THE LANCET Infectious Diseases

Supplementary webappendix

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Supplemental Materials

Lo NC, Lai YS, Karagiannis-Voules DA, Bogoch II, Coulibaly JT, Bendavid E, Utzinger J, Vounatsou P, and Andrews JR. Assessment of global guidelines for preventive chemotherapy against schistosomiasis and soil-transmitted helminthiasis: a cost-effectiveness modelling study.

Contents

Section 1: Technical appendix

In this supplement, we provide further methodological details relevant to our model structure and analysis. The basic model, which simulates transmission of disease and cost-effectiveness for preventive chemotherapy against schistosomiasis and soil-transmitted helminthiasis (STH), has been previously described (see Supplementary appendix).[1] In the following, we will discuss additional model and analytical details.

Modeling the disease distribution of helminths

The distribution of disease was modeled using the negative binomial statistical distribution following common practice and observed empirical data.[1-3] This distribution derives a relationship between prevalence (P) and mean worm burden (M; intensity of infection) using a dispersion parameter (k; see equation 1). If two of the three parameters (i.e. prevalence, mean worm burden, dispersion parameter) are known, the third can be computed. The mean worm burden is often measured in eggs per gram of feces (EPG), which is an indicator of infection intensity.

$$P = 1 - \left(1 + \frac{M}{k}\right)^{-k} \quad (1)$$

There is substantial heterogeneity in the disease distribution of helminths across different settings. Classically, the disease distribution in a given setting can be represented with the dispersion parameter, which incorporates prevalence and mean EPG (equation 1). In order to perform an analysis and develop guidelines for preventive chemotherapy, which must be applicable across many settings, we developed a generalized relationship for helminth epidemiology.

The dispersion parameter and infection intensity of helminths have been modeled as a function of prevalence.[4-8] In this study, we performed a more in-depth analysis by conducting a literature review and deriving a more comprehensive relationship between prevalence and the infection intensity for four worm species: *Schistosoma mansoni*, *Ascaris lumbricoides,* hookworm, and *Trichuris trichiura*. We searched PubMed for relevant articles published in English between January 1, 2010 and March 1, 2016, using the search terms 1) "*Schistosoma mansoni*" and "prevalence" and "intensity"; or 2) "soil-transmitted helminth" or "soil-transmitted helminthiasis" and "prevalence" and "intensity" restricted to the title and abstract field. We examined studies for data on prevalence and corresponding arithmetic mean EPG in humans for *S. mansoni*, *A. lumbricoides*, hookworm, and/or *T. trichiura*. We included studies in treatment naïve settings (based on context of the study) that reported the arithmetic mean for EPG and fit within the negative binomial distribution. We also included studies from an earlier exploratory analysis that fit this inclusion criteria.[4] Ultimately, 27 unique studies were included; we used data from 9 studies (N=152) for *A. lumbricoides*, 11 studies (N=92) for hookworm, 6 studies (N=24) for *T. trichiura*, and 19 studies (N=126) for *S. mansoni*. Studies often provided multiple data points (N) from different populations. We included epidemiological data from 12 countries. A list of these studies with information on publication year, country, age range, and total sample size of the study is included in Table A1. We used a 2nd order polynomial (quadratic) relationship to derive the relationship between prevalence and arithmetic mean EPG in infected individuals (Table A2). The data and lines of best fit are shown in Figure A1. We generated 95% prediction intervals around the fit line to characterize the heterogeneity in the prevalence to EPG

relationship (Figure A1). This relationship was extended to calculate the dispersion parameter (Figure A2).

Disability measurement and costs

There is great uncertainty and debate surrounding how to best measure disability from helminthiases. Following common practice for a cost-effectiveness analysis, we used disability weights, which allowed the calculation of disability-adjusted life years (DALY). Disability weights provide a conventional measure of annual health for an individual, and range from 0 (perfect health) to 1 (death). These disability weights have been recently revised for STH and we incorporated these estimates.[4] However, other estimates also exist[1] (see Supplemental Materials). The disability weight for a light STH infection is most controversial. We assigned minimal disability to a light STH infection (0.2% out of 100%) in an effort to be conservative, but also incorporate evidence that some disability may be present even with a light STH infection.[9-11] The disability weight was selected based on the lowest end of disability for an "acute infectious disease, mild" from the Global Burden of Diseases study.[10] We added this to the sensitivity and uncertainty analysis varying the STH light disability weight from 0 to 0.005 (see Figure 5-6, Table A3). For schistosomiasis, there has been great debate, and many argue that current disability weights underestimate the disease burden as they do not adequately account for chronic sequelae. We conservatively selected a base case estimate for schistosomiasis disability on the lower end of the possible disability range (0.014-0.05; equivalent to 1.4-5% disability) and also stratified by infection intensity. We then varied this in the sensitivity and uncertainty analysis from 1.4% to 5% (out of 100%) disability.

We sourced cost data from literature.[1,12-22] The cost estimates from literature incorporated many components of programmatic delivery including drug shipment, worker salary, transportation, administrative fees, and other fees. We did not correlate costs with coverage, and regardless of economies of scale, our cost estimates represent the highest end of estimations from literature and remain conservative. We modeled cost-effectiveness in a simulated 5,000-person community, although results were comparable for different sized populations. We followed convention for economic evaluation of a health intervention (CHEERS checklist).

We estimated the cost reduction of an integrated preventive chemotherapy program (praziquantel and albendazole) when compared to two single medicine treatment programs. The integrated school-based program yielded a cost savings of 40.3% of the total cost of the non-integrated program (Table S10). Hence, the advantage of integrated treatment when populations are co-endemic is substantial.

Additional model details

In our transmission model, we assigned mean infection intensity, represented by mean worm burden or mean EPG, to each sub-population. Worm reproduction number and uptake rates were estimated based upon literature, and school-aged children (SAC) and pre-SAC were assumed in the base case to contribute a two-fold greater amount of infectious material than adults due to behavioral differences in these age groups; this difference was varied in a sensitivity analysis.[1,3] The species-specific STH prevalence (i.e. *A. lumbricoides*, hookworm, and *T. trichiura*) within

the overall STH prevalence was calculated based on the STH epidemiology in sub-Saharan Africa.[4]

Polyparasitism of STH was modeled using the conservative assumption that acquisition of each of the three infections (*A. lumbricoides,* hookworm, and *T. trichiura*) was independent from one another.[1,4] As current guidelines determine the preventive chemotherapy strategy based on a prevalence threshold using a combined prevalence of all STH, an assumption on their relationship was necessary. The assumption that STH infections are acquired independent from one another has been supported with primary data from four communities in Côte d'Ivoire, and is commonly used amongst modeling studies.[1,23,24] Importantly, this assumption is conservative. If the opposite were true, and STH infections were correlated, species-specific STH prevalence would be higher at each combined STH prevalence. This alternative assumption would result in cost-effective preventive chemotherapy at a lower prevalence threshold than currently assumed. This assumption aimed to provide generalizable and conservative estimates. Sensitivity analysis demonstrated minimal impact of this assumption. Individuals with multiple disability weights were computed as multiplicative following standard practice.[25]

We applied a mating function to our transmission model for each helminth. This is most relevant to the transmission dynamics in low burden settings. Since helminths reproduce sexually, both a male and female is necessary. This means that in low burden settings, individuals with only one worm should not contribute to transmission as there would be no egg production or excretion, although disease disability would still be included. Indeed, previous studies have shown that inclusion of worm mating reduces the force of infection making sustained transmission less likely when treatment is applied in low burden settings.[26,27] We adapted a model for promiscuous mating under the negative binomial distribution (see eqn 2-3), which provides a simplified estimate for mating and provides comparable results to other mating structures, including monogamous mating.[28]

$$\phi(\mathrm{M},\mathrm{k}) = 1 - \left(1 + \frac{M}{2k}\right)^{-1-k} \quad (2)$$

$$\psi(\mathrm{M},\mathrm{k}) = \mathrm{M}\phi(\mathrm{M},\mathrm{k}) \quad (3)$$

Where: $\phi = mating\ probability$
$M = mean\ worm\ burden$
$k = dispersion\ parameter$
$\psi = mean\ mated\ worm\ burden$

We did not explicitly model the snail reservoir for *Schistosoma* spp, which could have two important effects on transmission: 1) amplification of infectious material that would influence force of infection; and 2) latency of snail infection that would allow the life cycle to persist despite treatment of human populations. If snails acted as environmental amplifier, this would be accounted for in the model structure through a scaling factor that is calibrated to epidemiological data.[3] If there were latency in snail infection, this would reduce the impact of treatment of humans. While this is likely to have some impact, the short life expectancy of miracidia (<24

hours; stage that infects snails), short life expectancy of snails (~50 days), and added snail mortality with infection reduces the impact of this effect.[2,29,30]

All models were coded in MATLAB (2014b). Python and R were used for supporting analysis and data visualization.

Uncertainty analysis

We performed an uncertainty analysis to test the robustness of our prevalence thresholds and to generate uncertainty intervals. We evaluated a full range of plausible values for both epidemiological and cost-effectiveness parameters in the model. To do this, we simultaneously varied multiple model parameters across a wide range of possible values including school-based delivery cost, community-wide delivery cost multiplier, willingness-to-pay threshold, infection intensity, coverage, schistosomiasis disability weight, STH disability weight, EPG to worm conversion multiplier, proportion between STH species, and age-specific distribution of disease (Table A3). This was repeated until general convergence was assessed, normally around 1,000 simulations. We used triangle probability distributions with Latin hypercube sampling to perform the analysis. The triangle distribution was chosen to be conservative, as this statistical distribution allows generous sampling at the lower and upper bound. The Latin hypercube sampling algorithm ensures efficient sampling throughout a given parameter space. The range of tested model parameters is given in Table A3. Importantly, the 95% uncertainty interval around the prevalence threshold should be understood as the range of values that captures the cost-effective prevalence threshold from 95% of simulations. Furthermore, this uncertainty interval is based upon the range of model parameters and their chosen distribution.

We used a wide range of values for each model parameter in the uncertainty analysis to characterize uncertainty in the model, but the base case estimation for model parameters may provide the best estimate for optimal global prevalence thresholds. This is because the base case parameter estimates were well characterized from literature and chosen to be conservative. Model parameters were chosen to be generalizable to low-resource settings, and were then explored through sensitivity and uncertainty analyses.

Latin hypercube sampling and partial rank correlation coefficients (LHS/PRCC)

We used LHS/PRCC to efficiently sample the parameter space for uncertain and heterogeneous model inputs, and understand the correlation between each parameter and the outcome of interest (prevalence threshold) for a given STH prevalence. We used the 1,000 simulations generated from the uncertainty analysis to compute the PRCC. Parameters with a strong PRCC (defined as absolute value above 0.2) were included in graphical visualization (Figure S4).

Geostatistical model fitting

A 5×5 km grid of 1,155,818 pixels was overlaid to sub-Saharan Africa. Bayesian geostatistical logistic regression models were fitted to obtain spatially explicit infection estimates of STH and *Schistosoma* spp. infections. We assumed the number of positive individuals Y_i arising from a binomial distribution $Y_i \sim Bn(p_i, n_i)$, where n_i and p_i are the number of examined individuals and the probability of infection at location i, respectively. We had $\text{logit}(p_i) = X_i^T \beta + \varepsilon_i + \phi_i$, where X_i and β are the vector of covariates and coefficients, respectively. The location-specific random effects $\vec{\varepsilon} = (\varepsilon_1, ..., \varepsilon_L)^T$ followed a zero-mean multivariate normal distribution, that is $\vec{\varepsilon} \sim MVN(0, \Sigma)$

with a Matérn covariance matrix $\Sigma_{ij} = \sigma_{sp}^2 (\kappa d_{ij})^{\upsilon} K_{\upsilon}(\kappa d_{ij}) / (\Gamma(\upsilon) 2^{\upsilon-1})$, where d_{ij}, κ, υ and K_{υ} represent the Euclidean distance between locations i and j, the scaling parameter, the smoothing parameter fixed to 1, and the modified Bessel function of second kind and order υ, respectively. The spatial range, defined as the distance that spatial correlation becomes negligible (<0.1), can be derived from κ, that is $\rho = \sqrt{8} / \kappa$. We assumed the exchangeable random effect ϕ_i follows a zero-mean normal distribution $\phi_i \sim N(0, \sigma_{nonsp}^2)$. We adopted a Bayesian inferential framework for estimation of parameters. The following priors are used: $\beta_0, \beta_k \sim N(0,1000)$, $\log(\kappa) \sim \log normal(0,100)$, $\log(\tau_{sp}) \sim \log normal(0,100)$ and $\log(\tau_{nonsp}) \sim \log gamma(1, 0.00005)$, where $\sigma_{sp}^2 = 1/(4\pi\kappa^2\tau_{sp}^2)$ and $\tau_{nonsp} = 1/\sigma_{nonsp}^2$. We undertook the model fitting in INLA using the homonymous R-package (available at www.r-inla.org).

Additional model limitations

We assumed that treatment was administered simultaneously throughout the community, instantaneous in reduction of worm burden and increase in hemoglobin, without adverse events, accepted at a constant percentage over time, and administered with random coverage without consideration for hard-to-reach population that may take substantial effort and cost to treat. In the future, better data can help address these limitations. Disease dispersion was assumed to remain constant under a negative binomial distribution with perfect mixing in the sub-population mean worm burden. We did not account for potential barriers to elimination that includes animal reservoirs, migration, super-spreaders, or development of drug resistance. Estimation of parameters that include EPG-to-worm conversion, dispersion parameter, and relative contribution of infectious material between pre-SAC, SAC, and adults remain uncertain and were tested with sensitivity and uncertainty analyses. Future analyses can also examine constructing treatment guidelines based upon mean infection intensity rather than prevalence.

Implementation of preventive chemotherapy

In the revision of preventive chemotherapy guidelines, broader evidence should also be incorporated to optimize the implementation of treatment campaigns, which often suffer low coverage. This is especially important as recent studies have demonstrate that high coverage (>75%) and sustained preventive chemotherapy programs (>5 years) may be necessary to decrease the rate of reinfection and burden of disease.[1,31,32] To meet the challenge of reaching a high and sustained coverage, contextual factors should be considered, such as investments in advertisement materials, community education and sensitization sessions, training and compensation of community-drug distributors, provision of a pre-treatment snack to reduce adverse events and enhance bioavailability, and other implementation steps.[33-37] Of note, the WHO has recently produced an implementation package for school teachers, which exemplifies one method of improving delivery of preventive chemotherapy.[38]

Technical appendix: Figures and Tables

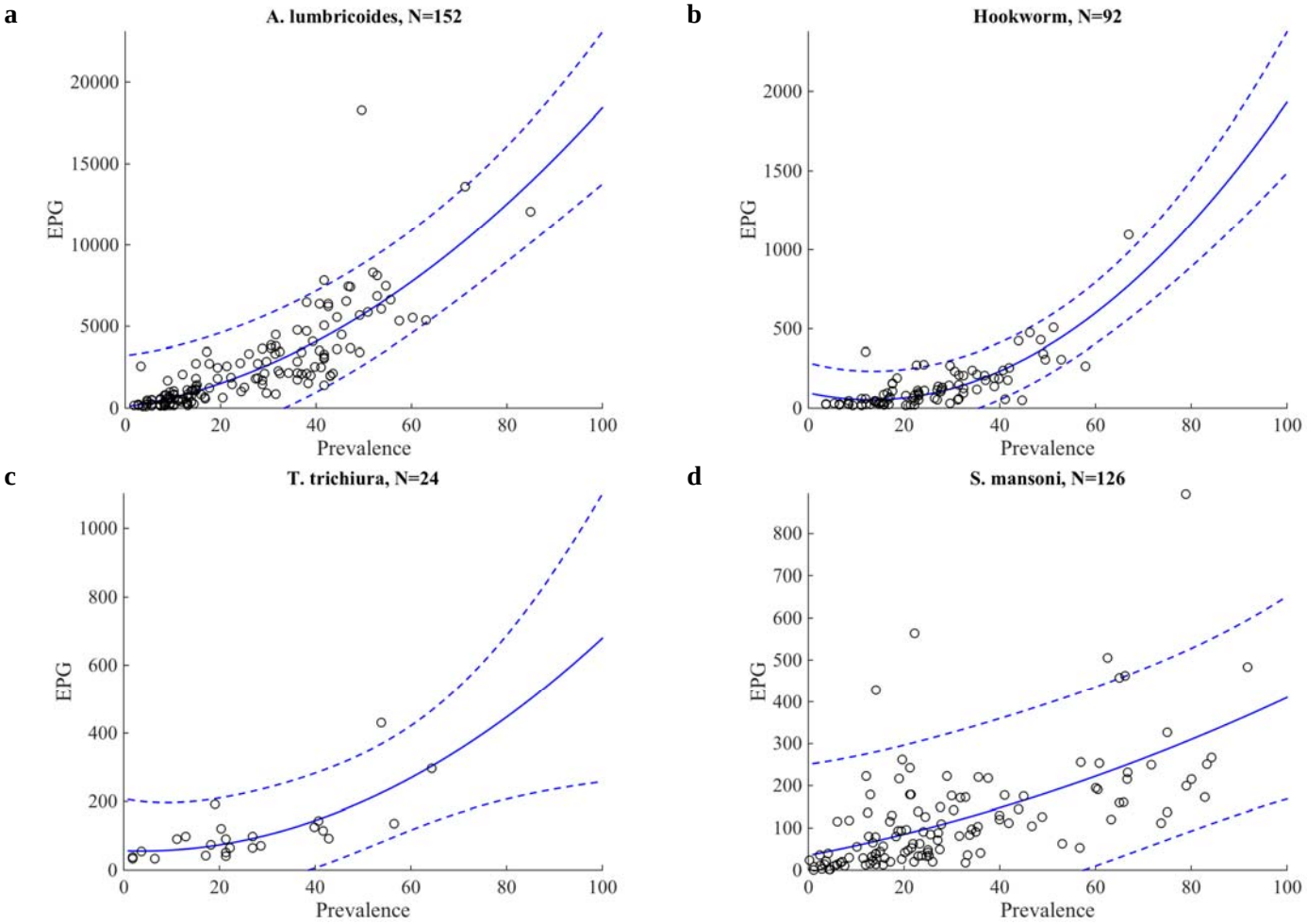

Figure A1: Infection intensity relationship to prevalence for STH and schistosomiasis. A literature review was conducted to obtain data on prevalence and EPG for each worm species: (A) *A. lumbricoides* (N=152); (B) hookworm (N=92); (C) *T. trichiura* (N=24); and (D) *S. mansoni* (N=126). A quadratic polynomial was used to characterize the relationship between prevalence and infection intensity (EPG; infected individuals), with 95% prediction intervals. Data from included studies are shown in black circles. A total of 27 unique studies from 12 countries were identified. EPG; eggs per gram of feces.

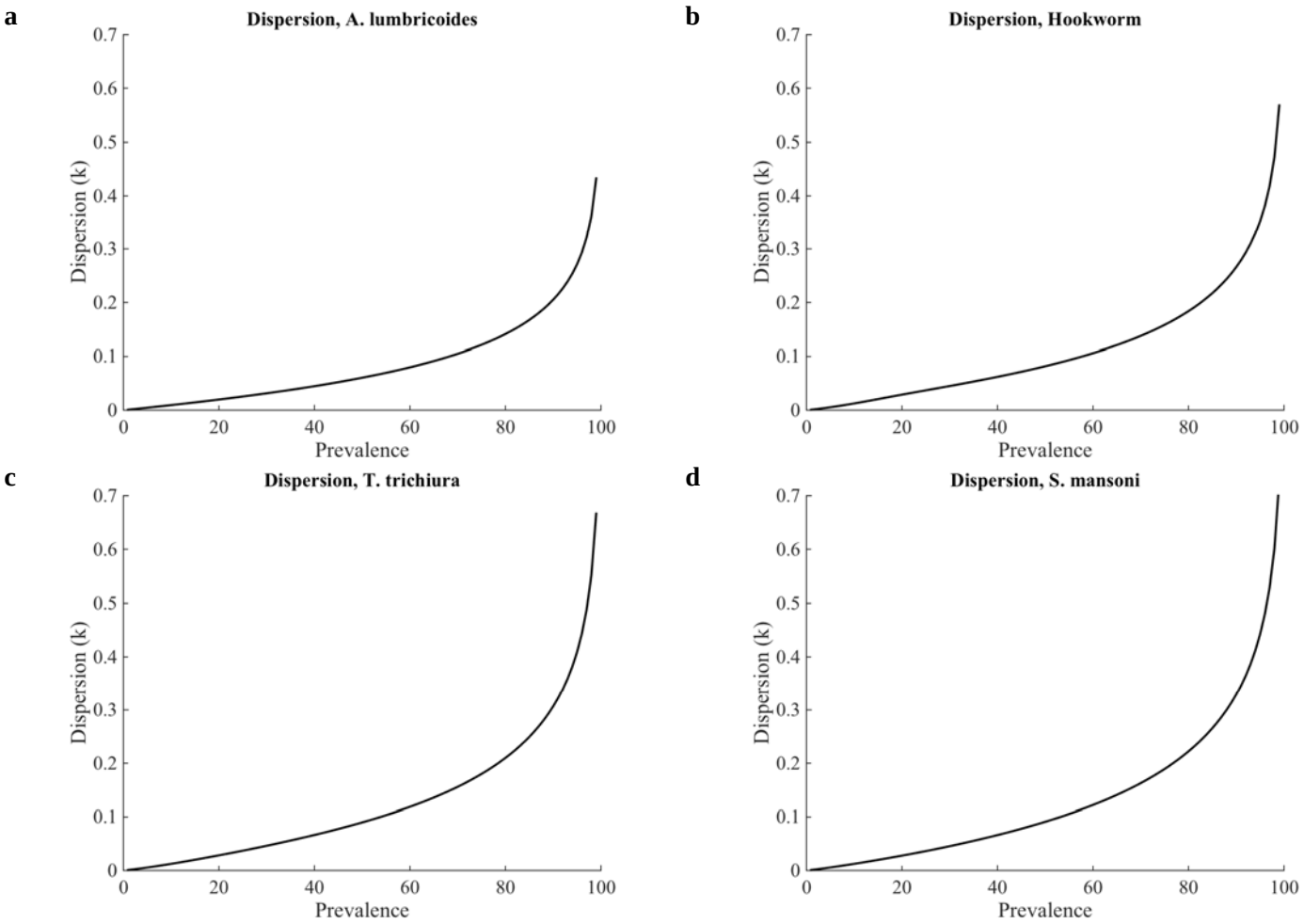

Figure A2: Dispersion parameter relationship to prevalence for STH and schistosomiasis. Using a negative binomial disease distribution and the relationship in Figure A1, the dispersion parameter was calculated for each prevalence value.

Table A1: Description of studies included in the analysis on relationship between prevalence, infection intensity, and dispersion.

Country	Year	Helminth	Age group	Total sample	Number of studied populations	Ref
STH						
Bangladesh	2015	asc, tri	Community	1630	4	39
Brazil	2006	hk	Community	1249	1	40
Côte d'Ivoire	2012	asc, hk, tri	SAC	446	2	41
Ecuador	2014	asc, tri	Community	211	2	42
Guinea	2011	hk	SAC	420	1	43
Kenya	2016	asc	Community	633	1	44
Kenya	2015	asc, hk, tri	SAC	13700	137	45
Kenya	2014	hk, tri	SAC	1022	1	46
Kenya	2013	asc, hk, tri	SAC	1925	4	47
Kenya	2012	asc, hk	Ages 5-19	4065	1	48
Madagascar	2016	asc, hk	Ages 7-10	1958	1	49
Sierra Leone	2012	hk	Pre-SAC	1803	3	50
Sierra Leone	2011	hk	SAC	1760	1	51
Tanzania	2015	asc, hk	SAC	41	1	52
Schistosomiasis						
Côte d'Ivoire	2016	*S. mansoni*	Ages 9-12	29582	53	53
Côte d'Ivoire	2016	*S. mansoni*	Ages 9-12	11964	2	54
Côte d'Ivoire	2012	*S. mansoni*	SAC	446	3	41
Ethiopia	2015	*S. mansoni*	SAC	1196	6	55
Ethiopia	2015	*S. mansoni*	SAC	206	1	56
Guinea	2011	*S. mansoni*	SAC	420	1	43
Kenya	2016	*S. mansoni*	Community	132	1	57
Kenya	2015	*S. mansoni*	Community	600	3	5
Kenya	2014	*S. mansoni*	SAC	3846	7	58
Kenya	2013	*S. mansoni*	SAC	915	1	47
Kenya	2013	*S. mansoni*	SAC	12926	2	59
Kenya	2012	*S. mansoni*	SAC	4064	2	48
Nigeria	2012	*S. mansoni*	SAC	365	3	60
Sierra Leone	2014	*S. mansoni*	SAC	770	7	61
Sierra Leone	2012	*S. mansoni*	Pre-SAC	1355	10	50
Sierra Leone	2012	*S. mansoni*	SAC	515	6	62
Sierra Leone	2011	*S. mansoni*	SAC	1760	7	51
Uganda	2012	*S. mansoni*	SAC	979	1	63
Uganda	2011	*S. mansoni*	SAC	172	10	64

Asc; *A. lumbricoides*, Hk; hookworm, Tri; *T. trichiura*, SAC; school-aged children, Pre-SAC; pre-school aged children
Year refers to publication year

Table A2: Quadratic polynomial parameters to model infection intensity according to prevalence

Helminth species	P1	P2	P3
A. lumbricoides	13910 (6502, 21320)	4432 (-352.3, 9216)	74.56 (-563.1, 712.2)
Hookworm	2491 (1663, 3319)	-655.7 (-1164, -146.9)	96.35 (28.1, 164.6)
T. trichiura	671.3 (-183.8, 1526)	-48.81 (-601.5, 503.9)	56.82 (-17.3, 130.9)
S. mansoni	155.9 (-206.2, 518.1)	219.3 (-89.3, 527.9)	34.86 (-14.39, 84.11)

Infection_intensity(prev) = p1*prev^2 + p2*prev + p3

Table A3: Parameter specifications for uncertainty analysis and generation of uncertainty intervals

Model parameter	Base case	Uncertainty analysis	
		Lower limit	Upper limit
School-based delivery cost	US$ 0.50	US$ 0.25	US$ 0.75
Community-wide delivery cost multiplier	3x	2x	4x
Willingness-to-pay threshold	US$ 1,045	US$ 945	US$ 1,145
Coverage	75%	5%	100%
Schistosomiasis disability weight	(0.014, 0.02, 0.05)	(0.01, 0.01, 0.02)	(0.02, 0.05, 0.1)
STH disability, light infection	0.002	0	0.005
Dispersion of disease	Fn(prev)[a], base	Fn(prev)[a], lower 95% interval	Fn(prev)[a], upper 95% interval
EPG to worm conversion multiplier			
Schistosomiasis	5	-50% (2.5)	+50% (7.5)
Ascaris lumbricoides	75	-50% (37.5)	+50% (112.5)
Trichuris trichiura	15	-50% (7.5)	+50% (22.5)
Hookworm	10	-50% (5)	+50% (15)
Proportion between STH species			
Ascaris lumbricoides	0.136	-25%	+25%
Trichuris trichiura	0.116	-25%	+25%
Hookworm	0.136	-25%	+25%
Age-specific distribution of disease[b]			
Schistosomiasis	(0.625,1,0.8333)	-10%	+10%
Ascaris lumbricoides	(0.625,1,0.8333)	-10%	+10%
Trichuris trichiura	(0.606,1, 1.212)	-10%	+10%
Hookworm	(0.625,1,0.8333)	-10%	+10%

[a]See Figure A1-A2 and Table A2 for relationship

[b]Age-specific distribution is described as (pre-SAC, SAC, adults)

References

1. Lo NC, Bogoch, II, Blackburn BG, et al. Comparison of community-wide, integrated mass drug administration strategies for schistosomiasis and soil-transmitted helminthiasis: a cost-effectiveness modelling study. *Lancet Glob Health* 2015; **3**: e629-38.
2. Anderson RM, May RM. Infectious diseases of humans: dynamics and control. Oxford Oxford University Press; 1991.
3. Anderson RM, Truscott JE, Pullan RL, Brooker SJ, Hollingsworth TD. How effective is school-based deworming for the community-wide control of soil-transmitted helminths? *PLoS Negl Trop Dis* 2013; **7**: e2027.
4. Pullan RL, Smith JL, Jasrasaria R, Brooker SJ. Global numbers of infection and disease burden of soil transmitted helminth infections in 2010. *Parasit Vectors* 2014; **7**: 37.
5. Mwinzi PN, Muchiri G, Wiegand RE, et al. Predictive Value of School-Aged Children's Schistosomiasis Prevalence and Egg Intensity for Other Age Groups in Western Kenya. *Am J Trop Med Hyg* 2015; **93**: 1311-7.
6. Montresor A, N AP, Albonico M, et al. Soil-transmitted helminthiasis: the relationship between prevalence and classes of intensity of infection. *Trans R Soc Trop Med Hyg* 2015; **109**: 262-7.
7. Levecke B, Anderson RM, Berkvens D, et al. Mathematical inference on helminth egg counts in stool and its applications in mass drug administration programmes to control soil-transmitted helminthiasis in public health. *Adv Parasitol* 2015; **87**: 193-247.
8. Forrer A, Vounatsou P, Sayasone S, et al. Risk profiling of hookworm infection and intensity in southern Lao People's Democratic Republic using Bayesian models. *PLoS Negl Trop Dis* 2015; **9**: e0003486.
9. Furst T, Silue KD, Ouattara M, et al. Schistosomiasis, soil-transmitted helminthiasis, and sociodemographic factors influence quality of life of adults in Cote d'Ivoire. *PLoS Negl Trop Dis* 2012; **6**: e1855.
10. Salomon JA, Vos T, Hogan DR, et al. Common values in assessing health outcomes from disease and injury: disability weights measurement study for the Global Burden of Disease Study 2010. *Lancet* 2012; **380**: 2129-43.
11. Stephenson LS, Latham MC, Ottesen EA. Malnutrition and parasitic helminth infections. *Parasitology* 2000; **121 Suppl**: S23-38.
12. International Drug Price Indicator Guide. 2014. http://erc.msh.org/dmpguide/pdf/DrugPriceGuide_2014.pdf (accessed 04/15/15.
13. Brooker S, Kabatereine NB, Fleming F, Devlin N. Cost and cost-effectiveness of nationwide school-based helminth control in Uganda: intra-country variation and effects of scaling-up. *Health Policy Plan* 2008; **23**: 24-35.
14. Fitzpatrick C, Asiedu K, Jannin J. Where the road ends, yaws begins? The cost-effectiveness of eradication versus more roads. *PLoS Negl Trop Dis* 2014; **8**: e3165.
15. Gabrielli AF, Toure S, Sellin B, et al. A combined school- and community-based campaign targeting all school-age children of Burkina Faso against schistosomiasis and soil-transmitted helminthiasis: performance, financial costs and implications for sustainability. *Acta Trop* 2006; **99**: 234-42.
16. Goldman AS, Guisinger VH, Aikins M, et al. National mass drug administration costs for lymphatic filariasis elimination. *PLoS Negl Trop Dis* 2007; **1**: e67.
17. Guyatt H. The cost of delivering and sustaining a control programme for schistosomiasis and soil-transmitted helminthiasis. *Acta Trop* 2003; **86**: 267-74.

18. Kabatereine NB, Tukahebwa EM, Kazibwe F, et al. Soil-transmitted helminthiasis in Uganda: epidemiology and cost of control. *Trop Med Int Health* 2005; **10**: 1187-9.
19. King CH, Olbrych SK, Soon M, Singer ME, Carter J, Colley DG. Utility of repeated praziquantel dosing in the treatment of schistosomiasis in high-risk communities in Africa: a systematic review. *PLoS Negl Trop Dis* 2011; **5**: e1321.
20. Turner HC, Truscott JE, Hollingsworth TD, Bettis AA, Brooker SJ, Anderson RM. Cost and cost-effectiveness of soil-transmitted helminth treatment programmes: systematic review and research needs. *Parasit Vectors* 2015; **8**: 355.
21. WHO. Preventive chemotherapy in human helminthiasis. Coordinated use of anthelminthic drugs in control interventions: a manual for health professionals andprogramme managers: Geneva: World Health Organization, 2006.
22. WHO. Helminth control in school-age children: a guide for managers of control programmes: Geneva: World Health Organization 2011.
23. Karagiannis-Voules DA, Biedermann P, Ekpo UF, et al. Spatial and temporal distribution of soil-transmitted helminth infection in sub-Saharan Africa: a systematic review and geostatistical meta-analysis. *Lancet Infect Dis* 2015; **15**: 74-84.
24. Lai YS, Biedermann P, Ekpo UF, et al. Spatial distribution of schistosomiasis and treatment needs in sub-Saharan Africa: a systematic review and geostatistical analysis. *Lancet Infect Dis* 2015; **15**: 927-40.
25. van Baal PH, Hoeymans N, Hoogenveen RT, de Wit GA, Westert GP. Disability weights for comorbidity and their influence on health-adjusted life expectancy. *Popul Health Metr* 2006; **4**: 1.
26. Gurarie D, King CH. Population biology of Schistosoma mating, aggregation, and transmission breakpoints: more reliable model analysis for the end-game in communities at risk. *PLoS One* 2014; **9**: e115875.
27. May RM. Togetherness among Schistosomes: its effects on the dynamics of the infection. *Math Biosci* 1977; **35**.
28. Nåsell I. Mating models for schistosomes. *J Math Biol* 1978; **6**.
29. Mangal TD, Paterson S, Fenton A. Effects of Snail Density on Growth, Reproduction and Survival of Biomphalaria alexandrina Exposed to Schistosoma mansoni. *J Parasitol Res* 2010; **2010**.
30. Sokolow SH, Huttinger E, Jouanard N, et al. Reduced transmission of human schistosomiasis after restoration of a native river prawn that preys on the snail intermediate host. *Proc Natl Acad Sci U S A* 2015; **112**: 9650-5.
31. Anderson R, Truscott J, Hollingsworth TD. The coverage and frequency of mass drug administration required to eliminate persistent transmission of soil-transmitted helminths. *Philos Trans R Soc Lond B Biol Sci* 2014; **369**: 20130435.
32. Truscott JE, Hollingsworth TD, Brooker SJ, Anderson RM. Can chemotherapy alone eliminate the transmission of soil transmitted helminths? *Parasit Vectors* 2014; **7**: 266.
33. Lu L, Liu C, Zhang L, Medina A, Smith S, Rozelle S. Gut instincts: knowledge, attitudes, and practices regarding soil-transmitted helminths in rural China. *PLoS Negl Trop Dis* 2015; **9**: e0003643.
34. Muhumuza S, Olsen A, Katahoire A, Kiragga AN, Nuwaha F. Effectiveness of a pre-treatment snack on the uptake of mass treatment for schistosomiasis in Uganda: a cluster randomized trial. *PLoS Med* 2014; **11**: e1001640.

35. Muhumuza S, Olsen A, Katahoire A, Nuwaha F. Uptake of preventive treatment for intestinal schistosomiasis among school children in Jinja district, Uganda: a cross sectional study. *PLoS One* 2013; **8**: e63438.
36. Njomo DW, Mukoko DA, Nyamongo NK, Karanja J. Increasing coverage in mass drug administration for lymphatic filariasis elimination in an urban setting: a study of Malindi Town, Kenya. *PLoS One* 2014; **9**: e83413.
37. Tuhebwe D, Bagonza J, Kiracho EE, Yeka A, Elliott AM, Nuwaha F. Uptake of mass drug administration programme for schistosomiasis control in Koome Islands, Central Uganda. *PLoS One* 2015; **10**: e0123673.
38. Conducting a schooldeworming day: a manual for teachers: World Health Organization: Geneva, 2013.
39. Benjamin-Chung J, Nazneen A, Halder AK, et al. The Interaction of Deworming, Improved Sanitation, and Household Flooring with Soil-Transmitted Helminth Infection in Rural Bangladesh. *PLoS Negl Trop Dis* 2015; **9**: e0004256.
40. Brooker S, Alexander N, Geiger S, et al. Contrasting patterns in the small-scale heterogeneity of human helminth infections in urban and rural environments in Brazil. *Int J Parasitol* 2006; **36**: 1143-51.
41. Coulibaly JT, Furst T, Silue KD, et al. Intestinal parasitic infections in schoolchildren in different settings of Cote d'Ivoire: effect of diagnostic approach and implications for control. *Parasit Vectors* 2012; **5**: 135.
42. Cepon-Robins TJ, Liebert MA, Gildner TE, et al. Soil-transmitted helminth prevalence and infection intensity among geographically and economically distinct Shuar communities in the Ecuadorian Amazon. *J Parasitol* 2014; **100**: 598-607.
43. Hodges M, Koroma MM, Balde MS, et al. Current status of schistosomiasis and soil-transmitted helminthiasis in Beyla and Macenta Prefectures, Forest Guinea. *Trans R Soc Trop Med Hyg* 2011; **105**: 672-4.
44. Easton AV, Oliveira RG, O'Connell EM, et al. Multi-parallel qPCR provides increased sensitivity and diagnostic breadth for gastrointestinal parasites of humans: field-based inferences on the impact of mass deworming. *Parasit Vectors* 2016; **9**: 38.
45. Nikolay B, Mwandawiro CS, Kihara JH, et al. Understanding Heterogeneity in the Impact of National Neglected Tropical Disease Control Programmes: Evidence from School-Based Deworming in Kenya. *PLoS Negl Trop Dis* 2015; **9**: e0004108.
46. Njenga SM, Mutungi FM, Wamae CN, Mwanje MT, Njiru KK, Bockarie MJ. Once a year school-based deworming with praziquantel and albendazole combination may not be adequate for control of urogenital schistosomiasis and hookworm infection in Matuga District, Kwale County, Kenya. *Parasit Vectors* 2014; **7**: 74.
47. Freeman MC, Clasen T, Brooker SJ, Akoko DO, Rheingans R. The impact of a school-based hygiene, water quality and sanitation intervention on soil-transmitted helminth reinfection: a cluster-randomized trial. *Am J Trop Med Hyg* 2013; **89**: 875-83.
48. Odiere MR, Rawago FO, Ombok M, et al. High prevalence of schistosomiasis in Mbita and its adjacent islands of Lake Victoria, western Kenya. *Parasit Vectors* 2012; **5**: 278.
49. Rasoamanamihaja CF, Rahetilahy AM, Ranjatoarivony B, et al. Baseline prevalence and intensity of schistosomiasis at sentinel sites in Madagascar: Informing a national control strategy. *Parasit Vectors* 2016; **9**: 50.

50. Hodges MH, Paye J, Koroma MM, Nyorkor ED, Fofonah I, Zhang Y. High level of Schistosoma mansoni infection in pre-school children in Sierra Leone highlights the need in targeting this age group for praziquantel treatment. *Acta Trop* 2012; **124**: 120-5.
51. Hodges M, Dada N, Wamsley A, et al. Improved mapping strategy to better inform policy on the control of schistosomiasis and soil-transmitted helminthiasis in Sierra Leone. *Parasit Vectors* 2011; **4**: 97.
52. Barda B, Albonico M, Ianniello D, et al. How long can stool samples be fixed for an accurate diagnosis of soil-transmitted helminth infection using Mini-FLOTAC? *PLoS Negl Trop Dis* 2015; **9**: e0003698.
53. Assare RK, Tian-Bi YN, Yao PK, et al. Sustaining Control of Schistosomiasis Mansoni in Western Cote d'Ivoire: Results from a SCORE Study, One Year after Initial Praziquantel Administration. *PLoS Negl Trop Dis* 2016; **10**: e0004329.
54. Assare RK, Hurlimann E, Ouattara M, et al. Sustaining the Control of Schistosoma mansoni in Western Cote d'Ivoire: Baseline Findings Before the Implementation of a Randomized Trial. *Am J Trop Med Hyg* 2016; **94**: 352-60.
55. Gashaw F, Aemero M, Legesse M, et al. Prevalence of intestinal helminth infection among school children in Maksegnit and Enfranz Towns, northwestern Ethiopia, with emphasis on Schistosoma mansoni infection. *Parasit Vectors* 2015; **8**: 567.
56. Jejaw A, Zemene E, Alemu Y, Mengistie Z. High prevalence of Schistosoma mansoni and other intestinal parasites among elementary school children in Southwest Ethiopia: a cross-sectional study. *BMC Public Health* 2015; **15**: 600.
57. Ng'etich AI, Rawago FO, Jura WG, Mwinzi PN, Won KY, Odiere MR. A cross-sectional study on schistosomiasis and soil-transmitted helminths in Mbita district, western Kenya using different copromicroscopic techniques. *Parasit Vectors* 2016; **9**: 87.
58. Sang HC, Muchiri G, Ombok M, Odiere MR, Mwinzi PN. Schistosoma haematobium hotspots in south Nyanza, western Kenya: prevalence, distribution and co-endemicity with Schistosoma mansoni and soil-transmitted helminths. *Parasit Vectors* 2014; **7**: 125.
59. Mwandawiro CS, Nikolay B, Kihara JH, et al. Monitoring and evaluating the impact of national school-based deworming in Kenya: study design and baseline results. *Parasit Vectors* 2013; **6**: 198.
60. Ugbomoiko US, Dalumo V, Danladi YK, Heukelbach J, Ofoezie IE. Concurrent urinary and intestinal schistosomiasis and intestinal helminthic infections in schoolchildren in Ilobu, South-western Nigeria. *Acta Trop* 2012; **123**: 16-21.
61. Sesay S, Paye J, Bah MS, et al. Schistosoma mansoni infection after three years of mass drug administration in Sierra Leone. *Parasit Vectors* 2014; **7**: 14.
62. Hodges MH, Dada N, Warmsley A, et al. Mass drug administration significantly reduces infection of Schistosoma mansoni and hookworm in school children in the national control program in Sierra Leone. *BMC Infect Dis* 2012; **12**: 16.
63. Sousa-Figueiredo JC, Betson M, Atuhaire A, et al. Performance and safety of praziquantel for treatment of intestinal schistosomiasis in infants and preschool children. *PLoS Negl Trop Dis* 2012; **6**: e1864.
64. Standley CJ, Adriko M, Besigye F, Kabatereine NB, Stothard RJ. Confirmed local endemicity and putative high transmission of Schistosoma mansoni in the Sesse Islands, Lake Victoria, Uganda. *Parasit Vectors* 2011; **4**: 29.
65. King CH. It's time to dispel the myth of "asymptomatic" schistosomiasis. *PLoS Negl Trop Dis* 2015; **9**: e0003504.

66. King CH, Dickman K, Tisch DJ. Reassessment of the cost of chronic helmintic infection: a meta-analysis of disability-related outcomes in endemic schistosomiasis. *Lancet* 2005; **365**: 1561-9.
67. Kassebaum NJ, Jasrasaria R, Naghavi M, et al. A systematic analysis of global anemia burden from 1990 to 2010. *Blood* 2014; **123**: 615-24.
68. Smith JL, Brooker S. Impact of hookworm infection and deworming on anaemia in non-pregnant populations: a systematic review. *Trop Med Int Health* 2010; **15**: 776-95.

Section 2: Supplemental figures and tables

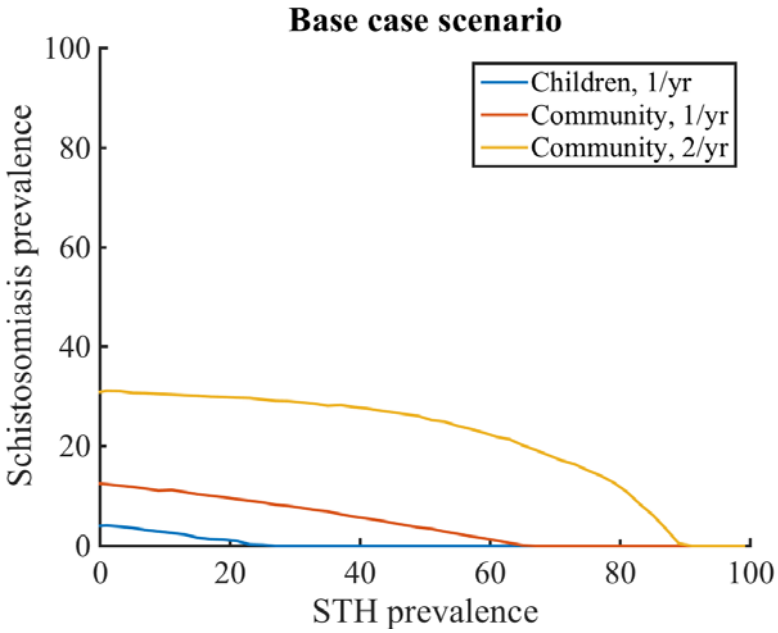

Figure S1: Base case analysis for cost-effective prevalence thresholds for implementing integrated preventive chemotherapy against schistosomiasis and STH.

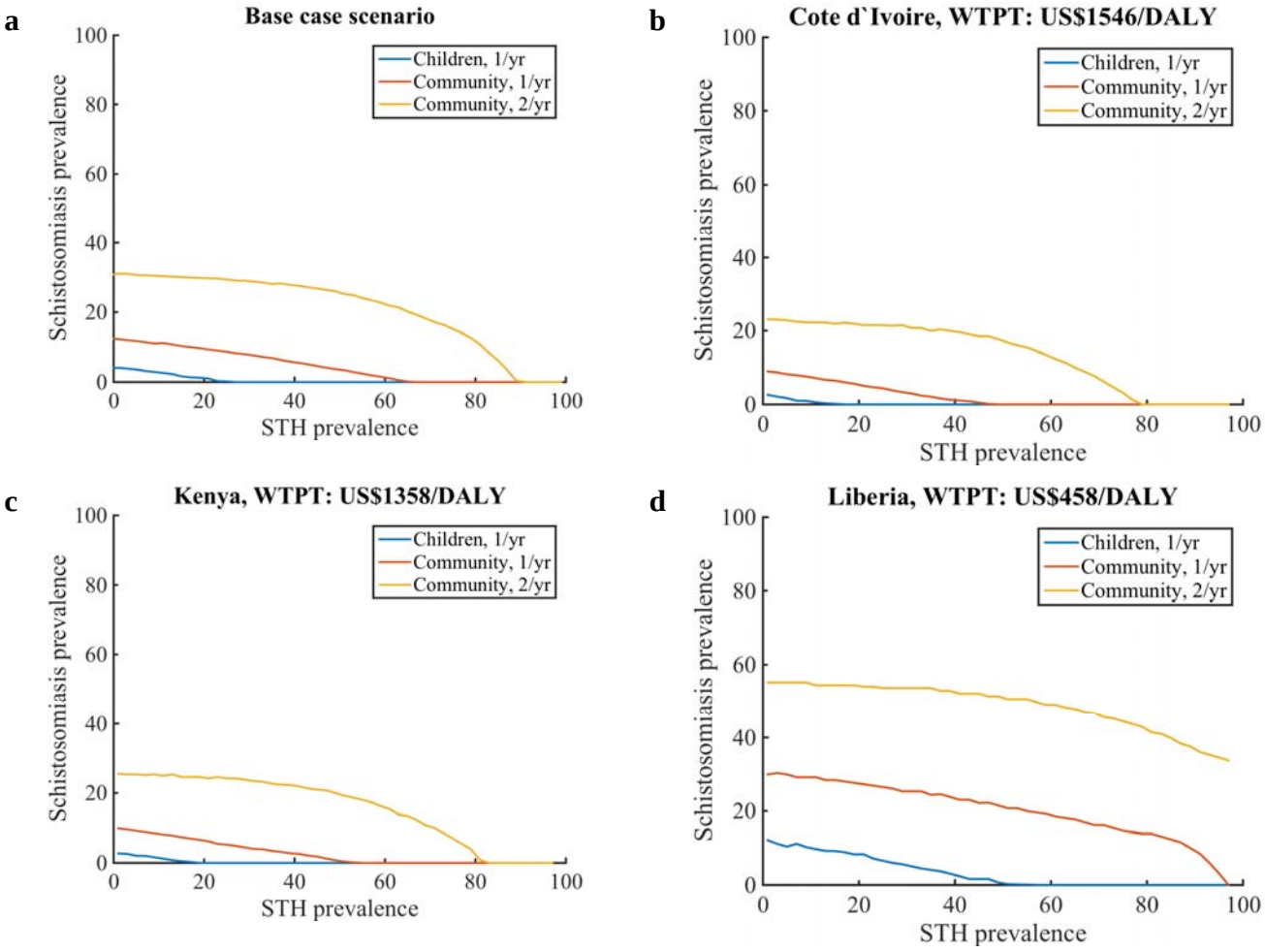

Figure S2: Country-specific scenario analyses for implementing integrated preventive chemotherapy against schistosomiasis and STH. The base case analysis was repeated using different willingness-to-pay thresholds (WTPT), which is traditionally defined using the GDP per capita of the country. If the incremental cost-effectiveness ratio (ICER) of a strategy is below the WTPT, the strategy is considered highly cost-effective. In the base case analysis (a), we assume a WTPT of US$ 1,045/DALY. We tested alternative WTPT using various countries (and their GDP per capita) to represent the various economic statuses in sub-Saharan Africa.

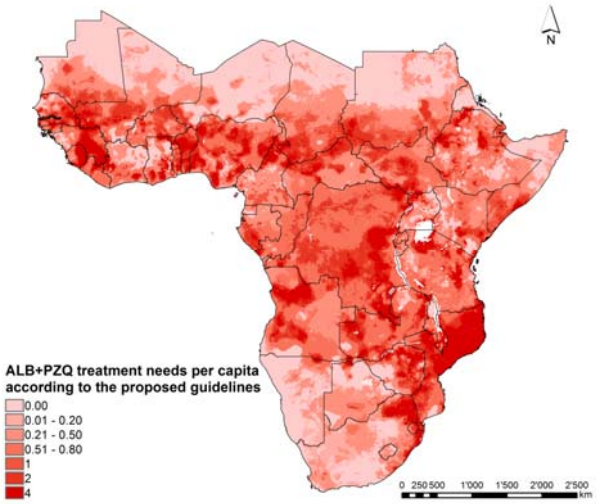

Figure S3: Predicted annual treatment needs per capita for schistosomiasis and STH in sub-Saharan Africa under proposed prevalence thresholds.

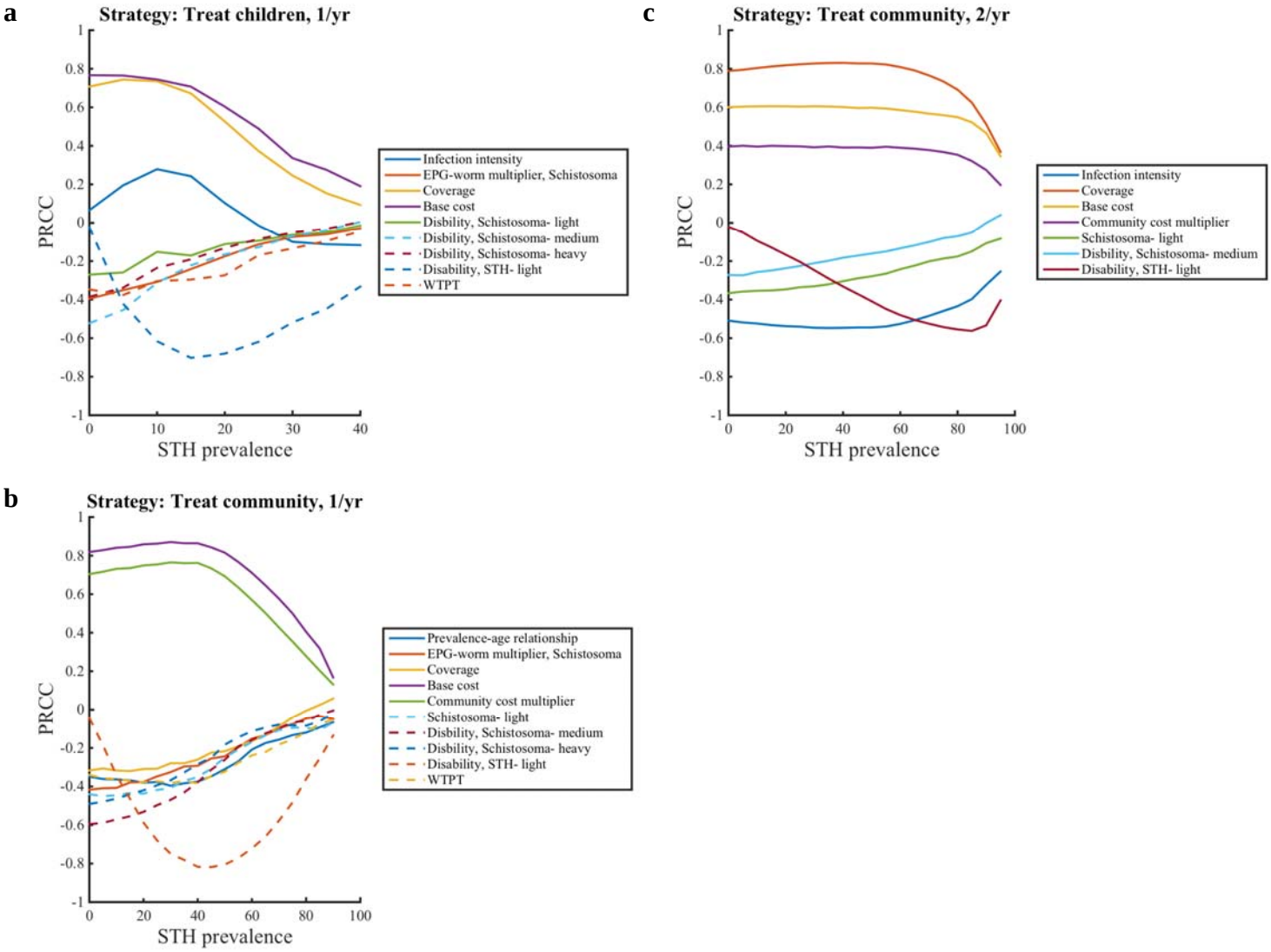

Figure S4: Partial rank correlation coefficients for uncertain or heterogeneous model variables. The PRCC provides a measurement for whether two variables are correlated, while all other covariates are held constant. The PRCC range from -1 (inverse relationship) to 1 (positive relationship). The results from the uncertainty analysis were used to compute PRCC in relation to STH prevalence. Only variables with a strong PRCC (absolute value greater than 0.2) were shown. WTPT; willingness-to-pay threshold, EPG; eggs per gram of feces

Table S1: World Health Organization guidelines for preventive chemotherapy against STH and schistosomiasis

Category	Prevalence (SAC)	Action to be taken	Frequency
STH			
High-risk	>50%	• Treat SAC • Also treat: pre-SAC, women of childbearing age, high-risk adults	2x per year
Low-risk	20-50%	• Treat SAC • Also treat: pre-SAC, women of childbearing age, high-risk adults	1x per year
No-risk	<20%	• No treatment recommended	N/A
Schistosomiasis			
High-risk	>50%	• Treat SAC • Also treat: high-risk adults with consideration for community-wide treatment	1x per year
Moderate-risk	10-50%	• Treat SAC • Also treat: high-risk adults	1x every two years
Low-risk	<10%	• Treat SAC	2x during primary school age

Note: SCORE study group uses a prevalence threshold of 25% for high-risk categorization.

Table S2: Disability structure for schistosomiasis and soil-transmitted helminthiasis

Helminth	Sequelae	Infection intensity	Disability weights	Ref
Schistosomiasis	Infection	Light	0.014	10,19,65,66
	Infection	Medium	0.02	10,19,65,66
	Infection	Heavy	0.05	10,19,65,66
A. lumbricoides	Light infection	Light	0.002	9-11
	Mild abdominopelvic problems	Medium	0.0108	4,10
	Symptomatic infection	Heavy	0.0296	4,10
	Wasting	Heavy	0.1245	4,10
T. trichiura	Light infection	Light	0.002	9-11
	Mild abdominopelvic problem	Medium	0.0108	4,10
	Symptomatic infection	Heavy	0.0296	4,10
	Wasting	Heavy	0.1245	4,10
Hookworm	Light infection	Light	0.002	9-11
	Mild abdominopelvic problems	Medium	0.0108	4,10
	Symptomatic infection	Heavy	0.0296	4,10
	Wasting[a]	Heavy	0.1245	4,10
Schistosomiasis and hookworm	Mild anemia	All	0.0041	4,10,67,68
	Moderate anemia	All	0.0056	4,10,67,68
	Severe anemia	All	0.1615	4,10,67,68

Table S3: Annual treatment needs of praziquantel and albendazole in 43 countries in sub-Saharan Africa under proposed guidelines and WHO guidelines

Country	Population (thousands)	WHO guidelines (95% CI; thousands)			Proposed guidelines (95% CI; thousands)		
		PZQ	ALB	PZQ+ALB	PZQ	ALB	PZQ+ALB
Angola	20163	3557 (3005; 4346)	5445 (4054; 11791)	9127 (7420; 15463)	20970 (14566; 26676)	16245 (11311; 22516)	37092 (26078; 48389)
Benin	8772	1491 (1293; 1665)	3280 (2115; 4710)	4760 (3545; 6191)	11449 (9347; 13263)	9883 (7555; 11947)	21259 (17066; 25091)
Botswana	2016	201 (170; 254)	121 (74; 241)	334 (262; 453)	1235 (557; 2224)	575 (283; 1039)	1835 (833; 3192)
Burkina Faso	17347	2588 (2446; 2750)	2321 (1451; 4362)	4910 (4028; 6985)	18093 (15779; 20225)	8282 (6175; 11668)	26412 (22568; 31246)
Burundi	8822	994 (952; 1068)	8244 (7205; 9093)	9238 (8176; 10068)	3223 (2155; 4747)	6963 (5778; 8371)	10285 (8292; 12915)
Cameroon	20335	2589 (2486; 2714)	10762 (9949; 11599)	13360 (12520; 14188)	10410 (9046; 11991)	12079 (10642; 13725)	22489 (20046; 25353)
Central African Republic	4434	560 (489; 700)	1442 (1051; 1982)	2009 (1584; 2568)	3497 (2353; 5154)	3508 (2544; 4990)	7039 (4933; 10268)
Chad	11752	2104 (1821; 2406)	1056 (599; 1824)	3147 (2644; 4055)	12364 (9352; 15253)	6670 (4683; 8860)	18884 (14147; 23674)
Côte d'Ivoire	19967	2308 (2207; 2434)	9353 (8001; 10666)	11649 (10302; 12962)	14516 (11964; 17376)	14927 (12761; 17080)	29499 (25369; 34218)
Democratic Republic of the Congo	68273	10200 (9515; 11054)	37211 (33190; 41517)	47391 (43308; 52139)	76161 (66816; 86667)	78467 (70581; 88792)	154826 (137594; 175273)
Djibouti	951	159 (99; 255)	20 (0; 749)	202 (109; 880)	1185 (247; 1841)	301 (42; 1481)	1559 (299; 3301)
Equatorial Guinea	721	64 (60; 80)	453 (232; 643)	517 (295; 709)	144 (26; 468)	409 (207; 725)	564 (260; 1131)
Eritrea	5526	635 (591; 694)	168 (38; 437)	807 (661; 1079)	1597 (976; 2488)	585 (266; 1079)	2193 (1335; 3346)
Ethiopia	86962	12003 (11191; 13092)	41346 (36809; 45788)	53307 (48820; 58165)	57584 (45305; 71340)	61552 (52462; 71949)	118776 (98383; 143021)
Gabon	1542	177 (144; 249)	930 (685; 1161)	1109 (869; 1354)	1379 (486; 2265)	1877 (1281; 2376)	3220 (1999; 4526)
Gambia	1754	290 (245; 396)	989 (207; 1724)	1292 (498; 2007)	1793 (1041; 2768)	1533 (700; 2399)	3307 (1835; 5047)
Ghana	24375	2868 (2728; 3054)	6685 (5123; 9102)	9544 (7901; 12011)	20592 (17648; 23402)	17641 (14707; 20661)	38191 (32587; 43617)
Guinea	10079	1489 (1358; 1633)	4524 (3396; 5837)	6041 (4836; 7416)	8466 (7013; 10388)	8742 (7188; 10503)	17260 (14252; 20743)
Guinea-Bissau	1523	195 (165; 240)	183 (57; 490)	387 (253; 695)	1352 (668; 2187)	863 (440; 1499)	2230 (1215; 3522)
Kenya	42146	4947 (4654; 5347)	18980 (17005; 21567)	23968 (21920; 26737)	26522 (20863; 33553)	27526 (23143; 33047)	53865 (44541; 66102)
Lesotho	2179	202 (177; 302)	987 (532; 1471)	1200 (726; 1710)	857 (86; 2632)	1179 (480; 2546)	2028 (636; 5069)
Liberia	3841	520 (454; 617)	2108 (1469; 2863)	2632 (1993; 3392)	3832 (2432; 5182)	3966 (2726; 5193)	7817 (5196; 10313)
Malawi	15490	2388 (2237; 2589)	3930 (2777; 5401)	6321 (5158; 7863)	16859 (14731; 19481)	11724 (9454; 14290)	28720 (24671; 32961)
Mali	16116	2452 (2343; 2560)	2133 (1513; 3038)	4590 (3966; 5495)	19043 (17651; 20207)	7894 (6222; 9901)	26935 (24601; 29345)
Mauritania	3627	519 (470; 596)	55 (15; 464)	578 (508; 988)	3063 (2434; 4371)	672 (366; 1292)	3763 (2987; 5425)
Mozambique	23667	4955 (4727; 5203)	8159 (6408; 10008)	13131 (11288; 14943)	35924 (33370; 38246)	30794 (27750; 33095)	66899 (61532; 70875)
Namibia	2403	238 (218; 275)	231 (99; 529)	469 (341; 770)	919 (526; 1606)	511 (277; 1021)	1453 (842; 2539)
Niger	16427	2437 (2315; 2575)	652 (335; 1159)	3103 (2753; 3609)	10793 (9134; 12158)	2568 (1800; 3843)	13344 (11466; 15618)
Nigeria	165415	22624 (21827; 23603)	69565 (61497; 76826)	92097 (83969; 99561)	153188 (141918; 164250)	140537 (128159; 152596)	292966 (270134; 317358)
Republic of Congo	3830	402 (355; 478)	1357 (720; 2235)	1775 (1095; 2656)	2742 (1679; 4490)	2820 (1616; 4493)	5587 (3298; 8880)
Rwanda	11014	1172 (1134; 1228)	11882 (10797; 12912)	13057 (11950; 14091)	3003 (1884; 4153)	11244 (9933; 13014)	14314 (12382; 16723)
Senegal	12681	1693 (1626; 1784)	1630 (858; 3808)	3333 (2532; 5473)	8544 (7452; 10900)	4633 (3352; 7231)	13092 (11010; 17732)
Sierra Leone	5714	1031 (938; 1144)	4772 (3120; 5679)	5804 (4150; 6723)	7385 (6428; 8392)	7672 (6528; 8532)	15053 (13116; 16898)

Somalia	9478	1390 (1259; 1549)	676 (408; 1151)	2074 (1776; 2593)	8663 (6562; 10561)	4656 (3253; 6256)	13361 (10040; 16206)
South Africa	50110	4883 (4514; 5359)	15297 (12271; 19937)	20247 (17265; 24756)	36133 (29061; 45910)	34127 (27895; 42898)	70656 (56840; 87699)
South Sudan	10567	1596 (1411; 1849)	1303 (901; 1889)	2916 (2465; 3565)	10799 (8086; 13460)	7959 (5933; 10506)	18677 (14163; 23987)
Sudan	34188	5422 (4999; 5759)	273 (135; 684)	5715 (5227; 6307)	35257 (29880; 39498)	6483 (4072; 9985)	41659 (35059; 47789)
Swaziland	1216	181 (143; 246)	434 (172; 812)	622 (353; 984)	1423 (745; 2071)	1181 (587; 1807)	2569 (1442; 3825)
Tanzania	46549	6870 (6528; 7272)	22499 (19839; 25773)	29390 (26650; 32890)	46023 (40886; 51293)	43841 (39412; 48601)	89931 (80742; 99566)
Togo	5863	731 (705; 758)	3590 (3321; 3915)	4323 (4048; 4641)	5140 (4726; 5652)	5492 (5059; 6020)	10631 (9817; 11614)
Uganda	34841	4442 (4207; 4973)	21763 (19715; 23624)	26241 (24174; 28260)	20921 (16906; 29167)	26763 (23696; 32769)	47669 (40529; 61557)
Zambia	13916	2200 (2028; 2380)	4720 (3538; 7257)	6959 (5730; 9396)	14596 (12104; 16613)	12506 (9956; 15124)	27127 (22744; 31368)
Zimbabwe	13200	2173 (2091; 2280)	2584 (1861; 3657)	4743 (4031; 5806)	14773 (13505; 16164)	9169 (7804; 10778)	23862 (21600; 26388)
Total	859791	120845 (118916; 123110)	336547 (321856; 353282)	457169 (442647; 472348)	754387 (728977; 782983)	659942 (635708; 687878)	1415163 (1366449; 1471237)

Notes: Pixel-level risk estimates are used in calculation. Estimates are based on gridded population estimates in 2012. Calculations are based on the median and 95% Bayesian credible interval of the posterior predictive distribution of the risk from 2000 onwards. WHO guidelines for preventive chemotherapy against schistosomiasis included only school-aged children, while WHO guidelines for preventive chemotherapy against STH included school-aged children, pre-school aged children, and women of childbearing age.

Table S4: Number of people changing their preventive chemotherapy strategy when using the proposed guidelines compared to WHO guidelines

Country	Total population (thousands)	Number of people (95% CI; thousands)
Angola	20163	16502 (13136; 17958)
Benin	8772	8038 (7224; 8429)
Botswana	2016	1206 (661; 1579)
Burkina Faso	17347	14531 (13589; 15207)
Burundi	8822	6595 (5916; 7198)
Cameroon	20335	13782 (12982; 14480)
Central African Republic	4434	3258 (2655; 3831)
Chad	11752	9387 (8111; 10362)
Côte d'Ivoire	19967	15252 (14170; 16127)
Democratic Republic of the Congo	68273	59073 (56425; 61595)
Djibouti	951	889 (233; 949)
Equatorial Guinea	721	427 (246; 592)
Eritrea	5526	1758 (1235; 2318)
Ethiopia	86962	59559 (53631; 65738)
Gabon	1542	1271 (1033; 1419)
Gambia	1754	1618 (1137; 1714)
Ghana	24375	18662 (17218; 19995)
Guinea	10079	7460 (6563; 8442)
Guinea-Bissau	1523	1204 (870; 1423)
Kenya	42146	29806 (26844; 32537)
Lesotho	2179	1336 (663; 1914)
Liberia	3841	3295 (2712; 3587)
Malawi	15490	13052 (12176; 13899)
Mali	16116	13620 (13123; 14129)
Mauritania	3627	2398 (1961; 3082)
Mozambique	23667	22004 (21337; 22554)
Namibia	2403	990 (653; 1442)
Niger	16427	9785 (8920; 10720)
Nigeria	165415	134647 (128838; 139041)
Republic of Congo	3830	2948 (2284; 3466)
Rwanda	11014	8555 (7764; 9278)
Senegal	12681	8042 (6846; 9619)
Sierra Leone	5714	5282 (5005; 5462)
Somalia	9478	6267 (5196; 7276)
South Africa	50110	32089 (27299; 37997)
South Sudan	10567	8319 (7089; 9222)
Sudan	34188	26362 (24157; 27870)
Swaziland	1216	1103 (837; 1207)
Tanzania	46549	38174 (35647; 40250)
Togo	5863	5020 (4754; 5285)
Uganda	34841	24769 (22439; 27740)
Zambia	13916	11723 (10924; 12430)
Zimbabwe	13200	11136 (10524; 11720)
Total	859791	658771 (646433; 671802)

Table S5: Number of people receiving both albendazole and praziquantel under proposed guidelines who would receive non-integrated treatment under WHO guidelines

Country	Total population (thousands)	Number of people (95% CI; thousands)
Angola	20163	4485 (3119; 6553)
Benin	8772	2608 (2006; 3085)
Botswana	2016	155 (82; 238)
Burkina Faso	17347	2418 (1853; 3455)
Burundi	8822	1309 (887; 1891)
Cameroon	20335	2664 (2225; 3212)
Central African Republic	4434	988 (702; 1310)
Chad	11752	1699 (1309; 2164)
Côte d'Ivoire	19967	4828 (3846; 5731)
Democratic Republic of the Congo	68273	23279 (20723; 25720)
Djibouti	951	55 (7; 363)
Equatorial Guinea	721	64 (12; 175)
Eritrea	5526	163 (68; 298)
Ethiopia	86962	18332 (14887; 22092)
Gabon	1542	378 (175; 544)
Gambia	1754	580 (243; 817)
Ghana	24375	5310 (4427; 6266)
Guinea	10079	2270 (1861; 2736)
Guinea-Bissau	1523	278 (151; 439)
Kenya	42146	7634 (6113; 9245)
Lesotho	2179	310 (44; 673)
Liberia	3841	1271 (873; 1598)
Malawi	15490	3329 (2634; 4103)
Mali	16116	2202 (1716; 2775)
Mauritania	3627	148 (80; 286)
Mozambique	23667	6941 (6215; 7520)
Namibia	2403	140 (71; 277)
Niger	16427	769 (532; 1147)
Nigeria	165415	41438 (38149; 44955)
Republic of Congo	3830	977 (588; 1463)
Rwanda	11014	1167 (709; 1586)
Senegal	12681	1390 (980; 2034)
Sierra Leone	5714	2293 (1793; 2622)
Somalia	9478	954 (673; 1296)
South Africa	50110	8203 (6674; 10387)
South Sudan	10567	1920 (1549; 2306)
Sudan	34188	1432 (943; 2139)
Swaziland	1216	310 (164; 446)
Tanzania	46549	12659 (11455; 14262)
Togo	5863	1875 (1742; 2029)
Uganda	34841	8129 (6666; 9990)
Zambia	13916	3787 (3130; 4827)
Zimbabwe	13200	2365 (1985; 2857)
Total	859791	183093 (175159; 190970)

Definition of non-integrated provided in Table S6.

Table S6: Methodology for comparing cost-effective preventive chemotherapy strategies and WHO recommended strategies in Table S3

WHO guidelines- PZQ	WHO guidelines- ALB	Classification of WHO strategy	Proposed guidelines equivalent	Comments on proposed guidelines equivalent
PZQ SAC, 1/yr	None	Not integrated	-PZQ SAC, 1/yr -PZQ, community 1/yr	-"PZQ community 1/yr" is only equivalent for SAC; not for rest of population
PZQ SAC, 1/ 2 yrs	None	Not integrated	None	
PZQ SAC, 1/ 3 yrs	None	Not integrated	No treatment	For non-endemic settings
PZQ SAC, 1/yr	ALB SAC+Pre+wocba 1/yr	Integrated- SAC only Not integrated- adults (incl. wocba), Pre	-ALB+PZQ SAC 1/yr -ALB+PZQ community 1/yr	"ALB+PZQ community 1/yr" only equivalent for SAC; not for rest of population
PZQ SAC, 1/ 2 yrs	ALB SAC+Pre+wocba 1/yr	Not integrated	-ALB SAC 1/yr -ALB community 1/yr	Equivalent for SAC population only
PZQ SAC, 1/ 3 yrs	ALB SAC+Pre+wocba 1/yr	Not integrated	-ALB SAC 1/yr -ALB community 1/yr	Equivalent for SAC population only
PZQ SAC, 1/yr	ALB SAC+Pre+wocba 2/yr	Integrated- SAC only Not integrated- adults (incl. wocba), Pre	None	
PZQ SAC, 1/ 2 yrs	ALB SAC+Pre+wocba 2/yr	Not integrated	None	
PZQ SAC, 1/ 3 yrs	ALB SAC+Pre+wocba 2/yr	Not integrated	None	

SAC; school-aged children, Pre; pre-school aged children, wocba; women of child-bearing age

Table S7: Comparison of single medicine and integrated preventive chemotherapy programs

PC strategy	STH prevalence (add ALB to PZQ-only PC program)	Schistosomiasis prevalence (add PZQ to ALB-only PC program)
Treat SAC, annual	2%*	1%
Treat community, annual	2%	2%
Treat community, biannual	3%	3%

PC; preventive chemotherapy, ALB; albendazole, PZQ; praziquantel

*For interpretation, in a setting with annual school-based PC program with praziquantel against schistosomiasis, if the STH prevalence is 2% or above, then it is cost-effective to also give albendazole.

Table S8: Costs, disability, and incremental cost-effectiveness of base case analysis of preventive chemotherapy for schistosomiasis and STH

	Total costs (2014 US$)		Total disability (DALYs)		ICER (US$/DALY)
Strategy	Discounted	Undiscounted	Discounted	Undiscounted	
Schistosomiasis, 5% prevalence					
No treatment	0	0	14.0	15.0	----
SAC only, annual	3140	3328	11.0	11.8	1050
Schistosomiasis, 15% prevalence					
No treatment	0	0	44.8	47.2	----
SAC only, annual	3140	3328	37.8	39.4	449
Community-wide, annual	25826	27375	15.8	16.4	1031
Schistosomiasis, 30% prevalence					
No treatment	0	0	120.8		----
SAC only, annual	3140	3328	101.2	105.2	160
Community-wide, annual	25826	27375	50.0	51.5	443
Community-wide, biannual	51652	54750	25.2	25.3	1042
STH, 20% prevalence					
No treatment	0	0	9.2	9.4	----
SAC only, annual	2344	2484	7.0	7.1	1077
STH, 60% prevalence					
No treatment	0	0	43.6	45.7	----
SAC only, annual	2344	2484	35.7	377	298
Community-wide, annual	22642	24000	16.4	16.9	1050
STH, 85% prevalence					
No treatment	0	0	95.8	100.0	----
SAC only, annual	2344	2484	82.3	85.7	174
Community-wide, annual	22642	24000	51.7	53.1	663
Community-wide, biannual	45284	48000	29.9	30.0	1039

DALY; disability-adjusted life year, ICER; incremental cost-effectiveness ratio, SAC; school-aged children. This simulation was for a 5,000-person community (see Methods). Costs and disability are discounted at 3% annually, and undiscounted results are also presented. Prevalence thresholds with undiscounted results were comparable to results with 3% discounting.

Table S9: Estimated annual drug costs for preventive chemotherapy in sub-Saharan Africa

	WHO guidelines		Proposed guidelines	
	ALB	PZQ	ALB	PZQ
Number (thousands)	336,547	120,845	659,942	754,387
Estimated cost* (2015 US$)	10,096,410	25,377,450	19,798,260	158,421,270

*Assumes drugs are not donated. Estimated cost is US$0.03 for ALB and US$0.21 for PZQ. Estimates are meant to provide a general understanding of magnitude of required funding.
ALB; albendazole, PZQ; praziquantel

Table S10: Estimated cost synergies from integrated preventive chemotherapy compared to non-integrated programs

	Non-integrated treatment		Integrated treatment	
Cost (US$)	School	Community	School	Community
Drugs	1,061.35	4,245.39	1,061.35	4,245.39
Programmatic delivery	4,422.28	44,222.80	2,211.14	22,111.40
Total	5,483.63	48,468.19	3,272.49	26,356.79
Cost savings (% non-integrated program)	--	--	40.3%	45.6%

*We did not assume drugs are donated. Estimated costs were US$0.03 for albendazole, US$0.21 for praziquantel, $0.50 for school-based delivery, and US$1.50 for community-wide delivery. Cost estimates are computed for a 5-year treatment program, discounted 3% annually, and estimated for a 5,000-person community. The results are meant to provide a general understanding of magnitude of cost synergies with integrated treatment.