Human population movement and schistosomiasis transmission risk: The case study of Senegal

M. Ciddio1,2, L. Mari1, R. Casagrandi1, S.H. Sokolow2, G. De Leo2, M. Gatto1

1 Politecnico di Milano, Italy; 2 Stanford University, US

manuela.ciddio@polimi.it

Introduction

Spatial coupling mechanisms are very important in the spread, persistence and infection intensity of infectious diseases. Social, environmental and behavioral factors contribute to disease prevalence working simultaneously at different spatial scales, especially in case of diseases characterized by complex transmission mechanisms.

An epidemiological model describing the spatial dynamics of schistosomiasis transmission is used to study the role of human mobility on disease prevalence patterns in the case study of Senegal.

Human mobility is retained as the main mechanism for the spatial spread of the disease at large spatial scale. Susceptible people can become infected while traveling, and import the disease back in their home communities, while infected travelers coming from endemic regions can introduce schistosomiasis into disease-free villages.

Occurrence of snail species involved in schistosomiasis transmission is widespread in Senegal, where the distribution of environmental freshwater makes the habitat suitable for the snails. In addition, 74% of the Senegalese people lives in rural conditions, lacking access to safe water supplies and improved sanitation (Fig. 2).

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.

The LOCAL MODEL

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

Georeferenced data on demography, water supply/sanitation and urogenital schistosomiasis prevalence are used for model calibration. Model predictions are in good agreement with the available data at the regional scale ($R^2 = 0.90$). The average absolute data-model deviation is 3.4%, while the largest difference is found for the region of Kaffrine (7) where the model underestimates prevalence by 8.5%.

Results

At arrondissement spatial scale, mobility can either increase or decrease schistosomiasis prevalence, with a more pronounced effect in the eastern part of the country (Fig. 4A). At the regional and country scales, it is generally expected to offer protection, decreasing prevalence almost everywhere (Fig. 4B,C).

Discussion

Current measures for schistosomiasis control are principally focused on preventive chemotherapy, which however does not confer permanent immunity to humans. Therefore, improving access to safe water (WASH interventions) and spreading awareness about disease transmission (IEC campaigns) represent promising paths towards reducing the burden of schistosomiasis.

Reference

Mari et al. Uncovering the impact of human mobility on schistosomiasis via mobile phone data, D4D-Senegal challenge Scientific Papers (2014)