



Exposure, hazard, and vulnerability and their contribution to *Schistosoma haematobium* re-infection in northern Senegal

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Abstract

Background The risk of infectious diseases, including snail-borne schistosomiasis, is determined by three inter-related components: exposure, hazard, and vulnerability. For schistosomiasis, exposure occurs through behaviours involving water contact, but not without the environmental hazard of snails and parasites in the water. Socioeconomic vulnerability makes it difficult to reduce exposure in the presence of hazard, because it increases reliance on hazardous activities and environments. We aimed to quantify the contributions of exposure, hazard, and vulnerability to schistosome re-infection presence and intensity.

Methods We used cross-sectional parasitological data from 821 school-aged children (5–15 years) in 13 villages along the Senegal River, survey data from 411 households where those children resided, and ecological data from all 24 village water contact sites. We fitted mixed-effects logistic and negative binomial regressions with indices of exposure, hazard, and vulnerability as explanatory variables of *Schistosoma haematobium* infection, along with demographic control variables. Multimodel inference was used to determine the relative importance of each component of risk and model averaging was used to quantify associations between infection outcomes and indices of hazard, exposure, and vulnerability.

Findings The most important component of *S haematobium* presence was hazard ($\Sigma wi=0.95$), followed by vulnerability ($\Sigma wi=0.91$), and the most important component of *S haematobium* intensity was exposure ($\Sigma wi=1.00$), followed by hazard ($\Sigma wi=0.76$). Hazard was positively associated with infection presence (odds ratio [OR]=1.49, 95% CI 1.12–1.97), whereas exposure was positively associated with infection intensity.

Interpretation Our findings highlight how social (exposure and vulnerability) and environmental (hazard) processes act together to facilitate the acquisition and accumulation of schistosome infection from the environment across time and space. This approach can inform targeting of social and environmental interventions as complements to mass drug administration.

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Contributors

AJL, SHS, GADL, and DLC were responsible for the conceptualisation. AJL, IJJ, AC, CLW, SA, NJ, AMS, SS, AF, and RN did the data curation. AJL did the formal analysis. SHS, CLW, GR, GADL, and DLC were responsible for the funding acquisition. AJL, IJJ, AC, SA, CLW, SA, ABS, MMS, AF, and RN were responsible for the investigation. AJL, SHS, IJJ, CLW, and DLC were responsible for the methods. NJ, AMS, SS, and GR did the project administration. NJ, AMS, SS, and GR were responsible for the resources. SHS and DLC did the supervision. AJL did the visualisation. AJL wrote the original draft. AJL, SHS, IJJ, CLW, SA, and DLC did the reviewing and editing.

Declaration of interests

All authors declare no competing interests.

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