The impact of human mobility on schistosomiasis in Senegal: An analysis via mobile phone data

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1 - Introduction

Schistosomiasis is a major parasitic infection that affects about 250 million individuals in many areas of the developing world.

We study country-scale patterns of schistosomiasis transmission in Senegal, where the disease represents a major health problem. In particular, we explore the role of human mobility, considered as one of the most relevant mechanism being responsible for the spatial spread of the disease.

Objective

To study the impact of human mobility on schistosomiasis in Senegal at different spatial scales.

2 - Materials and Methods

The analysis is performed by means of a spatially explicit model accounting for both epidemiological processes at the local scale and human mobility over medium-to-large spatial scales.

Georeferenced data on demography, water supply/sanitation and urogenital schistosomiasis prevalence are used for model calibration (Tab. 1).

<table>
<thead>
<tr>
<th>Georeferenced data set</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population distribution</td>
<td>2014 estimates with resolution of 30 arcsec</td>
</tr>
<tr>
<td>Water and sanitation</td>
<td>% of rural population in 2012 at department level</td>
</tr>
<tr>
<td>Schistosomiasis prevalence</td>
<td>1996 national survey and other data sources</td>
</tr>
</tbody>
</table>

Table 1: List of georeferenced data sets used for model calibration.

Mobility-driven exposure and contamination are estimated from low-resolution movement routes of anonymous mobile phone owners (Fig. 2). Specifically, they are assumed to be proportional to the time spent in a given administrative unit, as estimated from Call Detail Records (CDRs).

3 - Results

At the regional scale, model predictions are in good agreement with the available prevalence data (Fig. 3, Pearson’s r = 0.94).

We evaluate the impact of human mobility contrasting the best-fit model with a simulation in which human mobility is not allowed.

The results are different, focusing on different spatial scales:

- at the regional scale, in absence of human mobility schistosomiasis prevalence is generally expected to increase (Fig. 4A);
- at a finer spatial scale, mobility can either increase or decrease schistosomiasis prevalence, with a more pronounced effect in the eastern part of the country (Fig. 4B).

4 - Conclusions

The results show that our model can reproduce regional patterns of schistosomiasis prevalence across the country quite reliably.

Human mobility is found to play a nontrivial role in disease spread, with a protective effect at larger spatial scales.

The impact of mobility is even more complex at finer spatial scale, where it can locally increase disease prevalence.

High-resolution models can help in identifying the focal hotspots of disease transmission.

References


Additional readings

- Wessolowski et al, Scientific Reports 4, 5678 (2014)

Acknowledgements

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