

Publication

How do disease control measures impact spatial predictions of schistosomiasis and hookworm? The example of predicting school-based prevalence before and after preventive chemotherapy in Ghana

JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

ID 4694334

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Year 2023

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Journal PLoS Negl Trop Dis

Volume 17

Number 6

Pages / Article-Number e0011424

Mesh terms Animals; Ancylostomatoidea; Prevalence; Ghana, epidemiology; Schistosomiasis, prevention & control; Hookworm Infections, prevention & control; Feces; Water

BACKGROUND: Schistosomiasis and soil-transmitted helminth infections are among the neglected tropical diseases (NTDs) affecting primarily marginalized communities in low- and middle-income countries. Surveillance data for NTDs are typically sparse, and hence, geospatial predictive modeling based on remotely sensed (RS) environmental data is widely used to characterize disease transmission and treatment needs. However, as large-scale preventive chemotherapy has become a widespread practice, resulting in reduced prevalence and intensity of infection, the validity and relevance of these models should be re-assessed. **METHODOLOGY:** We employed two nationally representative school-based prevalence surveys of *Schistosoma haematobium* and hookworm infections from Ghana conducted before (2008) and after (2015) the introduction of large-scale preventive chemotherapy. We derived environmental variables from fine-resolution RS data (Landsat 8) and examined a variable distance radius (1-5 km) for aggregating these variables around point-prevalence locations in a non-parametric random forest modeling approach. We used partial dependence and individual conditional expectation plots to improve interpretability. **PRINCIPAL FINDINGS:** The average school-level *S. haematobium* prevalence decreased from 23.8% to 3.6% and that of hookworm from 8.6% to 3.1% between 2008 and 2015. However, hotspots of high-prevalence locations persisted for both diseases. The models with environmental data extracted from a buffer radius of 2-3 km around the school location where prevalence was measured had the best performance. Model performance (according to the R² value) was already low and declined further from approximately 0.4 in 2008 to 0.1 in 2015 for *S. haematobium* and from approximately 0.3 to 0.2 for hookworm. According to the 2008 models, land surface temperature (LST), modified normalized difference water index (MNDWI), elevation, slope, and streams variables were associated with *S. haematobium* prevalence. LST, slope, and improved water coverage were associated with hookworm prevalence. Associations with the environment in 2015 could not be evaluated due to low model performance. **CONCLUSIONS/SIGNIFICANCE:** Our study showed that in the era of preventive chemotherapy, associations between *S. haematobium* and hookworm infections and the environment weakened, and thus predictive power of environmental models declined. In light of these observations, it is timely to develop new cost-effective passive surveillance methods for NTDs as an alternative to costly surveys, and to focus on persisting hotspots of infection with additional interventions to reduce reinfection. We further question the broad application of RS-based modeling for environmental diseases

for which large-scale pharmaceutical interventions are in place.

ISSN/ISBN 1935-2735 (Electronic)1935-2727 (Linking)

URL <https://doi.org/10.1371/journal.pntd.0011424>

edoc-URL <https://edoc.unibas.ch/95261/>

Full Text on edoc Available;

Digital Object Identifier DOI 10.1371/journal.pntd.0011424

PubMed ID <http://www.ncbi.nlm.nih.gov/pubmed/37327211>

ISI-Number MEDLINE:37327211

Document type (ISI) Journal Article