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Socio-environmental Features Associated with Plague Risk in Rural Plague Foci in the Central Highlands of Madagascar: Experience of the Ambositra and Tsiroanomandidy Districts

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Introduction

- Human plague cases appear annually in the central highlands, particularly in rural areas.
- The lifestyles of rural populations in the central highlands, including the nature of their habitat (Box 1), could increase the vulnerability of rural societies to plague risk in this area.
- The aim of the study is to determine the socio-environmental characteristics that may be related to plague risk in rural areas in two districts of the central highlands [Fig.1].

Materials and Methods

- **Study sites:** Based on the distribution of reported plague cases between 2006 and 2015 in the municipalities of Ambositra and Tsiroanomandidy. The municipalities were classified according to the presence of human plague cases (case municipality) or absence (control municipality) of human plague cases between the selected period.
- **Data collection:** Based on direct observations and household surveys on socio-demographic and socio-environmental characteristics carried out among households recruited in the selected municipalities.
- **Data analysis:** Univariate and multivariate analyses were performed to identify the influence of socio-environmental characteristics on plague risk.

Results

- For the Ambositra district, 7 municipalities, including 5 case municipalities and 2 control municipalities, were investigated [Fig.2]. For the district of Tsiroanomandidy, 7 communes were investigated, including 6 case municipalities and one control municipality [Fig.3].
- Data were collected from 503 households: 54.9% (276/503) households in Ambositra and 45.1% (227/503) in Tsiroanomandidy [Table.1].
- Univariate analysis showed plague risks, linked to pet owning, cob walls, thatched roofs and no floors in a house are linked with vulnerability to plague risk for a household ($p < 0.05$).
- Multivariate analyses showed that thatched roofs [Adjusted odds ratio (ORa) 1.78 (95% Confidence Interval, 1.23-2.57; $p = 0.002$)] and the absence of a floor [ORa, 2.26, (95% CI, 1.42-3.60; $p = 0.001$)] are associate with vulnerability of a household to plague risk.

Box 1. Habitat types links to vulnerability to human plague risk in rural areas of the Central Highlands

Handschumacher et al (2000) showed significant relationship between the nature of human habitat and positive serology with regard to plague have been observed in rural areas in the central highlands of Madagascar. Housing with the following characteristics present a high risk of plague [picture 1] compared to other type of housing [picture 2]:

- Single storey houses
- Thatched roofs
- Cob walls
- Location on the outskirts of villages



Picture 1



Picture 2

Pictures. Two typical housing of rural areas in the central highlands
(Source: Sitraka Rakotosamimanana)

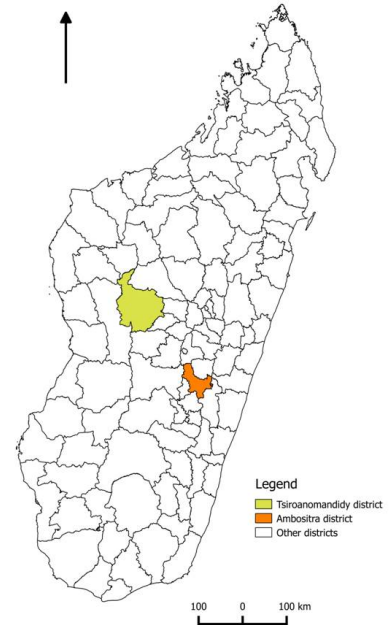


Figure 1. Study sites

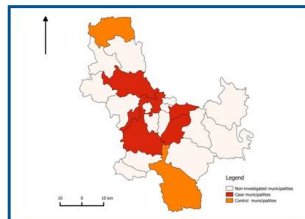


Figure 2. Municipalities investigated in the district of Ambositra

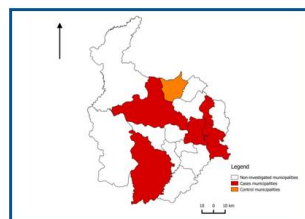


Figure 3. Municipalities investigated in the district of Tsiroanomandidy

Table 1. Overview of the socio-environmental features of the households investigated in the study sites

Socio-environmental features	Modalities	District				Total	
		Ambositra		Tsiroanomandidy		n	%
		n	%	n	%		
Household size (per number)	1 to 3	75	14.9	57	11.3	132	26.2
	4 to 6	140	27.8	104	20.7	244	48.5
	7 to 9	43	8.6	55	10.9	98	19.5
	>10	18	3.6	11	2.2	29	5.8
Farm animal owning	Yes	246	48.9	195	38.8	441	87.7
	no	30	6	32	6.3	62	12.3
Pet owning	Yes	122	24.3	76	15.1	198	39.4
	no	154	30.6	151	30	305	60.6
Types of dwelling walls	Brick	157	31.2	88	17.5	245	48.7
	Cob	112	22.3	133	26.4	245	48.7
	Wood	2	0.4	2	0.4	4	0.8
	Other	5	1	4	0.8	9	1.8
Types of roofs of dwellings	Tile	145	28.8	55	10.9	200	39.7
	Balm	93	18.5	170	33.8	263	52.3
	Sheet metal	29	5.8	2	0.4	31	6.2
	Other	9	1.8	0	0	9	1.8
Two-storey house	Yes	260	51.7	130	25.8	390	77.5
	no	16	3.2	97	19.3	113	22.5

Conclusion

- The variation in the epidemiological expression of human plague in the Ambositra and Tsiroanomandidy districts could be explained by the socio-environmental characteristics of rural humanized areas.
- Socio-environmental characteristics can be indicators of a locality's vulnerability in relation to plague risk exposure.
- In addition to the socio-environmental features associated with plague risk, knowing the links between contextualized human behavior and the occurrence of human plague cases in the central highlands would be an essential element in adapting plague control interventions to the specific contexts of rural societies in this area.

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