Investigation of free-roaming dog contact networks to improve canine infectious disease control programs

Charlotte Warembourg[1], Guillaume Fournié[2], Monica Berger-González[3,4], Danilo Alvarez[3], Filipe Maximiano Sousa[1], Ewaldus Wera[5], Terence Odoch[6], Grace Alobo[6], Sonja Hartnack[7], Salome Dürr[1]

[1]Veterinary Public Health Institute, Vetsuisse Faculty, University of Bern, Switzerland, [2]Royal Veterinary College,University of London, UK, [3]Universidad del Valle, Guatemala city, Guatemala, [4]Swiss Tropical and Public Health Institute, Basel, Switzerland, [5]Kupang State Agricultural Polytechnic (Politeknik Pertanian Negeri Kupang), Nusa Tenggara Timur, Indonesia, [6]College of Veterinary Medicine, Animal Resources and Biosecurity (CoVAB), Makerere University, Kampala, Uganda, [7]University of Zurich (UZH), Vetsuisse Faculty, Section of Epidemiology, Zurich, Switzerland

INTRODUCTION

Current recommendations to control canine rabies focus on mass vaccination of the **free-roaming domestic dog (FRDD)** population with at least 70% coverage. **Targeting vaccination** on highly connected dogs would improve the efficiency of vaccination programs.

Rabies is transmitted by direct contacts. Therefore, **understanding contact networks** in free roaming dog populations could help identifying dogs likely to play a major role in rabies transmission, and inform targeted vaccination programmes.

Objectives:

1. **Assess the dog behaviour heterongeneity within a contact network**
2. **Identify factors explaining why some dogs are more connected than others**

METHODS

Data collection

- **3 countries:** Guatemala, Indonesia and Uganda
- **Selection of three 1km² study areas in each country:** Urban/Semi-urban, Rural 1 and Rural 2
- Collaring with a **contact sensor** all FRDD whose owner's household is located in the areas

Data analysis

Comparing dogs within each network

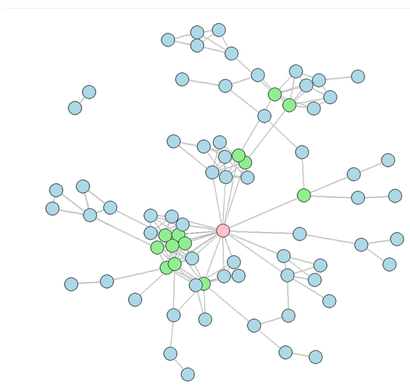
- Degree and betweenness centrality, hierarchical clustering

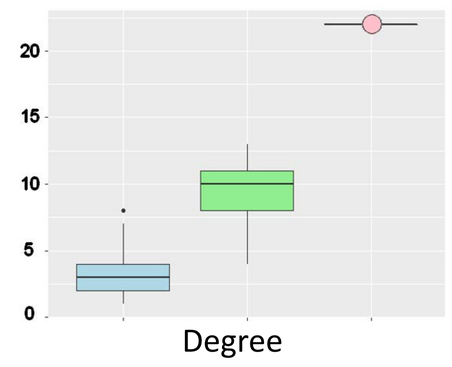
Assessing factors associated with network centrality

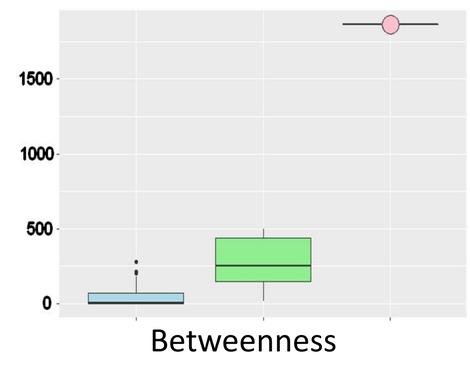
- Permutation-based linear regression model
- Response variable: degree or betweenness (log transformation)
- Factors: dog's sex, age, body conditioning score (BCS), reason for keeping the dog (shepherd, hunting, watch dog, pet or meat production), free-roaming time (FRT), number of dogs collared in the same household (NDC).

RESULTS

1. Comparison of individual dogs in urban/semi-urban network in Indonesia







18% of dogs have much higher centrality measures (pink and green clusters) than other dogs (blue cluster). Distributions of dog centrality measures are right-skewed in most study areas.

2. Investigation of explanatory factors of highly connected dogs

Degree

Country	Study Area	Explanatory factors									
		Sex	Age	BCS	Shepherd	Hunting	Watch dog	Pet	Meat	FRT	NDC
Guatemala	Rural 1										
	Rural 2	**male**		+		-		-			+
	Urban										
Indonesia	Rural 1										+
	Rural 2							+			
	Semi-urban			+				-		+	+
Uganda	Urban		-		-					+	+

blue: significant positive association; brown: significant negative association; white: no significant association; grey: not investigated in the model

Two study areas in Uganda are not presented because of too low numbers of dogs collared.

Betweenness

Country	Study Area	Explanatory factors									
		Sex	Age	BCS	Shepherd	Hunting	Watch dog	Pet	Meat	FRT	NDC
Guatemala	Rural 1										
	Rural 2	**male**									
	Urban										
Indonesia	Rural 1										
	Rural 2								-		
	Semi-urban									+	+
Uganda	Urban										

None of the investigated dog related factors investigated is consistently significantly associated with dogs' degree and betweenness

DISCUSSION

- **Dog's centrality measures** are **heterogeneous** within networks: a small number of dogs mediate most contacts.
- However, none of the tested **factors** explained centrality in all models and therefore **cannot be used to inform canine infectious disease control programs.**
- We will investigate the impact of **owner-related and environmental factors** on dog free-roaming behaviour.

Acknowledgment: The University del Valle, Kupang State Agricultural Polytechnic and the College of Veterinary Medicine, Animal Resources and Biosecurity, Makerere University, all the persons who were involved in the data collection, the dog's owners and our funding partners, the Albert-Heim-Stiftung, Wolfermann-Nägeli-Stiftung and the SpezKo of the Vetsuisse Faculty, Bern University.

Contact: Charlotte Warembourg
Veterinary Public Health Institute, University of Bern
+41 (0)76 217 62 94
charlotte.warembourg@vetsuisse.unibe.ch