Summary: Modelling to quantify the likelihood that local elimination of transmission has occurred using routine *gambiense* human African trypanosomiasis surveillance data

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Motivation

The *gambiense* human African trypanosomiasis (gHAT) elimination programme in the Democratic Republic of Congo (DRC) routinely collects case data through passive surveillance and active screening programmes, with several places now reporting no cases for several years, despite being endemic in the early 2000s. In this study, we use this screening and surveillance data to assess the probability that regions of the DRC have already achieved elimination of transmission (EOT) of gHAT.

Methods

Our modelling approach uses two stochastic models of gHAT infection adapted from previous work (originally presented in Rock et al. (2015) — Model W — and Stone et al. (2015) — Model S) to match to data from three selected health zones in former Equateur province of DRC — Bominenge, Budjala and Mbaya. We selected these regions as ones which have had low or no case reporting for several years and are therefore possible candidates for having recently met or may be soon to meet EOT. The models capture the underlying infection dynamics, and due to the stochastic framework, can directly compute EOT in the model simulations.

For each model, we calculate the probability of EOT in each year as the proportion of stochastic simulations that result in zero new infections (and continue to have no new infection for the next 10 years) .

Results

The models estimate that there has been a large decline in the number of infections over the study period (Figure 1), leading to predictions of moderate probabilities that EOT has been achieved in each of the health zones (Figure 2, first column). Using all simulation results based on data from 2000-2016, Mbaya, the health zone with least recent case reporting, has a high probability of having already achieved EOT in 2020 (72% for Model W, 96% for Model S). Bominenge and Budjala have more moderate EOT probabilities in 2020 (61% and 57% respectively for Model W, 86% and 98% for Model S), despite some low-level case reporting in recent years.

Budjala and Mbaya also had zero case detections in 2017 and 2018. If we factor in this information, our certainty that EOT has already been met by 2020 increases to 100% (Model S) and 92% (Model W) in Budjala and 99.8% (Model S) and 94% (Model

W) in Mbaya (Figure 2, second column). A subsequent year of zero case detections in 2021 could further raise the certainty in EOT, especially for Bominenge (Figure 2, third column). Increasing the screening coverage in 2021 for a single year of very high coverage (50%) active screening and still finding no cases, would mean we were very confident (>94%) of EOT (Figure 2, fourth column).

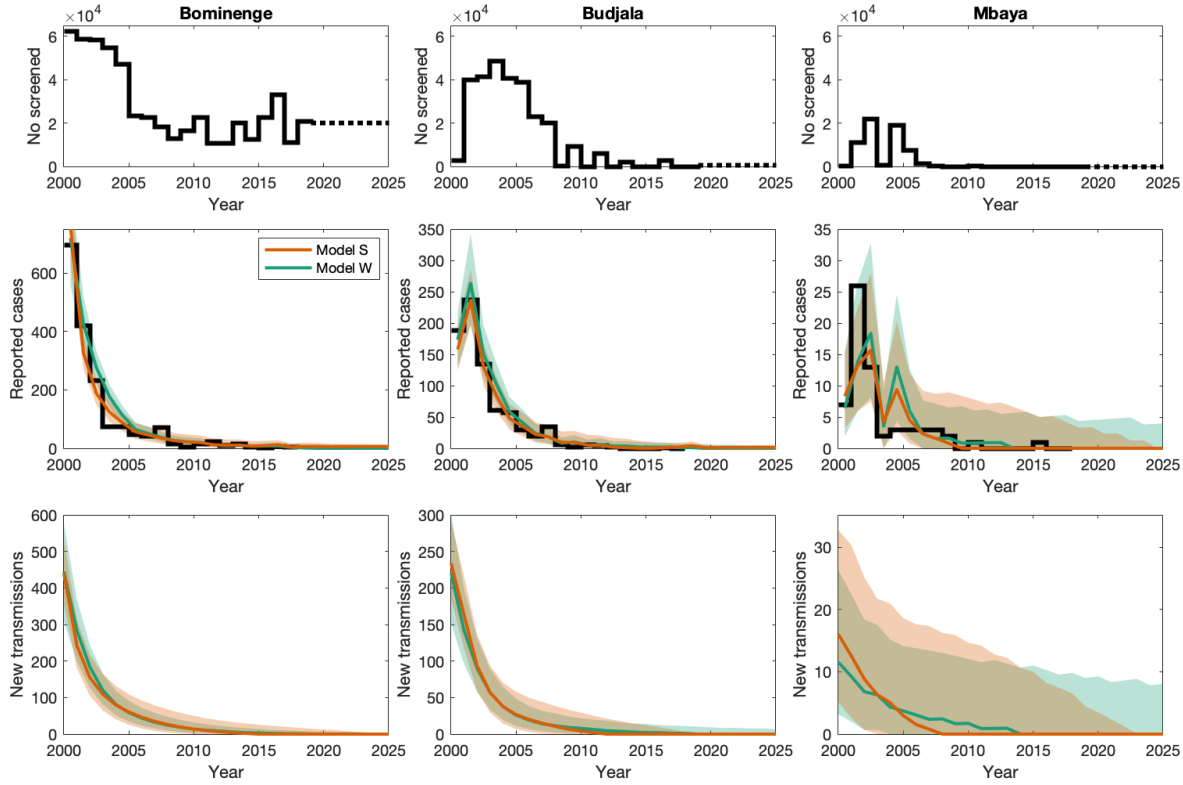

Figure 1: Case reporting and inferred infection dynamics by the two models. The first row shows the number of people screened in each year in each health zone, the second row shows the total reported case data as a black solid line and the model fits as a coloured lines (median) and shaded area (95% credible and prediction intervals), the last row shows our estimated number of new infections in humans (transmission) over time. Model S is orange and Model W is green.

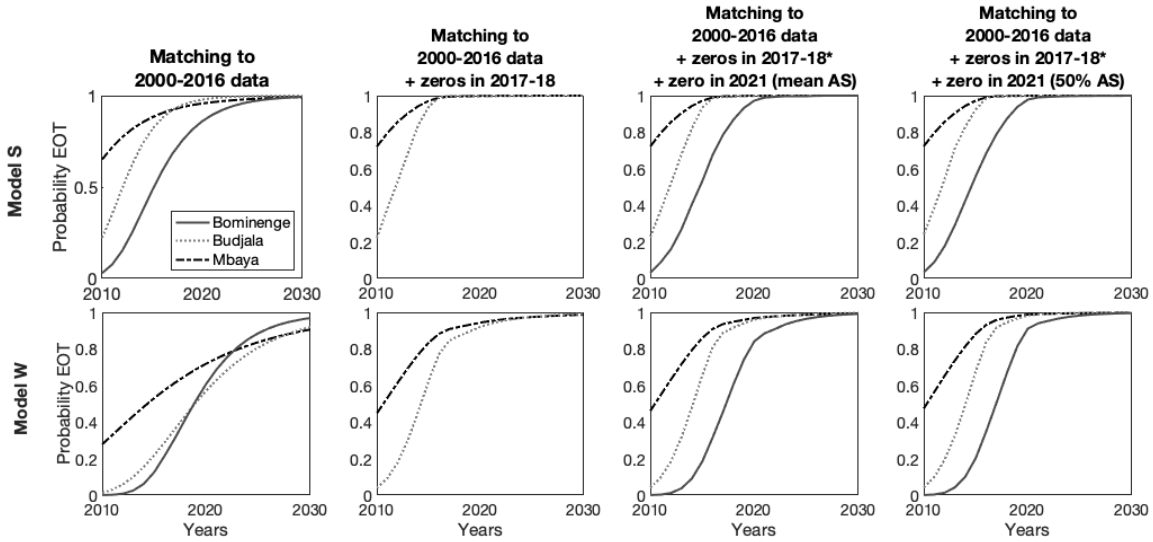

Figure 2: Probability of elimination of transmission (EOT) by year for each of the models. The top row is the results for Model S and the bottom row for Model W. Each column represents our results based on model fitting to data forFor the period 2000–20168, and using known screening coverage for 2017 and 2018. For 2019

onwards, these are predictions assuming continuation of the mean active screening coverage (based on 2014–2018 coverage) and passive surveillance. In columns 2-4 we only show the subset of results which also meet additional criteria. In column 2 we show the probability of EOT for those simulations which have zero case reporting in 2017 and 2018 in Budjala and Mbaya (matching the reported data for those years). In columns 3 and 4 we show the subset results if zero cases are observed in 2021 under mean active screening (column 3) or a 50% coverage screen (column 4). In these columns we allow cases to be detected in Bominenge during 2017/2018 but not in Budjala or Mbaya.

Conclusions

Historically good coverage in active screening has been shown to be effective in reducing the infection in populations, but maintaining this coverage can provide an accurate measure on the probability EOT has been met in health zones close to this goal. Passive surveillance remains a vital control mechanism, but broader screening can help to increase the certainty in measurement of EOT. Active screening in previously endemic areas could therefore be useful in certifying regional EOT. Modelling can be used to identify regions for which this could provide improved certainty, and those where further active screening is unlikely to be required.

In this study, the health zones of Bominenge, Budjala and Mbaya in Sud-Ubangi province were found very likely to meet the EOT goal by 2030 and indeed, Budjala and Mbaya were found to have may already have met this goal by 2020 with >92% probability. Bominenge, in particular, has lower certainty that the goal has been already met (61% under Model W and 86% under Model S), however a one-off year of large coverage active screening could provide valuable information to better inform this. AHowever, as we approach 2030, quantitative evaluation of gHATthe data will be key to safe cessation of activities and reducing the risk of recrudescence in areas believed to have no remaining transmission.