Modelling approaches for tuberculosis: are they realistic?

Authors' reply

In his Correspondence on our paper,[1] Sachin Atre describes factors that could reduce the impact of intensified tuberculosis control, and questions the usefulness of mathematical modelling that ignores these challenges. On these points we wholeheartedly agree. As part of this modelling collaboration, we took steps to ensure that modelled strategies reflected real-world constraints—to the extent possible, assumptions about uptake, retention, quality, and other factors influencing policy outcomes were based on empirical programme experience, and stakeholders from national tuberculosis control programmes were involved throughout to define realistic policy scenarios and review modelled results. These steps are detailed in our supplementary information and the related impact paper.[2]

Nevertheless, several policies that we examined have a limited evidence base—either there was little experience of their performance in the countries we included, or they had not been studied at the aggressive coverage levels defined in our policy scenarios. As a consequence there is substantial uncertainty in our results. This uncertainty is partly reflected in the variation between models, but even this range might not capture all uncertainty, owing to common (but potentially erroneous) assumptions made across models, or the fact that parametric uncertainty is not shown in the main results. Our estimates should not be taken as conclusive, but instead subject to re-examination and revision as new evidence becomes available.

Going forward, we hope these results stimulate implementation research and country-led modelling exercises. Ongoing implementation research will be critical to strengthen the evidence base as programmes expand and evolve. Country-led exercises could resolve some of the issues raised by Atre, by eliciting better information on operational constraints and validating modelling assumptions. On Atre's wider point—that mathematical modelling might simply not be useful where uncertainty is high—it is important to note that policy decisions are continuously being made, despite the presence of decision uncertainty. In this context, mathematical modelling can assist decision-making by providing a formal approach for synthesising available evidence, forcing conflicting information to be considered and reconciled, and allowing competing priorities to be weighed objectively. These benefits are not automatic, and require a modelling process that is transparent and sensitive to new evidence that might conflict with current beliefs.

Assumptions must be made when evidence is insufficient, yet this is universally true whether or not modelling is used. Done well, modelling can make these assumptions explicit—available for scrutiny and reconsideration—and highlight areas where uncertainty is particularly high and therefore new empirical research particularly valuable. Even so, a formal mathematical model is rarely able to capture all considerations relevant to the policy decision. For this reason, modelling such as we present in our paper should be considered an input to a deliberative policy-making process rather than a replacement for it.

We declare no competing interests.

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1 Menzies NA, Gomez GB, Bozzani F, et al. Cost-effectiveness and resource implications of aggressive action on tuberculosis in China, India, and South Africa: a combined analysis of nine models. *Lancet Glob Health* 2016; **4:** e816–26.
2 Houben RMGJ, Menzies NA, Sumner T, et al. Feasibility of achieving the 2025 WHO global tuberculosis targets in South Africa, China, and India: a combined analysis of 11 mathematical models. *Lancet Glob Health* 2016; **4:** e806–15.