Spatial patterns of soil-transmitted helminth types and associated environmental risk factors in Rwanda

Introduction

Background: Soil-transmitted helminth (ascariasis, trichuriasis, and hookworm) are important parasitic diseases in terms of public health in Rwanda. Although most of the time analyzed in combination (Fig. 1a), recent research shows that infection levels and spatial patterns differ between STH types. To date, however, research on STH distribution in Rwanda is solely based on a limited number of school-based prevalence surveys (Fig. 1b) and present the STHs infection in a combined manner.

Objective: This study aims (i) to identify the spatial pattern of incidence cases for each helminth at both medium and fine spatial resolution (ii) to assess the associated environmental risk factors.

Methods

Study area: Rwanda, the Landlocked country is inhabited by about 11 million with more than 450 hab./km2 . The health needs of the population are under the responsibility of district health office, operating autonomously, managing all primary and secondary health facility under his areas. The primary health facility (Fig. 2) is the lowest health service unit. Routine health data of STHs cases are collected at health facility level and reported to the Rwanda-HMIS.

Tools and approaches: Using routinely collected incidence data at health facility level, GIS-based spatial and statistical analysis were applied to detect the spatial autocorrelation (Moran's Index test) and clustering (Anselin Local Moran's I) of single and combined infection. Furthermore, an exploratory empirical regression analysis was done to assess relationships between helminths incidences and potential associated risk factors.

Results

Spatial distribution: In Rwanda combined incidences and single infection of ascariasis and trichuriasis were focalized with a significant spatial autocorrelation (Moran's I > 0: 0, 05 – 0.38 and p ≤ 0,03.) and high and very high incidence rates within some areas. Hookworm incidence was randomly distributed (Moran's I > 0: 0, 006 and p: 0.74) but with very low rates (Fig 3, 4 &5).

Associated factors: The detected spatial distribution of STH's incidences are associated with soil property (sand proportion and pH), rainfall, wetlands and their uses, population density and the proportion of rural residents (Table 1).

Table 1. Beta coefficients of associated factors at different scale.

Factors	Combined		Tr.Trichiura		Ascaris L.		Aknylostome	
	District	HFSA	District	HFSA	District	HFSA	District	HFSA
pH	-	-	0.43**	-	-	-	-	-
Sand prop (%)	-0.38**	-0.41**	-	-	-	-0.43**	-	-
Elevation (m)	-0.53**	-	-	-	-	-	-	-0.29**
Wetland area (ha)	-	-	-	-	-	-	-	-
Wetland proportion (%)	0.39**	0.22**	-	0.46**	-	-	-	-
Wetland cropped -Rice (ha)	-	-	-	0.26*	-	-	-	-
Rainfall	0.43**	0.29**	-	-	-	0.31**	-	-
Number of HH	-	-	-	-	0.37*	-	-	-
Unimproved sanitation	-	-	0.37*	-	-	-	-	-
Rural	-	0.125*	-	-	-	0.12*	-	-
Urban	-	-	-	-0.27*	-	-	-	-

Coefficient presented are significant with: $p < 0.05$ (*) and $p < 0.01$ (**)

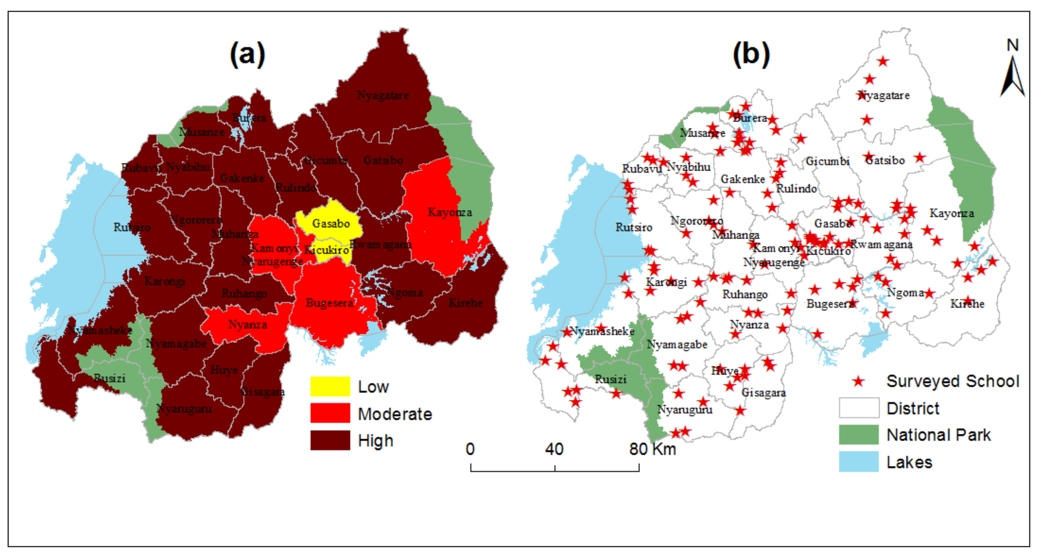

Fig. 1. Distribution of STH at distrcted level. Prevalence map extrapolated at district level (a) Using cross-sectional prevalence survey with primary school children (b).

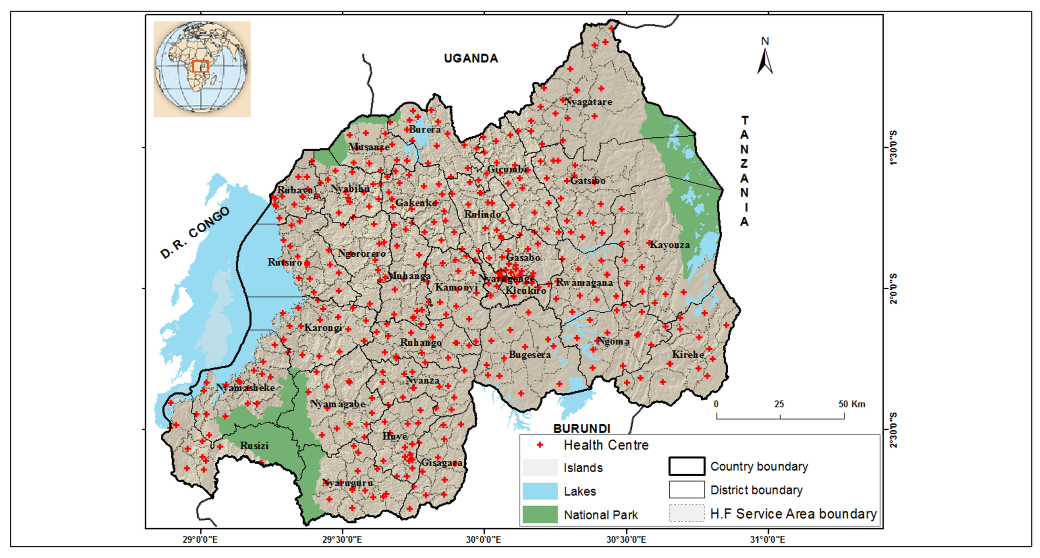

Fig. 2. Study area location, with its administrative district, the location of the health centre and Health Facility Service Areas (HFSA) boundaries.

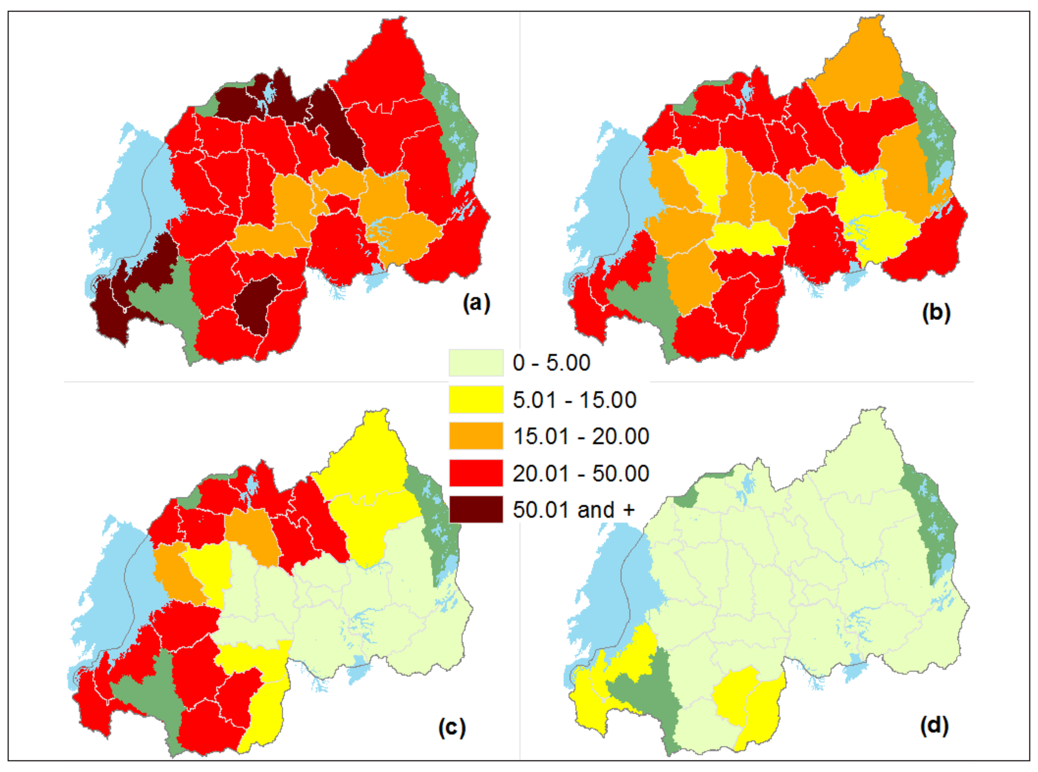

Fig. 3. The averaged incidence rates at district level for infection rates of (a) Combined STHs (b) Trichuriasis (c) Ascariasis and (d) Ancylostomiasis.

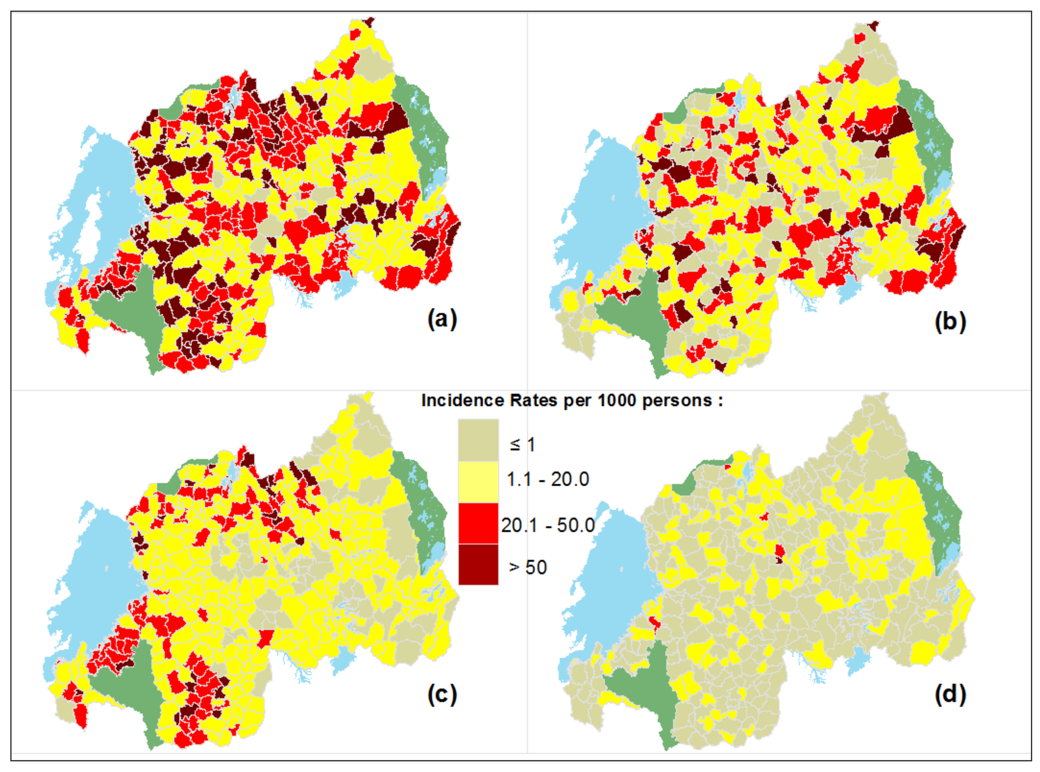

Fig. 4. Incidence rates at HFSA level for (a) Combined STHs (b) Trichuriasis (c) Ascariasis and (d) Ancylostomiasis.

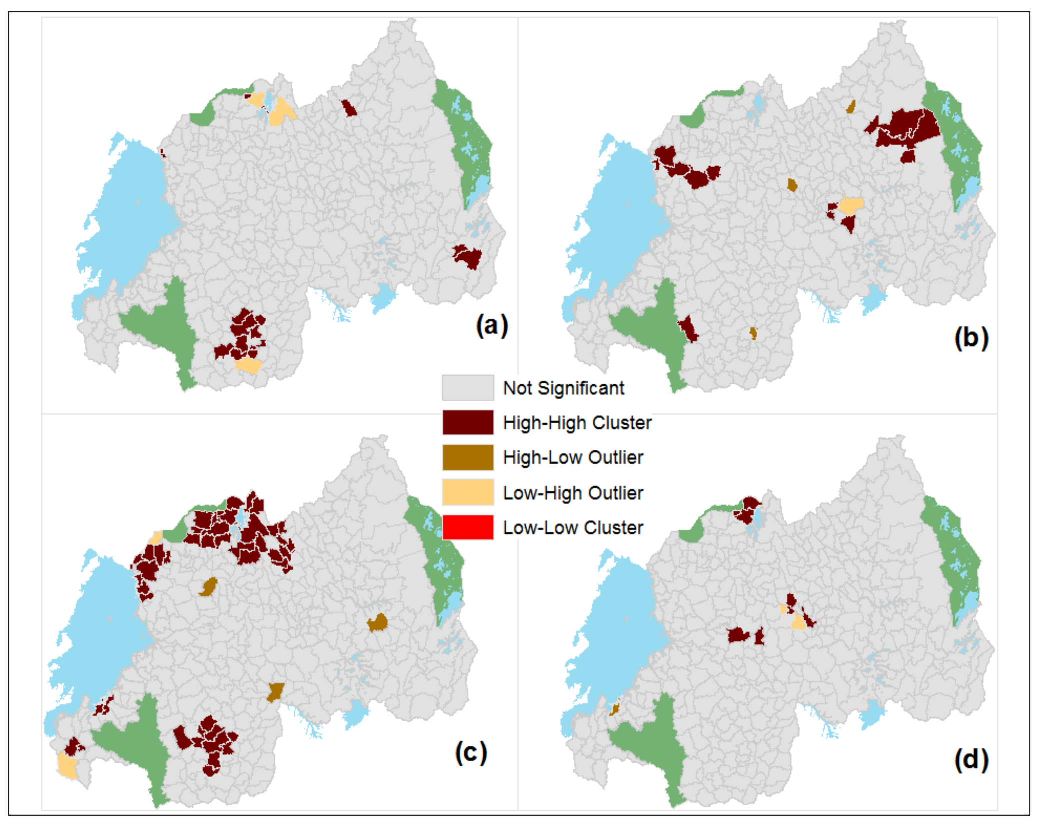

Fig. 5. Spatial distribution of Anselin Local Moran's I values at the HFSA level for (a) Combined infection; (b) Trichuriasis; (c) Ascariasis and (d) Ancylostomiasis.

Conclusion

Routine health data are readily available and the spatial distribution approach of incidence rates can complement the prevalence survey. Thus, the detected spatial pattern and associated risk factors at different spatial scales are important for prevention and control of helminths infection.

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