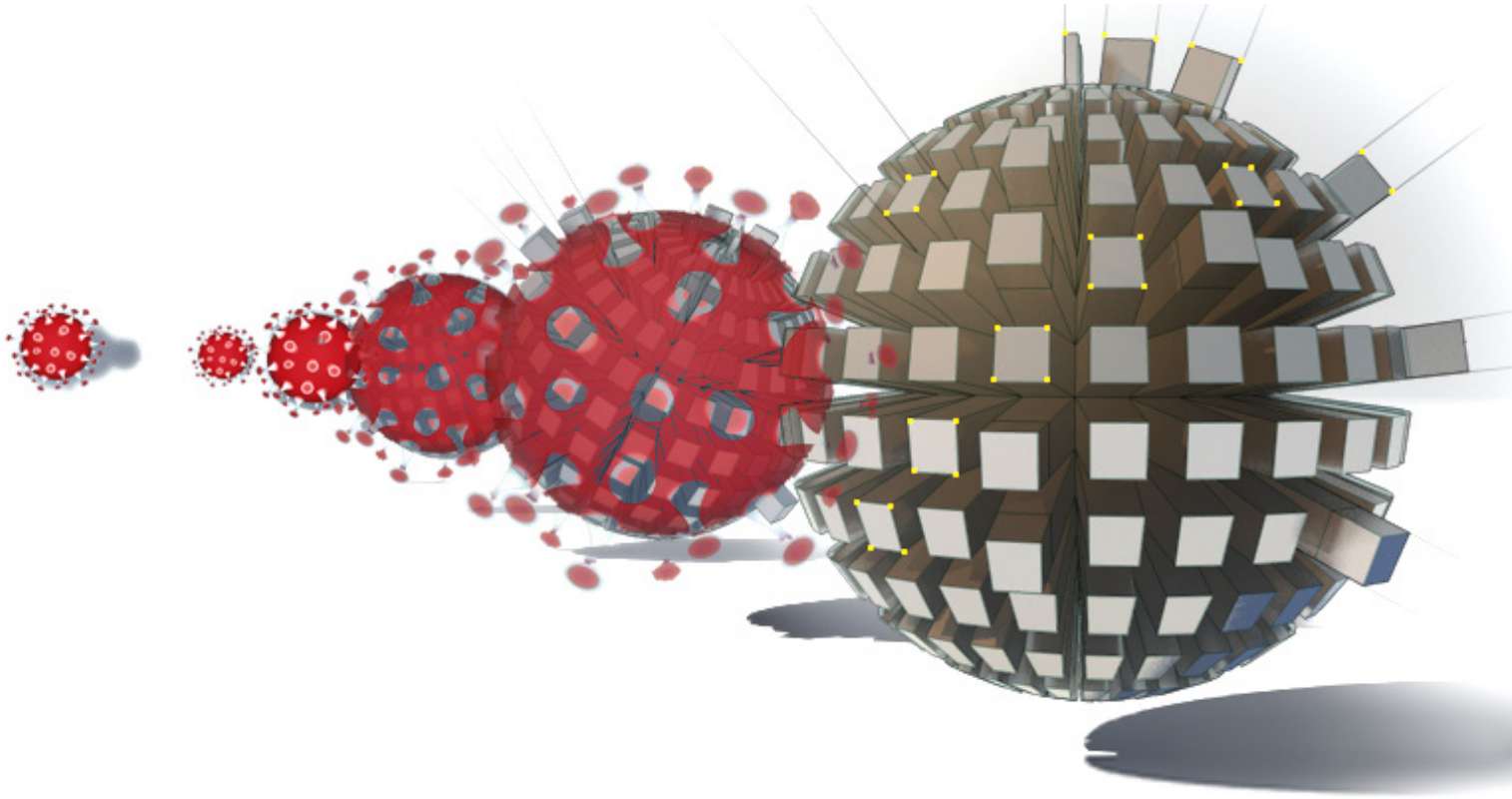

Impact of the COVID-19 pandemic on seven neglected tropical diseases: a model-based analysis

World Health Organization

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Key messages

- Delays in mass drug administration (MDA) and active case-finding activities due to COVID-19 will generally lead to a resurgence in neglected tropical diseases (NTDs) for which these interventions are an important part of the public health approach. More time and greater total numbers of rounds of MDA are likely to be needed to reach agreed public health targets for these NTDs.
- Existing models do not allow estimation of numbers of additional disability-adjusted life years lost or other possible negative or positive effects, such as on antimicrobial resistance in causative organisms.
- The underlying dynamics of each infection, local transmission parameters, duration of delay, history of programme activity, chance and implementation of remedial strategies will influence the ultimate impact.
- Populations in which infection transmission is most intense are at greatest risk because resurgence will be greatest in these populations.
- Populations served by programmes that are in their early stages will experience a return to pre-treatment endemicity levels, whereas those served by more advanced programmes that have previously managed to reduce or control transmission will observe lower levels of resurgence, provided the current transmission rate is not too high.
- Schistosomiasis, trachoma and visceral leishmaniasis (in high transmission settings for each) are the NTDs for which the models suggest that remedial strategies are most likely to be needed.
- Once programmes can resume community-based interventions, modelling analyses suggest that proposed remedial strategies may help to get progress towards 2030 targets back on track. This will require empirical confirmation in population-based studies. In some populations, modelling analyses suggest that remedial strategies might also provide an opportunity to accelerate progress; this would also require empirical confirmation.
- A limitation of the available evidence is that remedial strategies have only been modelled in terms of their potential impact on transmission. No analysis of cost, cost-effectiveness or cost-benefit was conducted, nor was the availability of the additional medicines and diagnostics that might be needed to implement them explored. It is therefore possible that some remedial strategies modelled here might not be widely implementable.

1. Background

Since the launch of the 2012–2020 World Health Organization (WHO) road map for the control, elimination and eradication of neglected tropical diseases (NTDs) (*1*), considerable progress against NTDs has been made. Between 2010 and 2020, the number of people requiring interventions against NTDs globally fell by 600 million, and 42 countries, areas and territories eliminated at least one NTD (*2*). In January 2021, a new NTD road map for 2021–2030 (*2*) was launched, setting future targets and milestones for 20 diseases and disease groups. The road map also sets cross-cutting targets, including for strengthened capacity of national health systems to deliver interventions through existing infrastructure.

The COVID-19 pandemic (*3*) represents an unprecedented threat to the gains already made against NTDs and to future progress towards the 2030 NTD control, elimination and eradication targets. In order to minimize the risk of programmes inadvertently facilitating transmission of SARS-CoV-2, the causative agent of COVID-19, on 1 April 2020, WHO recommended that NTD programmes temporarily suspend community-based surveys, mass treatment and active case finding (*4,5*).

Decisions to resume community-based activities require context-specific risk-benefit analyses taking into account the local epidemiology of COVID-19 and NTDs and the local capacity to undertake the work safely and effectively (*6*). To support rational decision-making, a number of questions may be important, including:

- How long can interventions against NTDs be postponed before progress towards the 2030 NTD targets is adversely affected?
- In which settings will delay-related impacts be greatest? In particular, how are impacts influenced by baseline NTD endemicity, treatment history and programme stage?
- Can any remedial strategies be implemented once community-based activities resume, which could help to regain ground lost to COVID-19-related programme interruptions and minimize the risks of resurgence of infection and disease?

WHO has collaborated with the NTD Modelling Consortium (https://www.ntdmodelling.org/) to develop scenarios to assess the impact of programme disruptions and to help formulate remedial strategies that could help programmes get back on target (*7,8*). This report presents initial results for five NTDs in which mass treatment of entire or targeted populations (often referred to as "preventive chemotherapy") is used: lymphatic filariasis, onchocerciasis, schistosomiasis, soil-transmitted helminthiases and trachoma. It also presents initial results for two NTDs for which individual-level screening and treatment is critical: gambiense human African trypanosomiasis and visceral leishmaniasis. For visceral leishmaniasis, only the situation in the Indian subcontinent has been considered.

2. Analyses

The analyses presented here are based on the transmission dynamic modelling frameworks previously developed by the NTD Modelling Consortium (*9–15*). These models have been used to investigate the impact of potential disruptions to NTD programmes by simulating the increase in infection prevalence during the period of COVID-19-related delay and the resulting effect on the timing or probability of achieving the 2030 NTD targets (*2*). The analyses consider the impact in different transmission settings and the potential remedial benefit of implementing alternative treatment strategies.

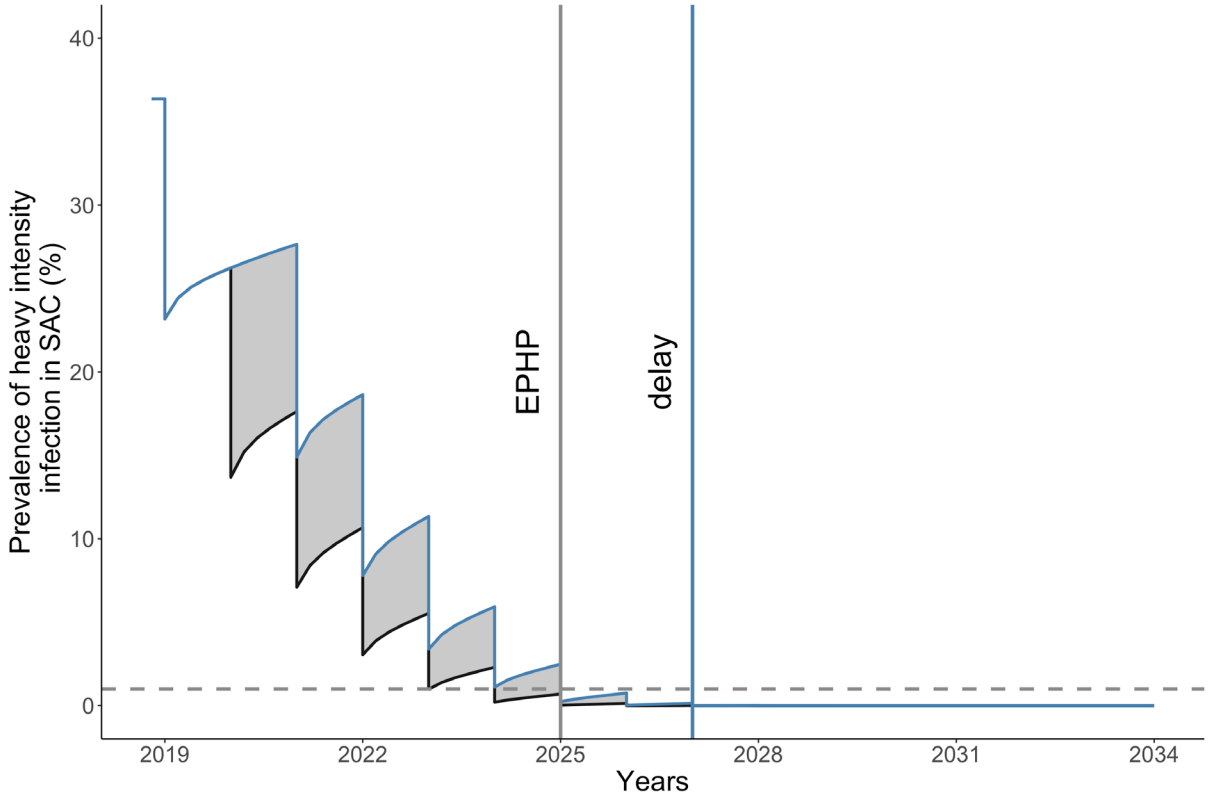
The models incorporate species-specific assumptions about pathogen lifespan; vector species; the dynamics, rates and heterogeneity of exposure; and pathogen distribution within human populations. Additionally, assumptions about case detection, treatment efficacy, treatment coverage and number of previous rounds of mass drug administration (MDA; where relevant) were made for each disease. Further details of these assumptions can be found in the technical report (*7*).

2.1 Impact of disruptions to MDA

Delays to MDA rounds will lead to greater numbers of infections in the community, through both prevalent infections remaining untreated and increases in onward transmission. This means that some of the gains (reductions in prevalence) achieved through previous rounds of MDA will be lost, requiring more rounds than might otherwise have been needed to reach the 2030 NTD targets. The longer the delay to the scheduled MDA, the greater the resurgence in infection, and the greater the number of rounds required to get back on track. In settings with higher transmission intensity, the resurgence of infection will be faster, and therefore the number of rounds required to catch up will be higher.

Fig. 1 shows an example of the forecast impact of a 12-month delay to MDA in a population for whom rounds of MDA were (a) delivered in March 2019 and (b) scheduled for March 2020, but (due to COVID-19) not delivered again until March 2021; a 12-month delay resulting in a 24-month interval between successive MDA rounds.

Fig. 1. Predicted impact of a 12-month delay to mass drug administration (MDA) for schistosomiasis in a hypothetical population with high baseline transmission intensity in school-aged children (SAC) but a low adult burden of infection. The black line represents the prevalence of heavy intensity infection over time if MDA had proceeded as originally planned, and the blue line represents the prevalence of heavy intensity infection over time with a missed second MDA round; there is a consequent delay to achievement of elimination as a public health problem (EPHP) from 2025 to 2027. The grey area shows the increased burden of heavy intensity infection which occurs as result of the delay.



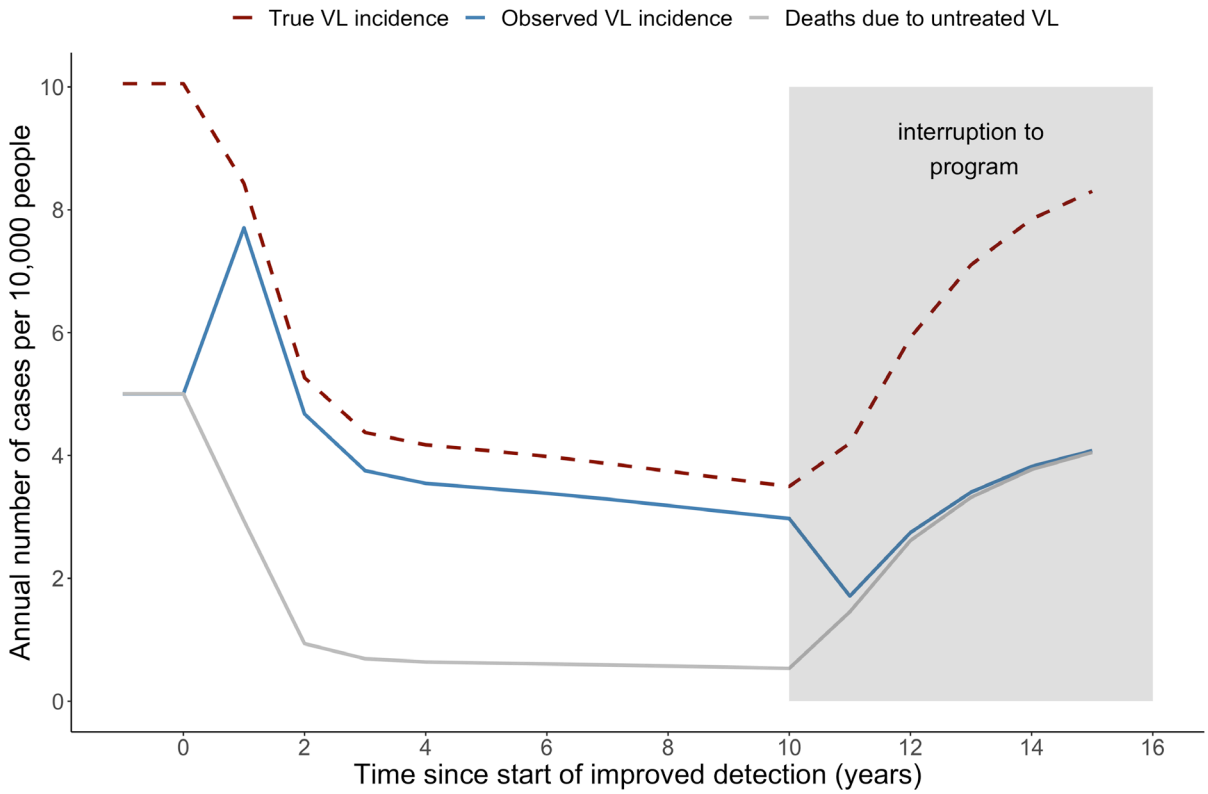
2.2 Impact of disruptions to case detection

For many NTDs, active and passive case-detection are likely to be affected by COVID-19-related disruptions to health systems. For some NTDs, delays to active case detection will lead to an increase in the underlying rate of new infections.

Here we outline some general points about the effect of changes in case-finding success over time on the incidence of new cases, using the example of visceral leishmaniasis (**Fig. 2**). In a new case-finding programme, as efficacy of finding cases increases, there may be an initial increase in the apparent case incidence as existing cases come to the attention of the health system more quickly than previously (Fig. 2, year 1, dashed line). Over time, earlier case detection is expected to result in a reduction in transmission, leading to a reduction in the true incidence (Fig. 2, dashed red line), and a related drop in the rate of case detection (Fig. 2, solid blue line).

During a programme interruption (due to COVID-19 or any other cause; Fig. 2, grey area, year 10 onwards), the link between detected cases and true incidence is broken, and it is possible that a drop in the number of detected cases could mask a resurgence in infection (year 10), or if the resurgence is detected, that it is detected late and its magnitude is underestimated (year 12 onwards).

Fig. 2. Deterministic model predictions for impact of improved case detection on visceral leishmaniasis (VL) incidence and mortality over time.



Adapted from Coffeng et al (*16*).

This breaking of the relationship between case detection and underlying incidence is likely to lead to a gradual increase in morbidity and mortality. The rate of increase may be slow due to the relatively slow epidemic growth rate of these NTDs, in comparison to, for example, malaria, but it is still important to quantify. A particularly concerning feature of this type of delay is that local outbreaks or pockets of transmission could be missed.

2.3 Impact of remedial strategies

Once community-based activities resume, alternative MDA strategies could potentially be used to help programmes resume their previous trajectory towards the 2030 NTD targets – or even to accelerate progress so that those targets could be reached earlier than might have otherwise been anticipated. These strategies include extra rounds of MDA on shorter timescales (e.g. biannual treatment); increasing treatment coverage; changing the target population (e.g. treating adults alongside an existing school-based deworming programme); or using different combinations of medicines (e.g. ivermectin + diethylcarbamazine + albendazole in suitable lymphatic filariasis-endemic populations (*17,18*)) (**Table 1**). The counterfactual for each scenario modelled in this report was no disruption to the previously-planned annual MDA rounds undertaken according to existing WHO guidance, delivered as either school-based or community-based treatment, depending on the NTD (*19–21*).

For NTDs for which case-detection is critical, the major aim will be to restart both active and passive case-detection activities as soon as possible. We therefore model resumption of activities, with possible extension of the timelines for active case detection of and vector control for visceral leishmaniasis (**Table 1**).

Table 1. Currently recommended strategies by disease, with modelled remedial strategies after a 12-month interruption

Disease	WHO-recommended intervention modelled	Potential remedial strategies modelled
Gambiense human African trypanosomiasis	Active screening and passive surveillance in moderate (1–10 reported cases/10 000 people per year) and high-risk (> 10 reported cases/10 000 people per year) settings (no vector control)	• Rapid resumption of screening activities
Lymphatic filariasis (*Wuchereria bancrofti*)	Annual MDA, 65% coverage of entire population in moderate (15–20%) and high (25–30%) baseline prevalence settings	• Single extra MDA round, 65% coverage • Three years annual MDA, 80% coverage • Single IDA round, 65% coverage (where appropriate)
Onchocerciasis	Annual MDA, 65% coverage of entire population in meso- (40–59%) and hyper-endemic (60–80%) baseline prevalence settings	• Single extra MDA round, 65% coverage • Single round of MDA achieving 80% coverage
Schistosomiasis (*Schistosoma mansoni*)	Annual MDA, 75% coverage of SAC in moderate (30% baseline prevalence among SAC) and high (70% baseline prevalence among SAC) in low and high adult burden of infection	• Higher coverage, annual MDA (treating 85% of SAC) until the 2030 target is achieved • Single community-wide MDA (treating 85% of SAC and 40% of adults)
Soil-transmitted helminthiases (*Ascaris lumbricoides, Ancylostoma duodenale, Necator americanus*)	Annual MDA in preschool-aged children (pre-SAC) and SAC in moderate baseline prevalence settings (20–50% in SAC) and biannual MDA in high baseline prevalence settings (> 50%)	• Bi-annual treatment in pre-SAC and SAC (moderate baseline prevalence only) until the 2030 target is achieved • One year of community-wide MDA following resumption, incorporating one or two MDA rounds, depending on prevalence
Trachoma	Annual MDA, 80% coverage of entire population in medium (mean baseline trachomatous inflammation—follicular prevalence of 20%) and high (mean baseline prevalence of 40%) in children aged 1–9 years	• Single extra MDA round with 80% coverage of entire population • Single extra MDA round to children (aged 6 months–10 years) only
Visceral leishmaniasis (Indian subcontinent)	Attack phase: intense indoor residual spraying of insecticide and active case detection; consolidation phase: limited indoor residual spraying of insecticide and increased active case detection for both moderate (5 reported cases/10 000 people per year) and high (10 reported cases/10 000 people per year) pre-control endemicity settings	• Extension or reinitiation of the attack phase

IDA: ivermectin plus diethylcarbamazine plus albendazole, MDA: mass drug administration, SAC: school-aged children.

3. Nature of the predictions in this report

For each disease, the outputs of the underlying mathematical models are summarized here in terms of the average expected outcomes in typical settings with low, medium or high baseline prevalence. References to the 2030 NTD targets indicate the disease-specific targets set out within the 2021–2030 NTD road map (*2*).

The models account for known uncertainties in biological parameters and for the impact of chance events on the dynamics of transmission and the effect of interventions. However, it is important to remember that:

1. Chance in this context is not just a theoretical possibility: variation between settings in the response to delays to interventions or the proposed remedial intervention strategies is virtually guaranteed. The impact on progress in any given population may be lesser or greater than presented here.
2. Variability in outcomes will also be affected by known local conditions and relative success in implementing interventions. For example, a population with high baseline prevalence or transmission intensity (*22*) or that has achieved low MDA coverage may experience faster resurgence, lower response to interventions after MDA resumes, or have a longer-term impact from delay to MDA. The converse is also true: populations with low baseline prevalence or low transmission intensity or that have had high MDA coverage may experience slower resurgence, etc. The number of previous rounds of high-coverage MDA is likely to influence outcomes in this way.
3. Even viewed (correctly) as the likely average outcomes, the outputs remain predictions. The predicted impact of remedial strategies should be interpreted with special caution. The impact of delays to interventions and the relative effectiveness of remedial strategies (and, more broadly, the economic, social and public health impact of the pandemic and any remedial strategies implemented by NTD programmes) can only be conclusively demonstrated through empirical study at population level.
4. The remedial strategies considered are presented in terms of their modelled impact on transmission, having been selected for their likely feasibility in a general context. However, no modelling has been undertaken to estimate relative cost, cost-effectiveness or cost-benefit. Additional costs might be necessary to implement the remedial strategies, including cost of more frequent rounds of MDA or the cost of undertaking active case searches. It is possible that the costs of the proposed remedial strategies outweigh the benefits that might be obtained.
5. No assessment was undertaken of the potential availability of the additional medicines and diagnostics that might be needed to implement the proposed remedial strategies. It is possible that these extra medical products would not be available for donation or even for purchase at market prices. It is therefore possible that, even if proven effective, cost-effective and cost-beneficial, the modelled remedial strategies would not be widely implementable.
6. Other than the possible extension of vector control for visceral leishmaniasis, interventions taken into account by the models included only MDA and active case-finding. Possible COVID-19-related effects on (or remedial strategies involving) water, sanitation and hygiene (WASH) interventions were not considered. WASH interventions are believed to be critical for some NTDs (*23,24*). In addition, models did not take into account the possible effects of public health and social measures, such as movement restrictions and physical distancing (*25*), implemented in response to COVID-19.
7. Models were based on parameters relating to infection, but for the purposes of emphasizing the impact on people, results are generally expressed below in terms of prevalence or incidence of disease.

4. Results

This report presents the forecast impact of programmatic delays on the achievement of disease-specific NTD programme targets (*2*) and investigates different potential remedial strategies for reducing this impact (**Table 1**).

For the purposes of modelling the effect of delays to MDA for lymphatic filariasis, onchocerciasis, schistosomiasis, soil-transmitted helminthiases and trachoma, programmes were assumed to deliver MDA in March each year (Fig. 3a, open circles), with delays experienced to the planned March 2020 MDA round (Fig. 3a, slashed black circles). The schematic shows 6-, 12- and 18-month delays (Fig. 3a, red brackets) and resulting interval between MDA rounds (Fig. 3a, yellow brackets).

For gambiense human African trypanosomiasis and visceral leishmaniasis, programmatic delays of the same duration, commencing 1 April 2020, were modelled.

Although analyses were undertaken to investigate the impact of delays of 6, 12 or 18 months (**Figs 3 and 4**), for illustrative purposes, in the conclusions summarized below, the focus is on models incorporating a 12-month delay.

Fig. 3. Mean delays (in years) to 2030 targets (2) for soil-transmitted helminthiases (*Ascaris,* hookworm, *Trichuris*); lymphatic filariasis (LF, in settings employing diethylcarbamazine plus albendazole [DA] or ivermectin plus albendazole [IA]); onchocerciasis (oncho); schistosomiasis (SCH); and trachoma; by model and endemicity setting, considering MDA delays (dashed line) of (b) 6 months, (c) 12 months and (d) 18 months. The dashed line facilitates visual comparison between the MDA delay and the predicted delay to the relevant 2030 target. Please refer to Table 1 for definitions of medium and high endemicity settings for each disease.

Fig. 3a.

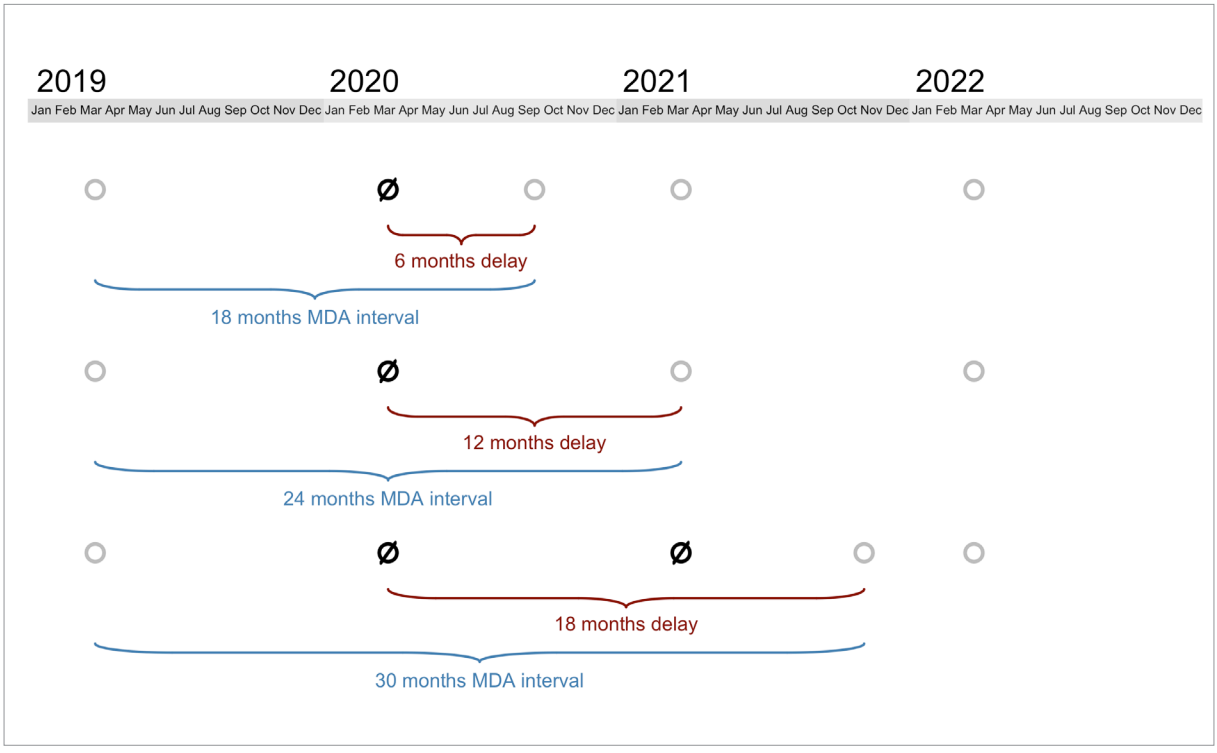


Fig. 3b.

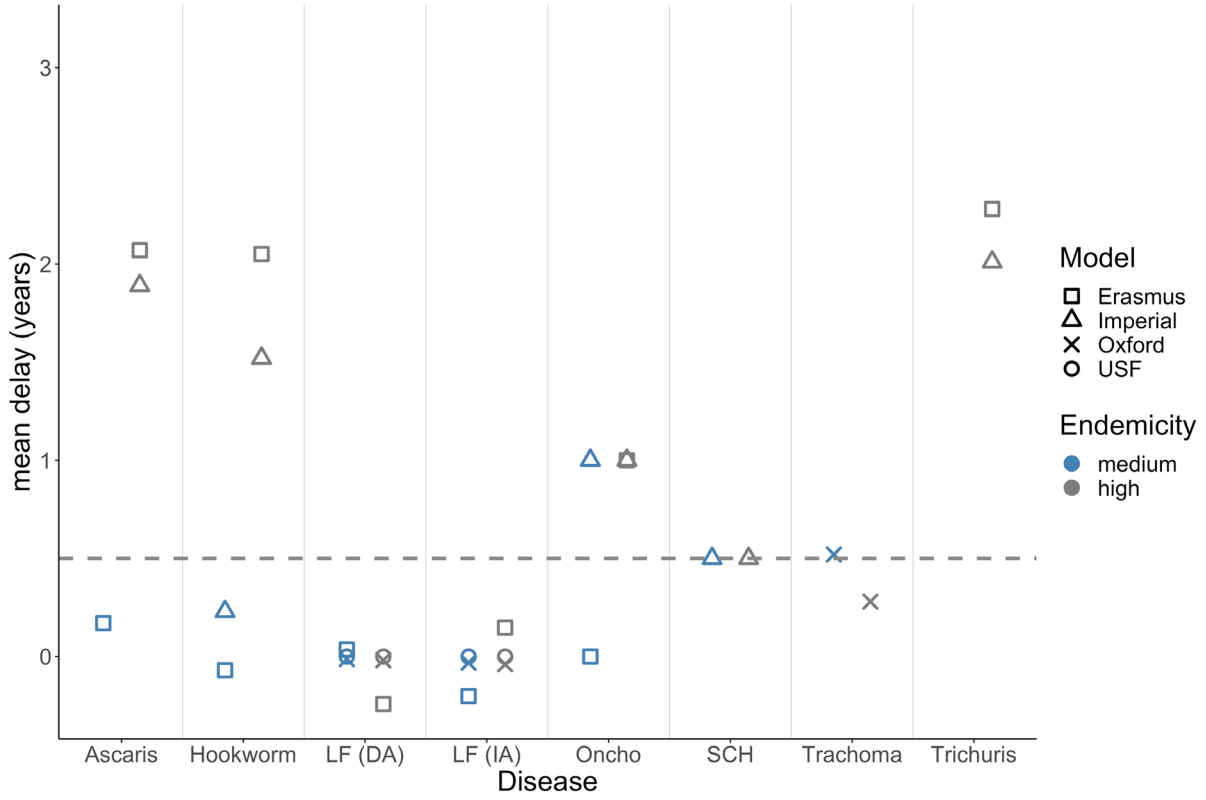

mean delay (years)
3
2
1
0
Ascaris
Hookworm
LF (DA)
LF (IA)
Oncho
SCH
Trachoma
Trichuris
Disease
Model
Erasmus
Imperial
Oxford
USF
Endemicity
medium
high

Fig. 3c.

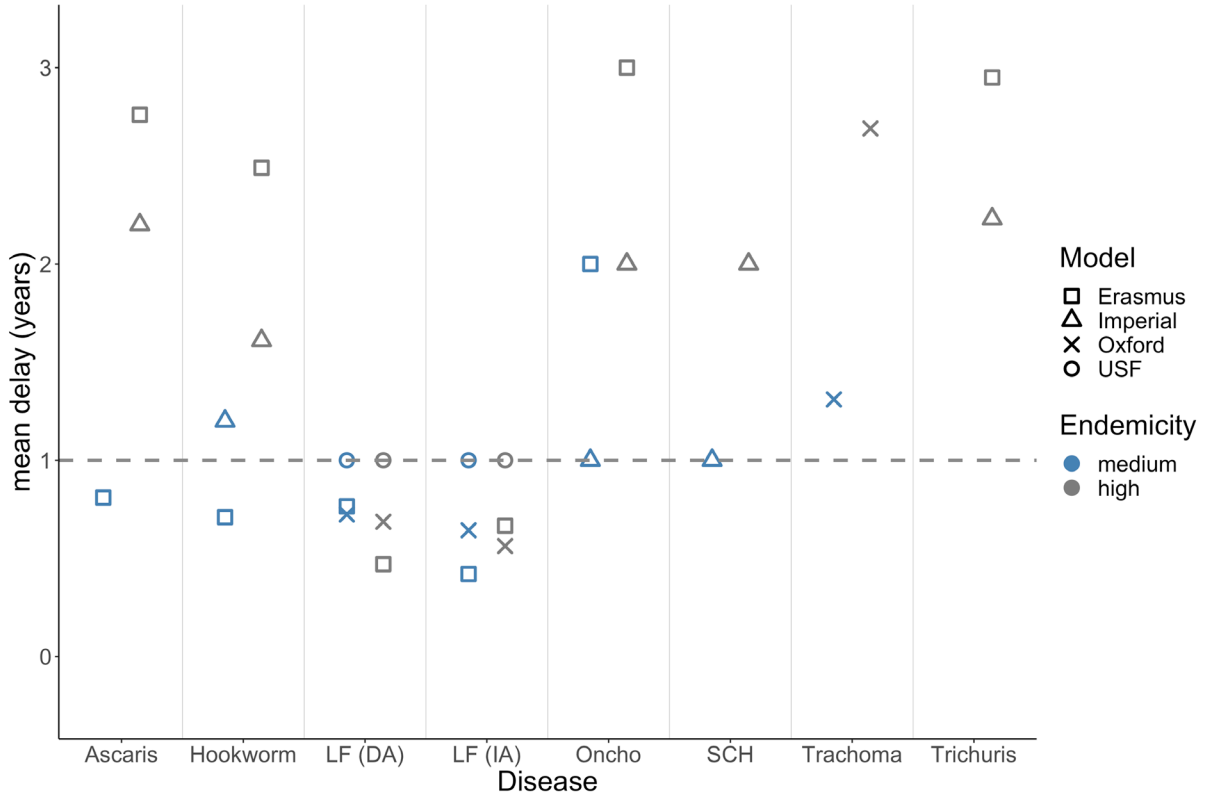

mean delay (years)
3
2
1
0
Ascaris
Hookworm
LF (DA)
LF (IA)
Oncho
SCH
Trachoma
Trichuris
Disease
Model
Erasmus
Imperial
Oxford
USF
Endemicity
medium
high

Fig. 3d.

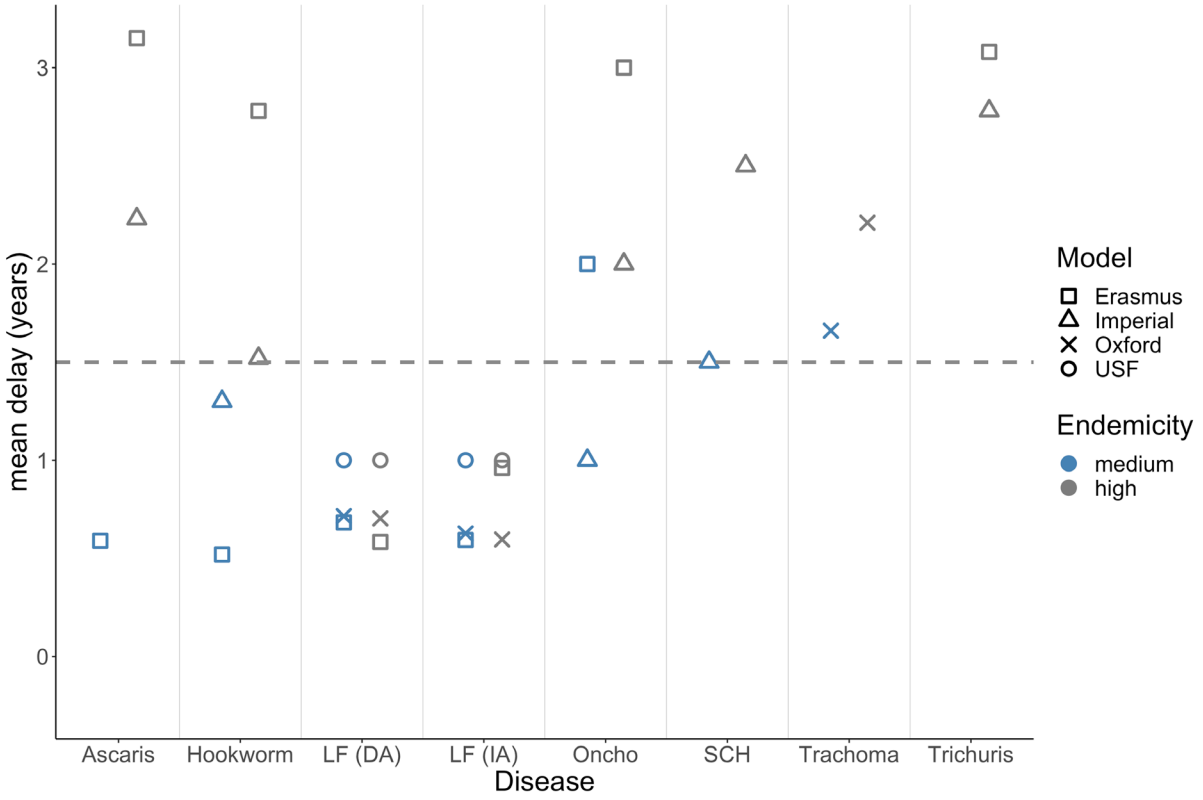

mean delay (years)
0
1
2
3
Ascaris
Hookworm
LF (DA)
LF (IA)
Oncho
SCH
Trachoma
Trichuris
Disease
Model
Erasmus
Imperial
Oxford
USF
Endemicity
medium
high

Fig. 4. Mean delays (in years) to the 2030 targets (*2*) for gambiense human African trypanosomiasis (gHAT) and visceral leishmaniasis (VL) using mathematical models developed by different research groups, for medium and high endemicity settings, considering active screening and case detection delays of 6 (a), 12 (b) and 18 (c) months (dashed line). E0 and E1 are two different arbitrarily-named VL models developed by Erasmus University. Please refer to Table 1 for the definitions of medium and high endemicity for each disease.

Fig. 4a.

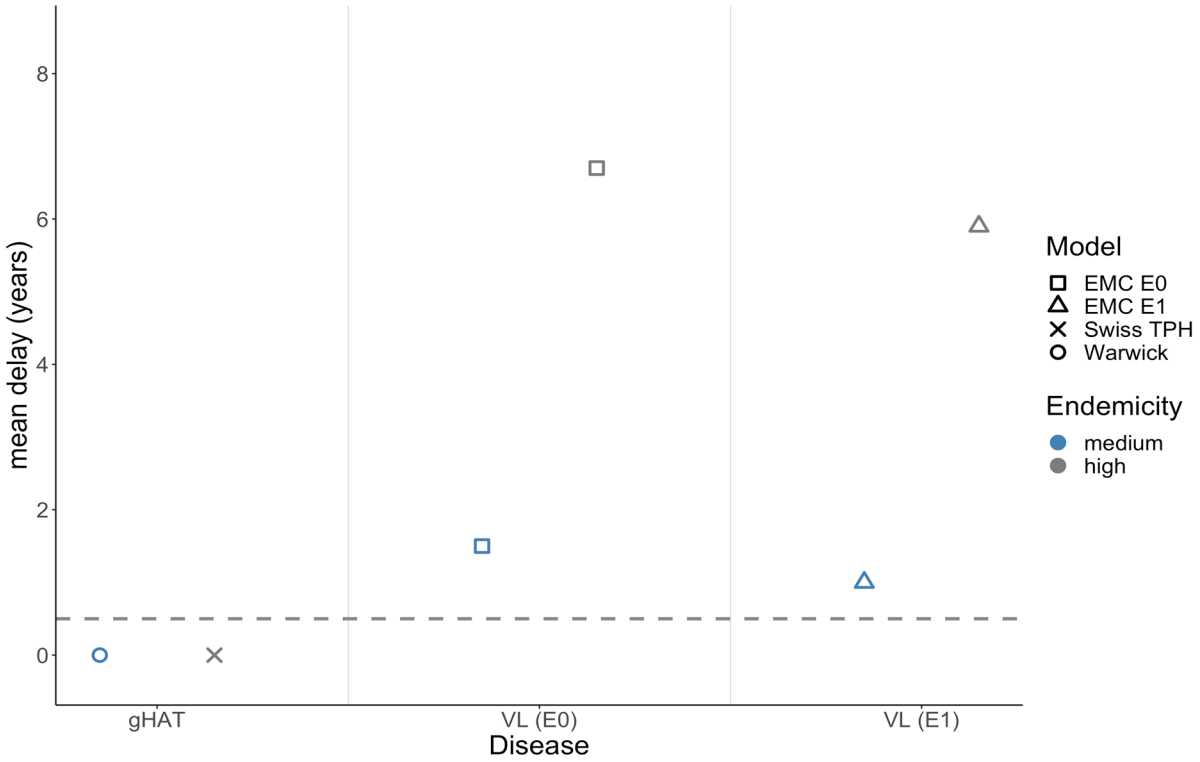


Fig. 4b.

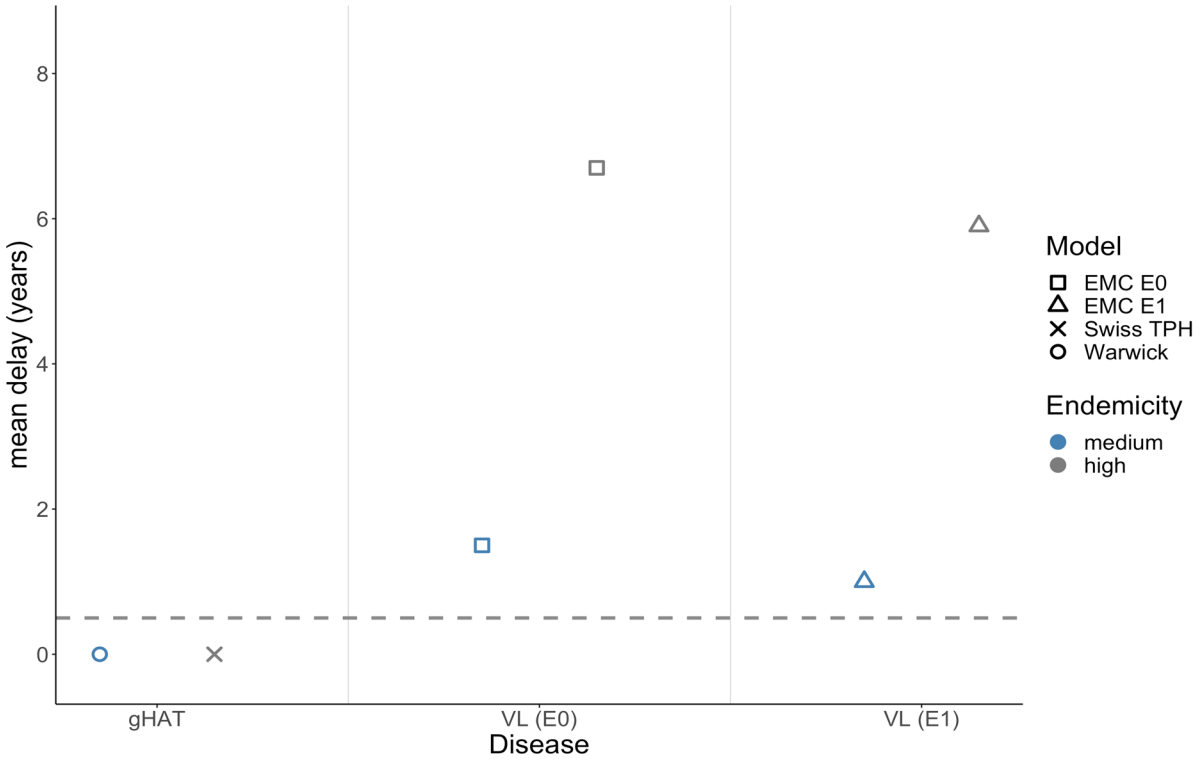
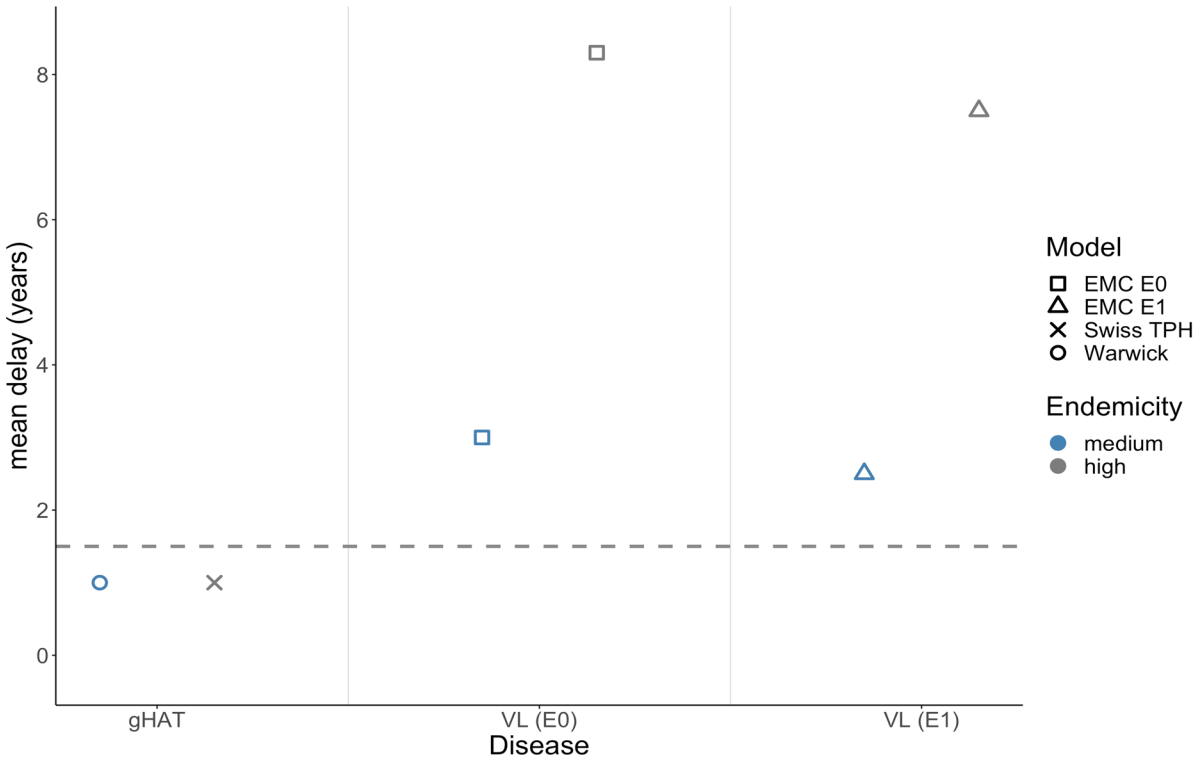


Fig. 4c.



4.1 Gambiense human African trypanosomiasis

- Analyses were undertaken to predict gHAT incidence in moderate- and high-risk settings without vector control following interruption of control activities.
- Modelled delays to target achievement: In both moderate- and high-risk settings, delays incurred through interruption of active screening alone are likely to be small (probably the same as or less than the duration of the interruption). In the most severe scenario modelled, in which both active and passive screening are interrupted until the end of 2021, the mean delay to elimination of transmission is predicted to be 2–3 years. In high-risk settings, the elimination target is unlikely to be attained, even in the absence of COVID-19-related delays, unless interventions are intensified. In such settings, COVID-19-related delays are likely to be followed by higher gHAT-induced mortality in the coming years.
- Modelled mitigation: After resumption of community-based activities is possible, increased coverage of active screening could improve the probability of meeting the elimination of transmission target by 2030. Retaining functioning passive surveillance, even if incomplete, could help to avoid significant delays to elimination of transmission and prevent substantial increases in mortality (*26*).
- Existing WHO guidance on active screening: In any village in which cases have been reported in the previous 3 years, WHO recommends annual screening of all consenting residents until no new cases are detected for 3 consecutive years. In villages in high-incidence areas (≥ 1 case/10 000 people per year), WHO additionally recommends that after no new cases have been detected at annual screening for 3 consecutive years, screening of all consenting residents continues at 3-year intervals until no cases are detected for 5 years (*27*).

4.2 Lymphatic filariasis

- Analyses were undertaken for bancroftian filariasis and the *Anopheles* vector, assuming 30% coverage of long-lasting insecticidal nets, with distribution, prior to MDA interruption, of either ivermectin plus albendazole, or diethylcarbamazine plus albendazole.
- Modelled impact of missed MDA rounds: Generally, the mean delay as a result of MDA interruption would be less than the duration of MDA interruption. Variation in impact is likely to be higher in high-endemicity populations, in whom it is possible that in some instances, up to 3 years of progress may be lost from one missed MDA round. In low-prevalence settings, if MDA started by 2018, any delay would not be expected to affect the likelihood of achieving elimination as a public health problem (EPHP) by 2030. Programmes with higher prevalence will require more MDA rounds to achieve the target, but one delayed round may not prevent achievement of EPHP by 2030. High-prevalence settings (microfilaria prevalence 25–50%) with MDA starting after 2018 are at greatest risk of not achieving EPHP by 2030 (*28*).
- Modelled mitigation: Biannual MDA or, in eligible populations (*21*), switching to MDA of ivermectin plus diethylcarbamazine plus albendazole are the most effective remedial strategies, with either strategy predicted to return populations to no-interruption prevalence levels one year after programme resumption. Increasing MDA coverage to 80% would require three rounds of MDA to achieve no-interruption prevalence levels.
- Modelled acceleration: Maintaining the mitigation strategies could lead to attainment of the EPHP target up to 3 years earlier.
- Existing WHO guidance on MDA: WHO recommends annual MDA of ivermectin plus albendazole (rather than biannual MDA of ivermectin plus albendazole) except in areas where biannual distribution of ivermectin is already being delivered for onchocerciasis. (Empirical evidence from comparative studies does not indicate a difference in efficacy between annual and binannual ivermectin plus albendazole.) In countries where onchocerciasis is not endemic, WHO generally recommends MDA of ivermectin plus diethylcarbamazine plus albendazole (rather than diethycarbamazine plus albendazole) in most settings (*21*).

4.3 Onchocerciasis

- Analyses were undertaken to simulate population-wide microfilarial prevalence trends, *Onchocerca volvulus* microfilarial prevalence and intensity by age group, and probabilities of elimination of transmission, for different ivermectin treatment histories and transmission settings in populations in Africa in which annual MDA without vector control measures was in place prior to any COVID-19-related delay.
- Modelled impact of missed MDA rounds: For high prevalence (hyperendemic) settings, a 12-month MDA delay would result in up to a 3-year delay in reaching a given microfilarial prevalence compared to continuation of MDA without interruption, and the probability of reaching elimination of transmission by 2030 will be reduced.
- Modelled mitigation: Upon resumption of MDA, one year of biannual MDA is likely to be more effective than annual MDA at ≥ 80% coverage. The microfilarial prevalence is predicted to return to no-interruption levels after one year of biannual MDA. If the MDA rounds originally planned for 2020 and 2021 could both be delivered in 2021, for example, the effect of the delay would be mitigated.
- Modelled acceleration: Populations with higher prevalence and shorter MDA histories should be prioritized for biannual MDA as these will be the most affected by a 12-month delay to MDA. Even in the absence of MDA delays, these populations are less likely to reach the target for elimination of transmission by 2030 without more intensive intervention (*29*).

- Existing WHO guidance on MDA: WHO recommends at least once- (ideally twice-) yearly MDA of ivermectin in endemic areas for 10–15 years. Implementation of vector control measures (where feasible) is also recommended to accelerate interruption of transmission. In areas where *Loa loa* is co-endemic, the decision to implement MDA should be based on a risk-benefit analysis following published guidance (*30*); in such areas, ivermectin MDA is indicated only in communities that are meso- or hyper-endemic for *Onchocerca volvulus* and with appropriate systems for severe adverse event surveillance and case management.

4.4 Schistosomiasis

- Analyses were undertaken for *Schistosoma mansoni* infection in moderate and high prevalence settings. Two different age-intensity profiles (low and high adult burden of infection) were modelled to determine whether this would differentially influence impact.
- Modelled impact of missed MDA rounds: In settings where the EPHP target was likely to have been achieved by 2030 if there had been no interruption, a 12-month delay to MDA results in achievement of the target being delayed by up to 2 years. The impact depends on pre-treatment prevalence, the burden of infection in adults, and whether the programme had only recently started or had already made significant gains.
- Modelled mitigation: A community-wide MDA round or an increase in coverage in school-aged children (SAC; from 75% to 85%) after programmes restart could help accelerate progress towards EPHP, by reducing the delay to target by up to one year.
- Modelled acceleration: In high prevalence settings, EPHP may not be achieved by 2030 even without disruptions to MDA, unless MDA is expanded to also cover adults. MDA disruption has a lesser impact in higher adult burden settings, since in these settings, school-based MDA has a limited effect on reducing overall transmission (*31*).
- Existing WHO guidance on MDA: In WHO guidelines that were in press at the time of publishing this Evidence Review, WHO recommends annual praziquantel MDA for all age groups (pre-SAC, SAC and adults) at risk in ≥ 10% prevalence settings, and biannual MDA in persistent hot spots. In endemic communities with prevalence < 10%, WHO recommends less frequent MDA or a test-and-treat strategy.

4.5 Soil-transmitted helminthiases

- Analyses were undertaken for the main soil-transmitted helminth species (*Ascaris lumbricoides, Ancylostoma duodenale, Necator americanus, Trichuris trichiura*) in different prevalence settings, defined in terms of prevalence of infection in SAC using the Kato-Katz technique (*20*).
- Modelled impact of missed MDA rounds: In settings where the EPHP target was likely to be achieved if there had been no interruption, interruptions do not strongly affect the probability of reaching the target, but will delay the date by which the target is reached. For moderate prevalence settings (20–50% of SAC infected at baseline), following resumption after a 12-month delay to MDA, populations would return to the prevalence of infection expected if there had been no interruption less than 2 years after the first resumed treatment.
- Modelled mitigation: For *A. lumbricoides* and hookworm infections in moderate prevalence settings, a round of community-wide MDA (instead of a standard round of school-based deworming) when programmes resume would be sufficient to compensate for a 12-month delay to MDA. If the programme were to switch to biannual school-based MDA as an ongoing strategy this would reduce the mean delay in reaching the EPHP target by 1–2 years.

- Modelled acceleration: High prevalence populations were unlikely to reach the EPHP target by 2030 even in the absence of a COVID-19-induced delay (*32,33*). Mitigation strategies can offer an opportunity to increase the probability of success. In other words, in high-prevalence settings, adding a year of biannual community-wide MDA as mitigation might be crucial in accelerating progress towards the EPHP target (*34*).
- Existing WHO guidance on MDA: in populations in which the STH prevalence in SAC is ≥ 20%, treat pre-SAC, SAC and women of reproductive age with albendazole or mebendazole once per year. In populations in which the STH prevalence in SAC is ≥ 50%, these groups should be treated twice per year.

4.6 Trachoma

- Analyses were undertaken to simulate the mean prevalence of trachomatous inflammation—follicular (TF) (*35*) in children aged 1–9 years in medium (mean baseline TF prevalence = 20%) and high (mean baseline TF prevalence = 40%) settings.
- Modelled impact of missed MDA rounds: In moderate transmission settings already on track to achieve EPHP after 3–4 rounds of MDA, the impact of a missed MDA round would be a delay equivalent to the duration of MDA interruption; in most cases, elimination targets would still be reached after the same number of treatment rounds. In such settings, if the MDA rounds originally planned for 2020 and 2021 could both be delivered in 2021, for example, the effect of the delay would be mitigated. In high-transmission settings, missing one MDA round (a 12-month delay) would lead to an increase in the number of MDA rounds needed to reach elimination targets: on average, without mitigation strategies, the mean delay to reach the EPHP target would be 2.7 years.
- Modelled mitigation: In some high transmission settings, an additional (biannual) round of MDA in the year after programmes resumed would accelerate progress, such that attainment of the elimination goal would be delayed by only ~1 year. The benefit of an additional round of children-only MDA is predicted to be similar to that of whole-community MDA.
- Modelled acceleration: For populations in which progress towards the EPHP target appears to have stalled, the effect of the interruption may be considerable, and strategies such as multiple rounds of MDA per year might mitigate the impact and even accelerate achievement of EPHP (*36*).
- Existing WHO guidance on MDA: WHO recommends annual antibiotic MDA (alongside implementation of the facial cleanliness and environmental improvement components of the SAFE strategy) where the district-level TF prevalence in 1–9-year-olds is ≥ 5% (*19*).

4.7 Visceral leishmaniasis in the Indian subcontinent

- Analyses were undertaken to simulate incidence during an interruption occurring during the attack or consolidation phases of a programme, assuming that prior to the interruption, interventions were implemented according to WHO recommendations.
- Modelled delays to target achievement: Highly endemic settings where control efforts have been ongoing for 5–8 years are likely to be the most significantly affected by an interruption, with delays of 7–8 years expected if interventions are halted for 12 months and no mitigation strategies are implemented. More importantly, all settings could expect an increase in the number of cases. This increase is substantial even for settings in which the expected delay in achieving the EPHP target is limited. If the interruption to interventions only lasts for 6 months, the delay to achieving the EPHP target is expected to be around 1 year in medium endemic settings (which is the majority of settings).

- Modelled mitigation: Extending the attack phase could in certain settings help to reduce the delay to the achievement of the EPHP target by as much as 4.5 years and, more importantly, reduce the number of new cases. The impact of a mitigation strategy is predicted to be highest in those settings affected most by the interruption (i.e. highly endemic settings with a history of 5–8 years of control interventions). Besides implementing mitigation strategies, it will be important to try to keep the duration of essential service disruption as short as possible, to prevent new individuals from becoming infected, and continue progress towards EPHP (*37*).
- Existing WHO guidance: WHO suggests that active case searches be undertaken in endemic areas at least once per year. Different methods may be used (*38*,*39*). The impact of COVID-19 needs to be assessed empirically. Elimination programmes should recognize that the observed incidence of visceral leishmaniasis may decrease while its true incidence is increasing (**Fig. 2**); extra effort may be needed to detect missed cases.

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