completed a questionnaire regarding the dog ownership, roaming status, vaccination
31 coverage of the dog and bite victims and their healthcare seeking behaviors within the household. The
32 aim of this analysis was to determine the incidence of humans being bitten by dogs, and the victims'
33 healthcare seeking behaviors for medical care and post-exposure prophylaxis (PEP) regimen. With the
34 goal of identifying barriers and developing programs to improve timely PEP delivery to persons with
35 likely rabies exposures.

36 **Methods:** During the door-to-door (DD) vaccination campaign in August 2016, the surveyors
37 completed a household questionnaire by interviewing respondents in the Croix de Bouquet community,
38 West Department of Haiti. The questionnaires highlighted questions regarding bite events within the
39 household. Information recorded on the event was the victim age, month of bite, animal ownership, bite
40 location, case definition of a potential rabid case, whether the victim sought medical care after the bite
41 event, and the choice to receive PEP and complete PEP. We were able to determine the incidence rate of
42 humans bitten by dogs in this community. When applicable, 2-tailed Chi-square test or Fisher's exact
43 test were calculated to determine the relationship between variables. We also used Multiple Logistic
44 Modeling to analyze the variance through likelihood ratio and Wald tests of fixed effects in generalized
45 linear models to identify associations between dog ownership, dog vaccination, and human healthcare
46 seeking behaviors.

47 **Results:** Among the total respondent population, there was 111 bite victims within the total household
48 population reported (n = 6993). The annual bite incidence was 3.7% (95% CI 3.2% – 4.2%). A little

49 over half of the victims (52.3%) sought healthcare for the bite wound. However, only 11.7% completed
50 at least three doses of the rabies post-exposure prophylaxis series. Responsible dog owners for poor
51 versus good was: (OR = 3.337) for adequate versus good was: (OR = 1.749) (p= .0032). Households
52 with dogs that died of a rabies-like illness 1 death versus 0 deaths (OR = 2.43), 2 vs 0 deaths (OR =
53 5.441), and 3 vs 0 (OR = 16.662) (p<.0001). Time from respondents home to medical center (OR =
54 1.012) (p=.0043). Household economics status for moderate vs poor (OR= 2.657) and above average vs
55 poor (OR = 1.395) (p=.0068). All of these variables were associated with dog-to-human bites within
56 surveyed households. All of variables were significant after backwards selection within the
57 multivariate model for household bite events.

58 For healthcare seeking behaviors the following variables were modeled: risk surrounding the event, if
59 the victim sought medical care, the number of people living in the household, rabies-like illness related
60 deaths in the household within the past year, time from the hospital, victim's age, if the household
61 experienced more than 1 bite, and the economic status of the household. After backwards selection
62 within the multivariate model for healthcare seeking behaviors, risk category was the only risk factor.
63 The risk score comprised of the ownership of the animal that bit, anatomical location of the bite, and the
64 case definition of a rabid dog, was a factor associated with PEP completion of the bite victim. Low risk
65 versus high risk (OR = 8.750) and medium risk versus high risk (OR = 1.923).

66 **Conclusions:**

67 Responsible dog ownership relates to lower incidence of canine bites within the Haiti community, Croix
68 De Bouquet. A positive association between responsible dog ownership and completion of PEP series
69 was noted, potentially indicating that awareness of dog-health issues improves dog owner's
70 understanding of the importance of rabies PEP. Respondents demonstrating a relatively high response
71 rate to seeking healthcare, may be attributed the current HARSP program and Ministère de l'Agriculture,
72 des Ressources Naturelles et du Développement Rural (MARNDR), in collaboration with the Ministère

73 de la Santé Publique et de la Population (MSPP), Christian Veterinary Mission (CVM) and the United
74 States Centers for Disease Control and Prevention (CDC) that was established in 2011. [2] Time
75 required to reach a hospital was a barrier to seeking healthcare, health officials should consider
76 establishing more community-bite centers to improve bite-victim healthcare seeking. Financial
77 obligations were also implicated as a barrier to not seeking medical care as well as not completing the
78 post-exposure prophylaxis dosage. Healthcare providers should consider providing the vaccination
79 campaign on a routine bases to reach the population that are not able to pay for medical services.

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97 **Background**

98 Rabies is a fatal disease that is preventable through vaccine and curable if treated with post-exposure
99 prophylaxis (PEP) prior to symptom onset. The World Health Organization estimates 59,000 human
100 deaths a year attributed to the complications of Rabies virus infection.[1] In most countries the
101 resources for obtaining dog vaccinations and post-exposure prophylaxis (PEP) is limited. Although, dog
102 vaccinations and treatments have been successful in majority of the western hemisphere, Haiti has been
103 identified as one of only several countries in the Western Hemisphere in which canine rabies control
104 efforts have not been successful in eliminating human rabies deaths (with Dominican Republic,
105 Guatemala, Cuba, and Bolivia); however, they have been successful in reducing rabies burden. The true
106 incidence of human and canine rabies in Haiti is currently not known. From 2010 – 2012 an annual
107 average of four canine rabies cases and seven human rabies cases were reported from Haiti [4, 5]. These
108 cases were identified through convenience reporting, rather than through standardized, laboratory-based
109 surveillance systems. Despite the lack of infrastructure to routinely identify the human rabies deaths in
110 Haiti, these annual case rates represent the highest in the Western Hemisphere [8]. Using mathematical
111 models, Hampson et al. (2015) estimated 130 human rabies deaths may occur each year in Haiti.

112 Using mathematical models, Hampson et al. (2015) estimated 130 human rabies deaths may occur each
113 year in Haiti, although recent efforts to improve dog vaccination and implementation of a national
114 Integrated Bite Case Management program in 2013 may have significantly reduced the human rabies
115 burden over the past several years (ref Undurraga et al 2017 and Etheart et al 2017).

116 Haiti's national vaccination program has historically utilized a central point vaccination clinic
117 methodology, in which several community sensitization events are conducted in the target community
118 during the week before the vaccination campaign. On the day of the campaign vaccinators set up fixed
119 vaccination stations to which community members bring their dogs. Limited door-to-door vaccination

120 occurs if time allows. Vaccination programs typically visit selected communities only once per year and
121 the campaign lasts for one day.

122 A recent study to evaluate the mass vaccination program in Haiti found that free-roaming dogs were
123 vaccinated during the 2015 campaign in urban, semi-urban, and rural communities, respectively. This
124 same study also investigated the ownership and confinement status of dogs in Haiti and found that the
125 majority of Haitian dogs are allowed to roam freely in the community for at least part of their day, and
126 Haitian dogs may be community owned. Community owned dogs typically receive food and other
127 resources from multiple families. Community owned dogs are a significant contributor to enzootic rabies
128 transmission because they spend more time on the streets interacting with other dogs, and because there
129 are typically few people who feel responsibility for the community dogs' veterinary care. Free roaming
130 and community owned dogs are typically harder to reach for rabies vaccination through central point
131 clinics.

132 To improve bite detection and healthcare-seeking behaviors, CDC and PAHO collaborated with
133 MARNDR, DELR, and MSPP to develop an IBCM system to assist in reporting bites to MARNDR for
134 animal investigation.[2] Based on the study of determining the best form of mass vaccination a
135 questionnaire was completed by the cohorts that were in the door-to-door population in Croix des
136 Bouquets. The questionnaire addressed the following: household characteristics, dog population and
137 vaccination coverage, dog bites, and healthcare seeking behaviors following the dog bite. The purpose
138 of this paper is to analyze the healthcare seeking behaviors of those that have been exposed to a potential
139 rabid case through a canine bite in the Croix des Bouquets commune.

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144 **Methods**

145 **Study design and study population**

146 During the 2016 vaccination campaign, questionnaires were completed by the door-to-door (DD)
147 cohorts that were approached. The selection process to complete a questionnaire for every 5th home
148 visited. Surveyors completed a household questionnaire for respondents in the Croix des Bouquet
149 community, West Department of Haiti. The questionnaire consisted of the following: demographic
150 questions household (age and sex of the respondent, and household population number), dogs (dog
151 population size within household, care for dog, vaccination history, and dog death history for the past
152 year), and instances of dog bites (number of incidences of dog bites within the household age of victim).

153 **Household Dog Population/Confinement/Vaccination Coverage**

154 Questions pertaining to the dogs within the household were: number of dogs, age of dogs (puppy, junior,
155 or adult), and vaccinations of the dog being within the past year or within the lifetime. Along with the
156 questions of the current dog population the surveyor asked the respondent if the household experienced
157 any potential rabid related dog deaths within the past 6 months. Rabid related dog deaths consisted of
158 excessive salivation, lethargy, aggressiveness, and dog bites. Each household was also asked their
159 distance and mode of transportation to the nearest medical facility.

160 **Dog Bite Event**

161 To calculate the incidence rate of dog bites in this population, the calculated number that was used to
162 obtain the total household population was captured as the denominator and the total victims as the
163 numerator. Bite events that took place outside of the previous six months were removed from the
164 analysis. The only months covered were from February – August.

165 When performing the statistical analysis the variable ‘Whose animal’ listed the options as follows: “My
166 Dog” and combining “Unknown” with “Neighbor’s Dog”, creating 2 options: “My Dog” and
167 “Neighbor’s Dog”.

168 A rabies-like illness (RLI) score was defined using the symptoms of the household dog deaths:
169 excessive salivation, behavior change, difficulty walking, and bark change. One point was assigned for
170 each symptom displayed. It was then totaled into an RLI score for each dog death within a household.
171 Although a question of if the dog was biting prior to death was asked, it was not included when
172 computing the RLI score.

173 If a dog displayed 2 or more symptoms of rabies like illness, then that dog received an RLI score of 1.
174 Then a total was captured for all of the dogs within that household that displayed more than 1 symptom
175 of RLI.

176 If the household displayed at least 1 dog with more than 2 symptoms of RLI, then that household
177 received a RD (rabies-like illness death) total of 1. If the household displayed at least 2 dogs with more
178 than 2 symptoms of RLI, then that household received a RD (rabies-like illness death) total of 2. If the
179 household displayed at least 3 or 4 dogs with more than 2 symptoms of RLI, then that household
180 received a RD (rabies-like illness death) total of 3.

181 If the household received multiple dog deaths with multiple symptoms, they received a greater RLI
182 score household total. If the household RLI score was greater than 2, then the that household was
183 considered to have been most likely exposed to rabies.

184 The questions regarding bite events within the household were as follows: number of victims within the
185 household, the victim age, month of bite, animal ownership, anatomic location that the victim received
186 the bite, the rabies status of the offending dog, whether the victim sought medical care after the bite
187 event, and the choice to receive PEP and complete PEP. The case definition was defined as: if the dog
188 died within 10 days this was a probable rabid case, if the victim was unsure of dog death this was a
189 suspect rabid case, if the dog did not die within 10 days then it was not a rabies case. Household rabid
190 dog risk score consisted of the same variables of the rabid dog risk; however it also includes the dogs
191 that have died within the last year.

192 **Healthcare Seeking Behavior**

193 The healthcare seeking behavior questions surrounding the dog bite were: did the victim seek healthcare
194 after bite, did the victim choose to receive the post exposure prophylaxis, the number of doses the victim
195 completed, if not vaccinated (why/why not), if the doses were not completed (why/why not).

196 Risk category was defined using the following variables surround the household bite incident:
197 ownership of the animal that bit, anatomical location of the bite, and the case definition of a rabid dog.
198 For ownership of the animal that bit, there were 3 categories: ‘ My dog’, ‘Neighbor’s dog’, and ‘Stray
199 dog’. Each answer was assigned a separate score of 4, 2, and 0 (respectively). The anatomical location
200 of the bite was categorized as: ‘Head/Neck’, ‘Upper Limb’, and ‘Lower Body’. Akin to the
201 aforementioned category, it too received a separate score of 4, 2, and 0 respectively. The final variable
202 of the case definition was categorized as: ‘Probable’, ‘Suspect’, and ‘Not a Case’. The scores assigned
203 were 4, 2, and 0 respectively.

204 For a risk score less than or equal to 2, meaning that only one moderate level characteristic was assigned
205 during the scoring process, then the associated risk of the incident was categorized as low risk. If the
206 risk score was less than or equal to 6, then the risk category associated with this event was considered to
207 be a moderate risk. When the risk score was greater than 6, then the associated risk for this event was
208 considered to be a high risk.

209 The risk score was similar to the risk category score with inclusion of the household rabid related dog
210 deaths within the previous 6 months. A normal distribution was reflected when performing a univariate
211 procedure in SAS.

212 A responsible dog ownership score (RDOS) was developed to identify the dog owners that provided
213 care and obtained vaccinations for a dog in their household or that freely roam. The household received
214 points for confinement status of dog (dogs roam sometimes or always home), vaccination status (some
215 dogs vaccinated or all dogs vaccinated), and providing care (water, lodging, veterinary care, and food)

216 An economics score was also developed using the following variables: dog ownership, dog vaccination,
217 and mode of transportation. The respondent received a point for each item that they affirmed. Time
218 from the respondents home to the medical center was also a factor when considering the bite event as
219 well as the healthcare seeking behavior. Time was used as a continuous variable.

220

221 **Statistical Analysis**

222 A univariate and multivariate analysis was performed using the statistical analysis software (SAS). To
223 perform more in depth logistic regression analysis, the following variables were created: risk score,
224 economic score, responsible dog ownership score.

225 The doses were dichotomized into 2 categories: complete or incomplete. A victim that received 0 – 2
226 doses was considered incomplete. If the victim received 3 or more doses, they were considered
227 complete. Bite location was classified as lower body, upper body, and head/neck. Note: There was one
228 reported bite to the head/neck.

229 Descriptive and 2-tailed Chi-square test or Fisher's exact test were calculated to determine the
230 relationship between variables using SAS. We also used Multiple Logistic Modeling to analyze the
231 variance through likelihood ratio and Wald tests of fixed effects in generalized linear models to identify
232 associations between dog ownership, dog vaccination, and human healthcare seeking behaviors.

233 Among household bite victims, we conducted logistic regression analyses to identify possible risk
234 factors for being bitten. We constructed contingency tables between explanatory variables and the
235 outcome, calculated crude odds ratios (OR) and the corresponding 95% confidence intervals and p-
236 values. The variables that had a significant crude association with the outcome (p -value $< .10$) were
237 selected for multivariable logistic regression modeling, using a forward stepwise selection approach.
238 Variables with p -values < 0.05 (based on the likelihood-ratio chi-squared test) in the multivariable
239 model were considered to be associated with household bites.

240 **Results**

241

242 *Respondent/Participant demographics*

243 There were 1,083 households approached for this survey. Table 1 shows the demographic characteristics
244 of 997 (92%) respondents who consented to participate in the survey. One hundred and two (10%)
245 respondents did not provide the number of persons residing in the household; for these surveys the
246 average household size was imputed and applied (6 members per household). For the purposes of this
247 study, the total household study population was determined to be 6,993 people. The largest population
248 that completed the survey were ages 16 – 30 years (29.7%), followed by ages 31-45 years (28.5%).
249 Females accounted for majority of the respondents (56.1%). There were households that reported
250 owning a dog 926 (86%), however they did not consider themselves the dog’s guardian. Only 811
251 households considered themselves the dog guardian. This could explain any discrepancy in the
252 vaccination status of the dogs.

Table 1: Demographics of Respondents to the Door to Door Household questionnaire

	All Households N=1083 (%)*
Household Surveys Completed	997 (92.1%)
Age (years)	
- >-15 years	34 (1.7)
- 16-30 years	585 (29.7)
- 31-45 years	562 (28.5)
- 46-60 years	369 (18.7)
- > 60 years	159 (8.1)
NOT REPORTED	260 (13.2)
Gender	
Male	424 (42.5)
Female	559 (56.1)
NOT REPORTED	14 (1.4)
Dog Guardian*	811

Dog-owning households	
Yes	926 (85.5)
No	98 (.9)
Total human pop represented	6993
Avg People per Household	7.0
Dogs per Dog Owning Household	2.1
People per dog	3.5

253

254 **Dog Guardian= No explicit definition was outline when answering this question. The respondent was able to identify as*
 255 *a dog guardian and/or providing care for the dog.*

256

257

258 **Household Dog Population Demographics**

259 There were a total of 1,972 owned dogs claimed by survey respondents. A majority of the dogs were
 260 adult and male (60.7%, 52.9% respectively). The majority of owned dogs were allowed to roam freely
 261 all (20.6%) or part-time (38.4%). Respondents reported that 41% of owned dogs were always under
 262 owner confinement.

263

Table 2: Demographics of Household Dogs

<i>Household Surveys Completed</i>	<i>Total Owned-Dog Population of All Households</i> N=1969 (%)* 998 (92%)
Age(stage)	1969 owned dogs
Adult	1196 (60.7)
Junior	399 (20.3)
Puppy	342 (17.4)
Sex	
Male	1042 (52.9)
Female	857 (43.5)
Not Reported	70 (3.6)
Dog-confinement status	
Always home	807 (41)
Home and roam	756 (38.4)
Always roam	406 (20.6)
Dogs vaccination status at the time of survey	
Vaccinated in Lifetime	571 (28.99)
Vaccinated w/i One year	532 (28.59)

Household RLI Related Dog Deaths

No dog deaths consistent with RLI	87
1 RLI dog death	52 (5.2)
2 RLI dog deaths	16 (1.6)
>2 RLI dog deaths	6 (0.6)

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266 Bite Victim Demographics

267 Of the total respondents, 107 (10.7%) respondents recorded information on bite events within their
268 household. There were a total of 111 victims that were bitten by a dog. The incidence rate for bite
269 victims within the preceding 6 months was 1.9%, and the annual incidence rate was 3.7% (95% CI 3.2%
270 – 4.2%). Of the victims reported, the highest proportion occurred in the age group of minors <15 years
271 of age, followed by the age group of 16 to 30 years (38% and 33%, respectively). In the 111 cases of
272 bite victims the source of potential exposure, respondents indicated the animal was classified as my dog
273 (36.7%), neighbor’s dog (49.5%), or unknown/free-roaming (13.5%). Sites of bite exposure were the
274 head/neck (0.90%), upper limb (11.71%), and lower limb (87.39%). The case definition is defining the
275 rabid animal as probable (20.7%), suspect (9.9%), or not a case (69.4%).

276 Healthcare Seeking Behavior

277 Out of the 111 victims of canine bites, 57 (52.3%) of them sought healthcare. When determining if the
278 victim chose to receive medical care, time had a significant association. On average it will take 24
279 minutes for the victims to reach the medical facility according to the respondents
280 PEP was obtained by 44.9% of bite victims. Age of the victim was a significant variable in initiating
281 PEP. The age group that showed significance was the age group 16 – 30 years. The variable of the
282 ownership of the animal that bit the victim reflected was significant for a stray animal for victims that
283 initiated PEP (p=0.042). Neighbor’s dog was significant factor for those that completed PEP
284 (p=0.4279). Rabid case definition for probable (p=0.0001) and suspect (p=0.0276) were significantly

285 associated to initiating PEP. A probable rabid case was significant in PEP completion (p=0.5249). Due
 286 to the association between the case definition and PEP completion, knowledge of rabies is an influencer
 287 to the community of Croix de Bouquet on obtaining healthcare as well as completing PEP. Time from
 288 the medical center was a significant variable for all 3 outcomes of seeking medical care, initiating PEP,
 289 and PEP completion.
 290

Table 2: Characteristics of Bite Victims and their Healthcare Seeking Behavior

Demographics	Population						
	All Victims N=111 (%)	Medical Care N=57 (52.29%)	P- value	PEP Initiated N=48 (44.86%)	P- value	PEP Complete N= 13 (11.71%)	P-value
Age of Victim							
≤15 years	44 (40.4)	24 (54.55)	ref	18 (43.9)	ref	9 (20.5)	ref
16-30 years	33 (30.3)	14 (42.4)	0.411	11 (34.38)	>0.999	5 (15.2)	>0.999
31-45 years	13 (11.7)	6 (50.00)	0.827	6 (46.15)	0.453	2 (15.4)	0.8202
46-60 years	14 (12.61)	8 (61.54)	>0.999	8 (57.14)	0.222	2 (14.3)	0.4513
≥ 61 years	7 (6.31)	5 (71.43)	0.681	5 (71.43)	0.5667	3 (42.9)	>0.999
Whose Animal							
My Dog	40 (36.70)	23 (57.50)	ref	21 (52.50)	ref	13 (31.7)	ref
Neighbor's Dog	54 (49.54)	25 (46.30)	0.387	22 (42.31)	>0.999	6 (10.9)	0.02769
Stray	15 (13.51)	9 (60.0)	>0.999	5 (33.33)	0.042	2 (13.3)	0.4279
Location Of Bite							
Head/Neck	1 (0.9)	0	0.949	0	>0.999	0	0.8864
Upper Limb	12 (11.01)	6 (50.0)	>0.999	5 (38.5)	>0.999	2 (15.4)	>0.999
Lower Limb	96 (88.1)	51(53.13)	ref	43 (46.2)	ref	19 (19.6)	ref
Case Defintion: Rabid Animal							
Probable	23 (21.1)	12 (52.17)	0.928	12 (52.17)	0.0001	8 (7.21)	0.05249
Suspect	11 (10.1)	4 (36.36)	0.469	5 (45.45)	0.0276	3 (27.3)	0.4779
Not a case	77 (68.8)	41 (54.67)	ref	31 (40.26)	ref	10 (12.9)	ref
Time *							
	n = 111	μ (sd)		μ (sd)		μ (sd)	
		24 (26.1)	<.0001	23.5 (23.9)	0.021	26.9 (28.5)	0.0003

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296 **Risk factors for dog bites and medical care**

297 An univariate analysis, responsible dog ownership, economic score, deaths associated with rabies-like
 298 illness, and risk category of the bite incident was conducted. There was a positive trend for all of the
 299 characteristics.

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Table 3: Characteristics of Bite Victims (univariate analysis)

Demographics	Population
	All Victims
	N=111 (%)
Responsible Dog Ownership	
Poor	40 (36.0)
Adequate	49 (44.1)
Good	16 (14.4)
No Dog	6 (5.4)
Economic Score	
Poor	72 (64.9)
Moderate	29 (26.1)
Above Average	10 (9.0)
Rabies Like Illness Score	
<i>269 dog deaths total</i>	
No dog deaths consistent with RLI	87
1 RLI dog death	52 (5.2)
2 RLI dog deaths	16 (1.6)
>2 RLI dog deaths	6 (0.6)
total RLI dog deaths	161
Risk of being bitten by a rabid animal (Risk Category)	
High Risk	13 (11.71)
Moderate Risk	53 (47.75)
Low Risk	45 (40.54)

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308 Poor responsible dog owners were 3-times more likely to report a household member bitten by a dog
 309 compared to responsible dog owners. Bite victims that were closer to medical center were more likely to
 310 be bitten by a dog (OR= 1.02 95% CI [1.004-1.02]). Households that experienced more dog deaths that
 311 was consistent with RLI posed a greater risk of being bitten by a dog (OR = 16.662 [2.759 - 100.607]).
 312 Economic Score reflects that households with a moderate income were more likely to experience a dog
 313 bite.

314

Table 3: Risk factors for Household Dog Bites (multivariate analysis)		
	Odds Ratio [95%CI]	p-value
Time from medical center	1.012 [1.004 - 1.02]	Time_N p=.0043
Responsible Dog Ownership		
Poor vs Good	3.337 [1.289 – 8.635]	GO_Score p=.0332
Adequate vs Good	1.749 [0.794 – 3.853]	
No Dog vs Good	1.528 [0.452 – 5.168]	
Household Rabid Dog Deaths		
RD_TOTAL 1 vs 0	2.43 [1.172 - 5.04]	RD_Total p<.0001
RD_TOTAL 2 vs 0	5.441 [1.804 - 16.405]	
RD_TOTAL 3 vs 0	16.662 [2.759 - 100.607]	

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316 ***Variables included in model**

- 317 • Time from the hospital
- 318 • Responsible dog ownership
- 319 • Deaths associated with rabies-like illness

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321 A logistic regression model for PEP completion was developed using the following variables: risk
 322 surrounding the event, if the victim sought medical care, the number of people living in the household,
 323 rabies-like illness related deaths in the household within the past year, time from the hospital, victim’s
 324 age, and if the household experienced more than 1 bite. The significant risk factor that leads to
 325 completion to PEP completion is the risk category. Victims that had a high incidence of rabid dog

326 deaths and a high risk score which consisted of bite location, potential rabid case, and ownership of the
 327 dog.

Table 4: Risk factors for PEP Completion (multivariate analysis)

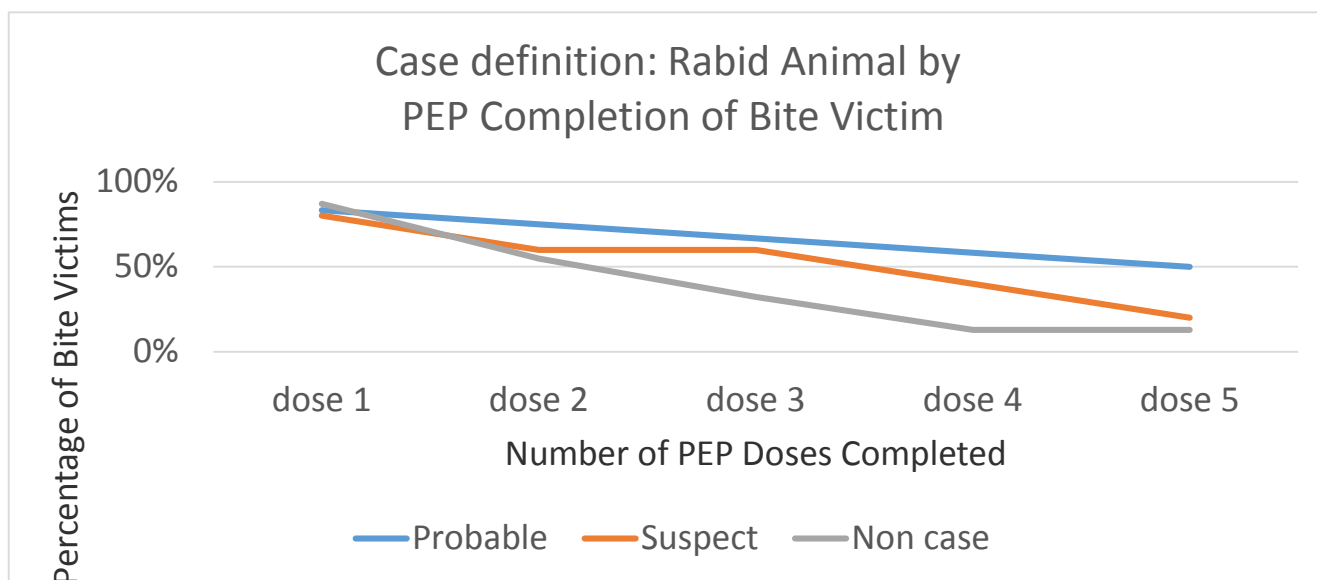
	Odds Ratio [95%CI]	p-value
Risk Category		
Low vs High	8.750 [1.734 – 44.160]	Risk_cat p=.0244
Medium vs High	1.923 [0.534 – 6.921]	

328

329 ***Variables included in model**

- 330 • Risk surrounding the event
- 331 • If the victim sought medical care
- 332 • The number of people living in the household
- 333 • Rabies-like illness related deaths in the household within the past year
- 334 • Time from the hospital
- 335 • Victim’s age
- 336 • If the household experienced more than 1 bite event

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Reasons for not receiving PEP	
Not Serious	12 (35.3)
Negligence	4 (11.8)
Money	2 (5.8)
Unknown	16 (47.1)
Total that did not receive PEP	34

- 344 • **Among those stating the bite was not serious, 16.7% (2) were categorized by study authors**
345 **as Low risk, 83.3%(10) as Medium risk, and 0 as High risk.**

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365 **Discussion**

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368 This study re-affirmed prior studies showing low levels of rabies vaccination among Haitian dogs, high
369 proportions of free-roaming dogs, and a relatively high rate of dog bites among community members; all
370 factors that compound the risk for dog-dog and dog-human rabies transmission. Bite rates were not
371 homogenous among all study respondents; households reporting more factors associated with
372 responsible dog ownership had a significantly lower risk of experiencing a dog bite. Among bite
373 victims, completion of the vaccination series was relatively poor, but respondents with higher risk bites
374 had a three-fold higher rate of PEP completion compared to persons with low-risk exposures. This study
375 is the first to show the positive associations between responsible dog ownership and bite prevention and
376 also provides insight into rationale behind bite victim healthcare seeking behaviors.

377

378 *Barriers to Dog Vaccination*

379 Respondents reported that the majority (greater than 50%) of the dog population were allowed to freely
380 roam in the community. Furthermore, vaccination coverage among dogs in this study was low (only
381 28.9%). These factors compound the risk for rabies transmission in the dog population. The main barrier
382 to dog vaccination reported by study participants was the dog owners felt their dog was too young to be
383 vaccinated. World Health Organization has recommended that dog owners vaccinate their dogs
384 regardless of dog age. Prior studies have reported higher vaccination coverages in Haiti, particularly the
385 study by Schildecker et al., in which reported coverages exceeding 80%.[3] However, the Schildecker
386 study only queried participants attending the vaccination campaign. Our study was conducted among
387 community members, at random, and is a more accurate reflection of the true dog vaccination coverage.
388 A 2015 investigation yielded results of 51.2% vaccination coverage from a mass vaccination campaign.
389 [9] Therefore, Haitian national rabies program should consider developing a study that will focus on the
390 education of dog vaccination schedule.

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392

393 *Risk Factors associated with dog bites*

394 The incidence rate for bite victims within the preceding 6 months was 1.9%, and the annual incidence
395 rate was 3.7% (95% CI 3.2% – 4.2%). In comparison to the Tran study, in 2015 study Haitian owners
396 had a bite rate of 4.3% per household. The reporting methods could also be providing a more accurate
397 number to the bite events because the recall bias for this study is more accurate due to the 6 month time
398 frame requested by the interviewer. According to the Fenelon study in Pétionville, Haiti, 2013 the bite
399 rate recorded was only 0.9%.[2] This increase in bite rates could be attributed to increase in surveillance
400 systems established in Haiti because Pétionville is considered an affluent city in Haiti and people are
401 able to afford to care for the dog population. Fenelon study was in affluent area of port au prince. Croix
402 De Bouquette is a semi-rural community, more densely populated, higher density of dogs.

403 Biting dogs in this study were more likely to be classified as higher risk (probable rabies case status)
404 compared to prior publications (20.7% vs 4.6%). [8] In our study dogs were assigned a rabies case status
405 based on reported characteristics from the bite victim or head of household. In prior studies this case
406 status was assigned by a veterinary professional who conducted an in-person assessment of the dog.
407 Therefore, this study is likely over-estimating the risk of rabies in these biting dogs, and reflects the
408 importance of a rabies risk assessment conducted by trained veterinary professionals.

409 Several factors were identified that led to decreased risk of dogs bites among the study participants and
410 household members. Particularly, households that provided more responsible care dog to their dogs and
411 households that lived closer to healthcare facilities had significantly lower odds or experiencing a dog
412 bite. This may be attributed to the fact that generally medical facilities are located in urban areas, and
413 prior studies have shown that bite rates are higher in rural Haitian communities (Schildecker). The
414 finding that responsible dog owners were less likely to experience a dog bite (either their own dog or a

415 community dog), is an exciting finding and provides support for the inclusion of animal welfare and
416 responsible dog ownership training as critical components of a comprehensive rabies control program.
417 Furthermore, responsibly owned dogs are more likely to have a history of rabies vaccination, providing
418 further benefits to curbing rabies spread in endemic countries like Haiti.

419

420 Factors related to PEP Adherence

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422 Less than 53% bite victims sought medical care for the bite and even fewer initiated PEP. In comparison
423 with the Fenelon study only 37% sought medical treatment.[2] Therefore, this constitutes as an increase
424 in awareness of the importance of medical care post dog bite. Common barriers to initiating PEP
425 included trivializing the exposure and negligence. However, we found that 16.7% were Low risk and
426 83.3% as Medium risk of trivialized bites were actually from low risk animals. This could potentially
427 reflect that the Haitian population are able to accurately perform a self-risk assessment before
428 proceeding with PEP. Of the victims that chose not to complete PEP (56.7%), the most common
429 response for the reason was unknown because the respondents were answering the questions for the
430 victim. If the respondent did know, the second most common response was because it was not serious.
431 This should be reviewed closer in future studies to investigate the reasons behind not receiving PEP.

432 There were no significant associations between the variables collected in this study the participants'
433 rates of seeking medical care post-bite and initiating PEP. This may be a factor of the active rabies
434 surveillance program which has been operational in this community since 2013. This could potentially
435 mean that the Haiti Animal Rabies Surveillance Program (HARSP) could be the attributing factor to the
436 awareness of the Haiti population. [8] Under the tutelage of this program, all participants are counseled
437 and informed to obtain medical care regardless of the circumstances regarding the bite event. [8]
438 Therefore, regardless of degree of exposure, clinical signs in the animal, age, gender, economic status,

439 all persons with dog bites are encouraged to seek medical care, which would limit our ability to detect
440 any such associations.

441 While there were no associations with seeking care, there was one significant association with
442 completing vaccination: rabies risk in the biting dog. Bite victims with exposure to a dog with high-risk
443 factors for rabies (i.e. multiple bites, symptoms of rabies, etc.) were more likely to complete the
444 vaccination series. In studies that have reported adherence in countries with endemic rabies, it has been
445 poor, with rates as low as 28% in Tanzania, 40% in Nepal, and 48% in the Ivory Coast, and only
446 reaching 60% in Bhutan PEP completion being largely attributed to the perceived risk of the bite event
447 is a good sign that shows that perhaps the Haitian community is aware of rabies like symptoms and the
448 importance of seeking healthcare and PEP completion. [10] It may also be a factor of the HARSP, which
449 counsels people on the risks for rabies and encourages completion of the series when rabies is possible
450 and discontinuing the series when rabies is ruled out through testing or quarantine [8].

451 The limitations of this study were that of the specific questions pertaining to rabies knowledge and
452 poverty, two factors known to be associated with rabies outcomes, were not captured in this survey.
453 Therefore, in future studies questions should implicate the economic status of the household. Time from
454 hospital also posed a barrier in determining the risk factor. The distance in miles/kilometers was not a
455 consistent question answered by the respondents; therefore the only unit that could be used was time
456 from medical center.

457 Overall the findings from this study, reflect a novel idea that responsible dog ownership will lower the
458 incidence of bites within the Haitian community and improve dog vaccination coverage. More efforts
459 could be made to promote responsible dog ownership among this community. The current surveillance
460 programs that are established in Haiti appear to have a positive impact on raising the awareness of rabies
461 and seeking medical care after being bitten. However, there is room for improvement in closing the gap
462 of attending the medical facility and initiating PEP.

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579 **DD/ORV: Owner survey (complete)**

Interviewer: _____

580 ** To be completed every 5th house - if two houses are empty, restart your count

581

582 1. What is your age? _____ 2. What is your gender? _____

583
584 3. How many people live with you, in your household? _____

585
586 4. How many people live with you, in your household? _____

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588 5. Are you the primary care taker for your dogs?

- 589 a. Yes
590 b. No
591 c. Unknown

592
593 6. How many dogs are you getting vaccinated today? _____

594
595 7. How many dogs belong to your household? _____

596
597 8. What level of care do you provide for your dog(s)? (Mark all that apply.)

- 598 a. None e. Veterinary Care
599 b. Food f. Other: (free response)
600 c. Water g. Declined to answer
601 d. Shelter

602
603 9. Dog Information and vaccination status:

Dog	Age	Sex	Confinment Status: - Always on property - Roaming, sometimes -Roaming, always	# Vaccines during its lifetime	Was the dog vaccinated in the past year?	If not ever vaccinated, why? - Dog is too young - No money to buy vaccine - No vaccine available from veterinarian - No vaccine available from government - No need to vaccinate - Other (free response) - Declined to answer
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10. Have you had any dogs that died **in the past year**? If so, what was the cause of death?

Hit By Car	Poisoned	Disease/Illness	Age Related	I don't know	Declined to answer	Other (free response)

614

615 11. **In the past year**, have you ever owned a dog that **died** after displaying **at least two** of the following symptoms?
616 (*Hypersalivation, Aggressive, Biting people or animals, difficulty walking, change in voice*)

Dog	Month of Death	Hypersalivation	Aggression	Biting (people or animals)	Difficulty Walking	Change in Bark	Cause of Death (killed, natural)
1							
2							
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619 12. Please list any new dogs acquired in the past year, and how you acquired them

620

Dog	Dog gave birth (list number of puppies)	Got the dog from my community	Got the dog from outside of the community	Declined to answer	Other (free response)
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622 13. Do you provide care for any dogs that you do **NOT** own? (*Mark all that apply.*)

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- a. None
- b. Food
- c. Water
- d. Shelter
- e. Veterinary Care
- f. Other: (free response) _____
- g. Declined to answer

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635

636 14. In the past year, have you or anyone in your household been bitten by a dog? Mark all that apply.

Victim Age	Month of bite	Dog was: - Mine - Neighbors - Unknown	Did the dog die within 10 days of biting?	Was medical care sought?	Did you/they get a rabies vaccine?	If not vaccinated, why?	If yes, how many doses were given?	If not all doses given, why?	Is this person still alive?
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3									
4									
5									
6									
7									

637

638 15. How much do you know about a disease called rabies? Note: interviewer must evaluate.

- 639 a. I have never heard of rabies
640 b. Little knowledge (i.e., have heard of rabies/dog disease, but can't identify transmission routes or severity
641 of disease)
642 c. Basic understanding (knowledge that rabies is both a highly fatal disease and is transmitted by dog bite)
643 d. Extensive knowledge (basic understanding plus knowledge of non-bite routes of exposure AND wildlife
644 reservoirs besides dogs without prompting)
645 e. Declined to answer

646

647 16. How severe is the disease called rabies?

- 648 a. Mild
649 b. Somewhat severe
650 c. Very severe, but possible to recover
651 d. Very severe, resulting in death
652 e. I don't know
653 f. Declined to answer

654

655 17. How do humans get rabies from an infected animal? (Mark all that apply.)

- 656 a. Bite
657 b. Scratch
658 c. Observing the animal
659 d. Touching the animal
660 e. Contact with blood
661 f. Contact with saliva
662 g. Contact with urine/feces
663 h. Other: (free response)
664 i. I don't know
665 j. Declined to answer

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18. What animals can be infected with rabies? (*Mark all that apply.*)

- a. Dogs
- b. Cats
- c. Livestock (Cattle, sheep, goats, etc.)
- d. Poultry (Chickens, ducks, geese, etc.)
- e. Horses
- f. Mongoose
- g. Fox
- h. Wild Birds
- i. Bats
- j. Rodents
- k. Other: (free response)
- l. I don't know
- m. Declined to answer

19. If you thought that you had an exposure to an animal with rabies, what would you do?

- a. Nothing
- b. Wash wound
- c. Consult with a traditional healer
- d. Call a medical doctor
- e. Call a veterinarian
- f. Actively seek medical treatment at a pharmacy, hospital, clinic or outpost
- g. Receive rabies post-exposure prophylaxis
- h. Isolate the animal for observation
- i. Submit animal for disease testing
- j. Kill the animal
- k. Kill and eat the animal
- l. Other: (Free response)_____
- m. Declined to answer

20. Where do you normally go to receive medical treatment? (*Mark all that apply.*)

- a. Veterinary clinic
- b. Pharmacy
- c. Medical Clinic
- d. Hospital
- e. Traditional Healer
- f. Other: (free response)
- g. Declined to answer

21. How far do you need to travel to receive medical care at this location? (*Indicate frequency if multiple locations were identified.*)

- a. <1km
- b. 1-5km
- c. 6-10km
- d. 11-20km
- e. 21-30km
- f. >30km
- g. I don't know
- h. Declined to answer

22. What are the primary obstacles for getting medical treatment in your community? (*Mark all that apply.*)

- a. Lack of facilities to provide treatment
- b. Lack of trained personnel at facilities to provide treatment
- c. Lack of medicines at facilities for treatment

- 714 d. No means of transportation
- 715 e. No money to pay for treatment
- 716 f. Can't miss work
- 717 g. Other: (free text)
- 718 h. I don't know
- 719 i. Declined to answer
- 720