Part B: Intestinal & urogenital schistosomiasis co-infection focus: Investigating age-infection relationships for school-aged children along shoreline of Lake Malawi

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Introduction

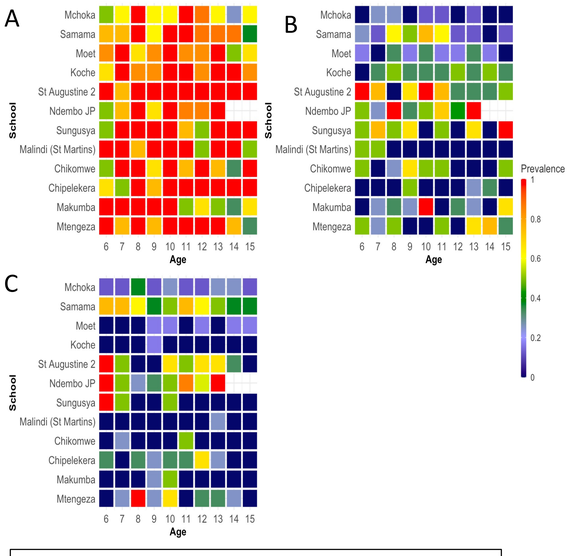
There are two forms of schistosomiasis in Africa, intestinal and urogenital, that collectively blight the lives of millions of children. Whilst co-infections are possible their dynamics are poorly understood and we present in this poster, a secondary analysis of epidemiological data collected from school-aged children (SAC) in Mangochi District, Lake Malawi where both intestinal (IS) and urogenital (UGS) schistosomiasis is now occurring from *Schistosoma mansoni (S.m.)* and *S. haematobium (S.h.)* infections respectively.

Data sources

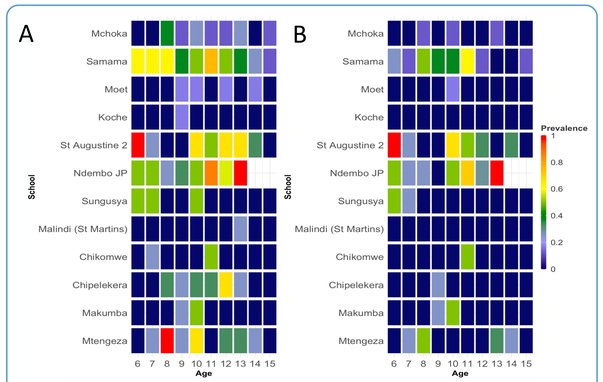
In 2019, a parasitology survey of SAC was carried out in June[1], being a follow-up and expanded surveillance study upon initial observations of schistosome co-infections made the year before[2]. The study sampled 80 SAC from 2 schools (*annual follow-up),* 60 SAC from 2 different schools (*assessment of two schools near known snail vectors)* and then carried a rapid surveillance map of lakeshore schools taking 30 SAC samples at all the others chosen schools.

Heatmaps

Age of SAC vs school prevalence for



A *S.m.* [T+] **B** *S.m.* [T-] **C** *S.h.*



Coinfection of *S.m.* and *S.h.* **A.** [T+] **B** [T-]

Low intensity *S.m.* infections were common among all the schools except Mchoka (MC) school. Visual indication of co-infection dependent on the presence of *S.m.* and *S.h.* infections in the area as expected. Samama (SA) school shows a possible increase in co-infection [T-] prevalence between ages 8-11 years whereas the pattern at other schools are not clear.

GAM Model Formulation

Let Yij be a **binary response** for individual SAC i at a named school j. This follows Yij is either Yij=1 if SAC had a positive result for both *S.m.* and *S.h.* or Yij=0 if the SAC has both negative result or only one positive result for *S.h.* and *S.m.* at named school j. The following equations can represent the distribution of the model as

$$Y_{ij}|X_{ij} \sim Bernoulli(p_{ij}),$$
$$p_{ij} = E(Y_{ij}|x_{ij}).$$

These give a logistic regression with **Bernoulli distribution** and mean p_{ij}. The $\boldsymbol{x_{ij}}$ **is a vector of the explanatory variables with the** $\boldsymbol{i}$**th subject (i=1, 2….n) with jth school (j=1,2…..k), where n is the number of subjects and k is the sample of schools**. We then represent the model as a generalised additive model (GAM),

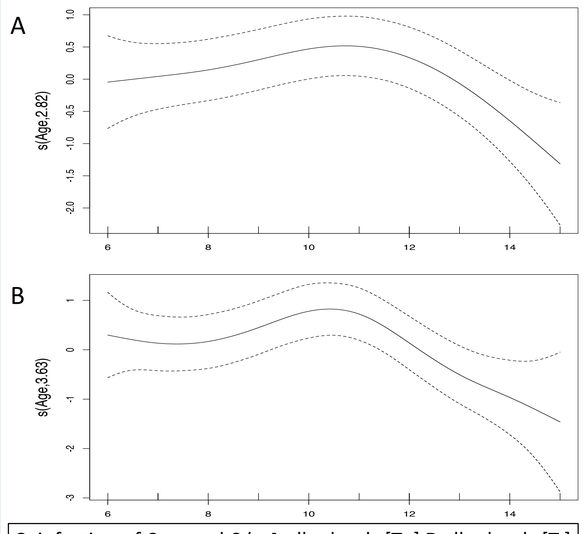
$$\boldsymbol{logit(p_{ij}) = \alpha + x_{ij}^T + \beta + s(z_{ij}, \phi)}$$

where $\boldsymbol{s}$ **is the smooth function of** $\boldsymbol{z_{ij}}$ **given** $\boldsymbol{\phi}$ **where** $\boldsymbol{z_{ij}}$ **denotes the age of the SAC i at school j.**

Results

GAM smooth term

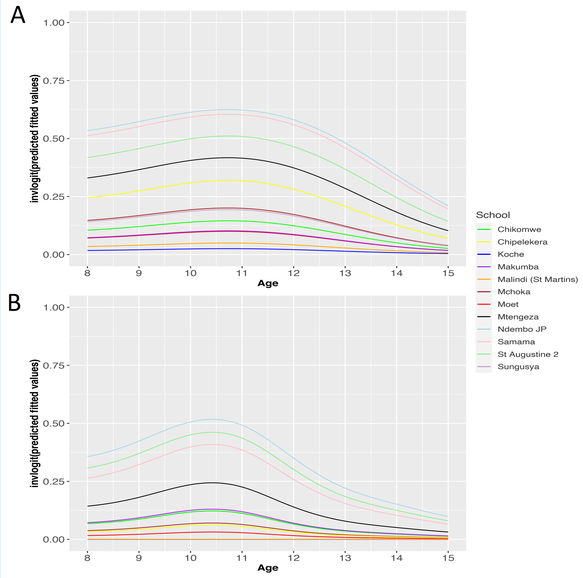
Inverse logit of smooth term for Schistosoma infection association with age of SAC adjusted for age and school



Coinfection of *S.m.* and *S.h.* **A** all schools [T+] **B** all schools [T-]

GAM covariates

Inverse logit predicted values for Schistosoma infection association with age of SAC adjusted for age and school



Coinfection of *S.m.* and *S.h.* **A** [T+] **B** [T-]

Table 2: Coinfection GAM of the smooth term age adjusted for school

	Coinfection			
	T+	CI	T-	CI
AIC	444		295	
Smooth term				
Age (p-value)	0.0843 .		0.032 .	
Factors (estimate coefficient)				
School				
Samama	1.81***	[1.01, 2.59]	2.21**	[0.939, 3.48]
Moet	-0.815	[−2.02, 0.391]	-0.838	[−3.13, 1.46]
Koche	-2.26*	[−4.34, −0.180]	-28.3	[−178, 178]
StAugustine2	1.43**	[0.440, 2.41]	2.43***	[1.01, 3.84]
Ndembodp	1.89***	[0.920, 2.86]	2.65***	[−1.27, 4.03]
Sungusya	-0.0433	[−1.28, 1.20]	0.618	[−1.24, 2.47]
Malindi(StMartins)	-1.57	[−3.67, 0.532]	-28.3	[−254, 254]
Chikomwe	-0.387	[1.75, 0.97]	0.611	[−1.24, 2.46]
Chipelekera	0.628	[−0.444, 1.70]	-0.146	[−2.46, 2.17]
Makumba	-0.788	[−2.37, 0.791]	0.681	[1.17, 2.54]
Mtengeza	1.05*	[0.0228, 2.07]	1.45.	[−0.133, 3.03]
Mchoka				

Summary of Results

- Four schools (SA, Ndembo dp, St Augustine 2 [T+][T-] and Mtengeza [T+]) all had significant evidence to suggest as SAC aged the log odds of being coinfected increased compared to MC school.
- Koche [T+] school had significant evidence to suggest as SAC aged the log odds of being coinfected decreased compared to MC school.
- Coinfection [T+][T-] smooth term prediction has an indication of steady increase in prevalence rate up to age 11, then decreasing there afterwards and the pattern becoming unclear.
- Similarly, coinfection [T+][T-] for each school showed increasing prevalence of coinfection as SAC aged up to age 11 before decreasing there after.

Conclusions

An increasing prevalence of IS and UGS co-infection for SAC up to around 11 before decreasing there afterwards. A similar age-profile for dual-infection was found (Part A). The peak of prevalence around 11 years for both dual and co-infection requires further investigation with follow-up studies. Further analysis is planned using malacological ***niche maps*** *and* a **statistically-grounded dynamical infection model** to find the main determinants of infection within school-aged children and how future praziquantel treatment targeted at schools could be better optimised.

Acknowledgements

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1. Angus More O'Ferrall. "The changing epidemiological landscape of schistosomiasis in Lake Malawi, Mangochi District: prevalence and morbidity associated with urogenital schistoso- miasis in school children." In: *Msc Biology and Control of Parasites and Disease vectors, Liverpool School Tropical Medicine* (2019).
2. Rosie Christiansen. "A parasitological survey to ascertain the prevalence of intestinal schistosomiasis in school-aged children around a new focus of Biomphalaria in Lake Malawi". In: *Msc Biology and Control of Parasites and Disease vectors, Liverpool School Tropical Medicine* (2018).