# The case for optimal investment in combating HIV, tuberculosis, and malaria: a global modelling study

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## Summary

**Background** The Sustainable Development Goals (SDGs) include ending the epidemics of HIV, tuberculosis, and malaria by 2030. With 5 years remaining to meet this goal, and with the Global Fund to Fight AIDS, Tuberculosis and Malaria seeking funding for programmes in 2027–29, establishing what can be achieved through continued investment in combatting these diseases is crucial. We aimed to estimate the potential for impact by analysing the funding landscape and epidemiological situations of these three diseases, the costs of key programmes, and the extent of possible future progress in the countries eligible for Global Fund support.

**Method** In this modelling study, we developed estimates of the financial resources needed in Global Fund-supported countries to combat HIV, tuberculosis, and malaria from the global plans produced by UNAIDS, the Stop TB Partnership, and WHO. Estimates of available resources in the coming years were obtained by assuming that national expenditure on the three diseases would grow in line with general governmental expenditures, that the Global Fund would contribute an additional $18·0 billion, and that other developmental assistance would be at the same level in real terms as the average in the period 2020–22. Epidemiological and costing models for each of the three diseases were used to quantify the possible impact in Global Fund-eligible countries (including on aggregated mortality and incidence rates). The return on investment (ROI) was computed considering both the intrinsic value of health and the direct economic benefits of the reduced risk of morbidity and premature mortality. The analysis was completed at the end of 2024 with the latest available data, which pertained to the year 2023. The focus of the projection period was 2027–29, a period for which scale-up plans and funding have not yet been committed and the period when most of the resources raised by the eighth replenishment of the Global Fund would be used.

**Findings** The total resource needs for the three diseases were estimated to be US$140·6 billion in 2027–29. We calculated that $111·3 billion (79%) of this need could be met from domestic financing ($69·7 billion), the Global Fund ($18·0 billion), and other external donors ($23·6 billion). Optimal use of these available resources could save 23 million lives and avert 400 million cases and new infections during 2027–29. The trajectory of the combined mortality rate for all diseases was projected to approach that needed to reach the SDG for 2030 (with a difference between the target in 2030 and the projection at the end of 2029 of between 1·5% and 15·5% of the normalised aggregated mortality rate), inequality in life expectancy between countries would be 7% lower by 2029, and 189 million fewer hospital days and 572 million fewer outpatient visits would be needed in 2027–29, saving $1·1 billion. For every $1·00 invested, there could be up to $19·00 in intrinsic health value created or $3·50 in direct economic benefits.

**Interpretation** Continued investments to combat HIV, tuberculosis, and malaria could yield enormous health gains and a high return on investment. Realising these benefits will require continued growth in national expenditure and a broad maintenance of external financing for these diseases, including a successful replenishment of the Global Fund in 2025.

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## Introduction

In 2000, the Millennium Development Goals aimed to halt and reverse the spread of HIV, tuberculosis, and malaria.[1] In that year, these diseases collectively caused over 4·5 million deaths globally.[2] In 2015, these ambitions were substantially extended in the Sustainable Development Goals (SDGs), which included the goal of ending "the epidemics AIDS, tuberculosis, malaria" by 2030.[3] Progress in the fight against HIV, tuberculosis, and malaria since 2000 has been, by any measure, astounding: in 2023, the annual number of deaths due to all three diseases was 2·3 million (a 49% reduction from levels in 2000).[2] But now, with only 5 years remaining to the 2030 SDG target date, asking what impact is still possible by 2030 and what needs to be done to achieve this is crucial. The significance of this moment is compounded by a rapidly evolving political and funding landscape, which demands a clear view of what can be achieved with continued investment.

## Research in context

### Evidence before this study

Several studies have investigated the potential health impact of and economic rationale for investing in combating HIV, tuberculosis, or malaria interventions in individual countries. Few studies have investigated the consequences of global investments to combat all three diseases. We conducted a systematic search of PubMed to identify relevant studies with the search terms ("health impact" OR "return on investment" OR "cost-effectiveness" OR "cost-benefit" OR "economic evaluation" OR "cost analysis" OR "resource needs" OR "priority setting" OR "investment case") AND ((HIV AND tuberculosis AND malaria) OR "Global Fund"). We did not include any publication date or language restrictions. The identified studies were systematic reviews and meta-regression analyses of published research (n=4), modelled analyses of past investment performance (n=2), and econometric analyses of empirical data (n=1). Past investments to combat HIV, tuberculosis, or malaria interventions were generally found to be cost-effective and to have prioritised high-value interventions. Across countries, these investments were found to have produced statistically significant reductions in mortality and contributed to reducing global inequality in life expectancy.

### Added value of this study

With economic and epidemiological models for each disease, this study assessed the financial resource needs, health impacts, return-on-investment, and other consequences of using global resources that could be available to combat HIV, tuberculosis, or malaria. Total resource needs for 2027–29 were estimated as US$140·6 billion, of which $111·3 billion (79%) might become available from all sources. Optimal use of available resources could save up to 23 million lives and avert 400 million cases of disease and infection, while also reducing inequality in life expectancy between countries by 7% and averting 760 million health visits for untreated symptomatic disease. Considering the intrinsic value of health, the return on investment was estimated to be as high as $19 for every $1 invested.

### Implications of all the available evidence

Continued global investments in combatting HIV, tuberculosis, and malaria would produce major health improvements, with a high return on investment. Substantial resources will be required to sustain these investments, requiring partnerships between the governments of affected countries, the Global Fund, and other sources of developmental assistance.

### *Panel*: Targets for ending the epidemics of HIV, tuberculosis, and malaria set by mandated technical agencies

**HIV (UNAIDS)[12]**

- 90% reduction in the number of new HIV infections in 2030, compared with a 2010 baseline
- 90% reduction in the number of deaths from complications of advanced HIV in 2030, compared with a 2010 baseline

**Tuberculosis (the End TB Strategy, Global Plan to End TB, and second UN high-level target 2023 status meeting)[13]**

- 90% reduction in the absolute number of deaths from tuberculosis in 2030, compared with a 2015 baseline
- 80% reduction in the tuberculosis incidence rate in 2030, compared with a 2015 baseline
- 95% reduction in the number of deaths from tuberculosis in 2035, compared with a 2015 baseline
- 90% reduction in the tuberculosis incidence rate in 2035, compared with a 2015 baseline

**Malaria (WHO)[11]**

- 90% reduction in the malaria mortality rate in 2030, compared with a 2015 baseline
- 90% reduction in the malaria case incidence rate in 2030, compared with a 2015 baseline

This is the question being asked by the Global Fund to Fight AIDS, Tuberculosis and Malaria as it makes the case to governments, philanthropists, and the private sector for further investments to combat these diseases. The Global Fund was established in 2002 with the aim of pooling funding from these sources and investing it effectively in country programmes to address HIV, tuberculosis, and malaria.[2] This approach—with one organisation assessing need and raising and investing funds to maximise health impact—has proven effective with a total of US$63 billion being disbursed by the end of 2023. In countries supported by the Global Fund, the coverage of antiretroviral therapy for HIV increased from 3·6% in 2005 to 78% in 2023, treatment coverage for tuberculosis increased from 38% in 2005 to 75% in 2023, and the percentage of populations with access to a long-lasting insecticide-treated net increased from 5·6% in 2005 to 61% in 2023. The Global Fund is now seeking a further replenishment, which would fund programmes in the crucial 2027–29 period.[4]

This work comes at a time when the outlook for international funding is highly uncertain.[5] Several major donors have signalled a shift in policy that could mean less funding for overseas aid than has previously been the case. However, whether and how this shift might be implemented remains unknown, as does the effect it would have on funding for HIV, tuberculosis, and malaria.

We aimed to estimate the impact on combatting HIV, tuberculosis, and malaria that is still possible by 2030 and establish the funding needed to achieve it by analysing the funding landscape and epidemiological situations of these three diseases, the costs of key programmes, and the extent of possible future progress in countries eligible for Global Fund support.

## Methods

### Study design

Mandated technical agencies (ie, UNAIDS, Stop-TB Partnership and WHO),[6–11] through extensive consultation, have developed global plans that define the target of ending the epidemics of HIV, tuberculosis, and malaria called for by the SDGs (panel). These plans also establish assumptions for the availability and effectiveness of services, therapies, and treatments, and show how programmes can be scaled up to achieve the targets. In this modelling study, we used the epidemiological and costing models that underpin the quantifications of these plans (the Goals Model for HIV, the Global TB Portfolio Model for tuberculosis, and malariasimulation for malaria[14–17]) and the assumptions and targets established in them.

To estimate the achievable impact on combatting HIV, tuberculosis, and malaria, and the extent to which the aspirations of the global plans for each disease can still be reached, the following sequential analyses were performed: estimation of the financial resources required for the full implementation of each global plan; estimation of the financial resources that might be available for use in programmes for these three diseases; projection of the potential health impact such resources could generate, using epidemiological and economic models; and computation of statistics that set derived health gains in context (ie, in relation to reductions in life expectancy inequalities, effects on primary health care, and return on investment). Details of each analysis are provided below.

This analysis was completed at the end of 2024 with the latest available data, which pertained to the year 2023. The focus of the projection period was 2027–29, a period for which scale-up plans and funding have not yet been committed and the period when most of the resources raised by the eighth replenishment of the Global Fund would be used.[4] The geographical scope of the analysis is all 129 countries eligible for Global Fund support.[18]

### Resources needed

The global plans estimate the total programme costs needed for the period 2027–29 to be on track to reach the 2030 SDG targets. These costs were extracted for each of the countries included in this analysis. Modifications were made to reflect updated assumptions for the scale-up of vaccines for tuberculosis and malaria (appendix pp 3–4).

### Resources available

Projected national expenditure on these diseases by the countries included in this analysis in the period 2027–29 was computed in two steps. This expenditure comprised both government expenditure and private expenditure. The private expenditure included pooled private expenditure (eg, insurance) and out-of-pocket expenses, of which the latter was by far the largest component. The different sources of funding were not distinguished in terms of what they could be spent on or their respective efficiencies. First, a baseline amount of annual spending for each country and disease was established for the year 2023 on the basis of the actual reported spending over the preceding 5 years (ie, 2018–22) and its trend over time in each country. This baseline calculation drew on data reported to UNAIDS or WHO on which the data in online tools are based.[19–21] Next, this baseline was projected to the end of 2029 under the assumption that spending on each disease in each country would grow in line with all other aspects of governmental expenditure (specifically, the International Monetary Fund forecasts for non-debt governmental expenditure).[22] The only exception was for tuberculosis in India where, given the strong political will to combat tuberculosis,[23] an increase in the proportion of spending on tuberculosis was incorporated (appendix p 6).

Two sources of additional external financing were incorporated: non-Global Fund and Global Fund financing. We assumed that non-Global Fund external financing for 2027–29 would remain at the same level in real terms as the average in the period 2020–22. We assumed that Global Fund financing would reflect the $18·0 billion target for the eighth replenishment being fully met and that this amount would be divided between the diseases according to its allocation methodology.[4,24] Further details on each of these projections is provided in the appendix (p 4).

### Epidemiological impact

The epidemiological and costing models used to create the global plans were used to create an investment scenario under the assumption that resources would be constrained to the levels projected to be available. This scenario assumed that total funding for a disease in a country would be allocated to maximise impact, with flexibility by intervention type (and subnational targeting for malaria). We also assumed that Global Fund resources would be distributed to countries where they would have the greatest additive impact, with impact represented mathematically as a reduction in the number of infections (for HIV) or cases (for tuberculosis and malaria) and a reduction in the number of deaths to that disease, in the period 2024–30, giving equal weighting to each measure.

To construct this investment scenario, the epidemiological and costing models were used to establish the greatest possible impact that could be achieved for each of a large set of possible total funding envelopes for a given disease in a given country (appendix pp 9–13). From these results, a frontier was constructed for each disease in each country to describe the maximum impact achievable for any funding envelope. The projections of domestic and non-Global Fund resources available were then mapped onto these frontiers. Finally, the allocation of Global Fund finance (within each disease but across countries) that maximised

For the **Goals Model** see https://www.avenirhealth.org/software-spectrum.html

For the **Global TB Portfolio Model** see https://github.com/CarelPretorius/GlobalTBTransmissionModel and https://github.com/CarelPretorius/GlobalTBCostingModel

For **malariasimulation** see https://mrc-ide.github.io/malariasimulation/

See **Online** for appendix

impact across the portfolio of countries was identified. This process resulted in a total resource envelope for the period 2027–29 being assigned to each country and each disease. Thus, the investment scenario for each country was based on the full use of that envelope.

The key services and technologies that mediated the impact for each disease were as follows: for HIV, testing, antiretroviral therapy, voluntary medical male circumcision, prevention of vertical transmission, pre-exposure prophylaxis, condom promotion, economic empowerment for adolescent girls and young women, and comprehensive sexuality education and prevention services for key populations; for tuberculosis, screening, diagnosis and treatment, preventive therapy, and (from 2029 onwards) vaccination; and, for malaria, distribution of long-lasting insecticide-treated bed nets, indoor residual spraying, chemoprevention for children, and treatment and vaccination (appendix pp 2–4).

Analyses were done with separate country-specific and disease-specific models, covering almost all the burden of the three diseases in eligible countries (appendix p 14). Results from these models were then extrapolated to represent all countries eligible for Global Fund support.[18] Intervals for the projections represent the uncertainty that arises as a result of uncertainty in the overall disease burden, intervention effectiveness, and costs of the proposed interventions. The investment scenario was compared with a no-scale-up scenario, in which services are fixed at the levels (in terms of the percentage of the population in need receiving the service) observed at the end of the year 2023.

### Outcomes

The health gains under the investment scenario were quantified in several ways. Trends in the aggregated mortality rate were obtained by first computing the mortality rate for each disease in the portfolio of countries (total deaths in a year due to that disease divided by the person-years at risk), normalising this trend (to a value of 100 in the year 2020), and finally taking the arithmetic average of the normalised trends across the three diseases. The same approach was applied for aggregated incidence rate, for which the numerator was the number of new infections (for HIV) and new cases (for tuberculosis and malaria). To avoid double-counting deaths of people with both HIV and tuberculosis in the aggregated mortality rates calculation, only the deaths attributed to tuberculosis of HIV-negative people were counted in the tuberculosis model.

The lives saved metric was computed by comparing the total number of deaths from HIV, tuberculosis, and malaria in the investment scenario to that in a counterfactual projection in which no services would be available from 2024 onwards. The cases averted metric was computed by comparing the total number of infections (for HIV) and cases (for tuberculosis and malaria) in the investment scenario with that in the no-scale-up scenario.

To enable comparison of these projections with the targets from the different global plans for the three diseases (panel), the targets were recomputed with updated values for the relevant baseline year (2010 or 2015), and population denominators that were consistent with the model projections.

Following Haacker,[25] health impact was also quantified in terms of the effect it had on reducing between-country variation in life expectancy. To do this quantification, the Gini coefficient for life expectancy between countries was quantified for the year 2029 in the investment scenario and the no-scale-up scenario. The Gini coefficient is a summary measure of variation, on a scale from 0 (implying all countries have the same life expectancies) to 1 (implying extreme differences). Projections of life expectancy for both scenarios incorporated the changes in age-specific risks of death from the models, while also assuming the risk of other causes of death remained constant. Further details are provided in the appendix (p 18).

To quantify the health-care resources that could be freed up by these investments, the difference in primary health-care utilisation between the investment scenario and the no-scale-up scenario was estimated for each country and disease. This difference in utilisation results from greater numbers of individuals developing symptoms of disease caused by HIV, tuberculosis, or malaria, and seeking health care (and potentially hospitalisation) due to these symptoms under the no-scale-up scenario compared with the investment scenario. Utilisation was quantified as the number of outpatient visits and hospital bed-days received by individuals with untreated HIV, tuberculosis, or malaria from the health-care system.[26,27] Further details are provided in the appendix (p 20).

To gauge the extent of health gains in comparison with the size of investments, two forms of return-on-investment (ROI) statistics were computed. For both, the comparison was between the investment scenario and the no-scale-up scenario. First, the intrinsic value of the health gains was ascribed a monetary value on the basis of the value that the people affected would place on the reduced risk of premature death (ie, following the concept of the value of a statistical life-year).[28] Second, the instrumental economic value of these health gains was quantified by assessing the value of the productive work that people would be able to perform with a reduced risk of premature death (ie, employing the human capital approach).[29] Further details are provided in the appendix (p 20).

### Role of the funding source

All authors, including those employed by the funder, had a role in study design, data collection, data analysis, data interpretation, and writing of the report.

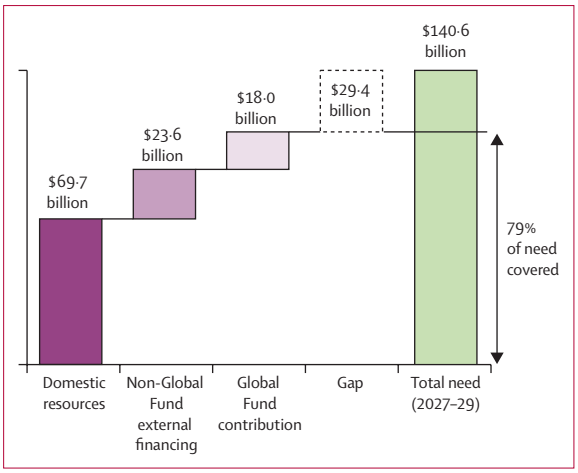


*Figure 1:* **Estimated resources needed and resources potentially available (in US$) for HIV, tuberculosis, and malaria in 2027–29 in countries eligible for Global Fund funding**

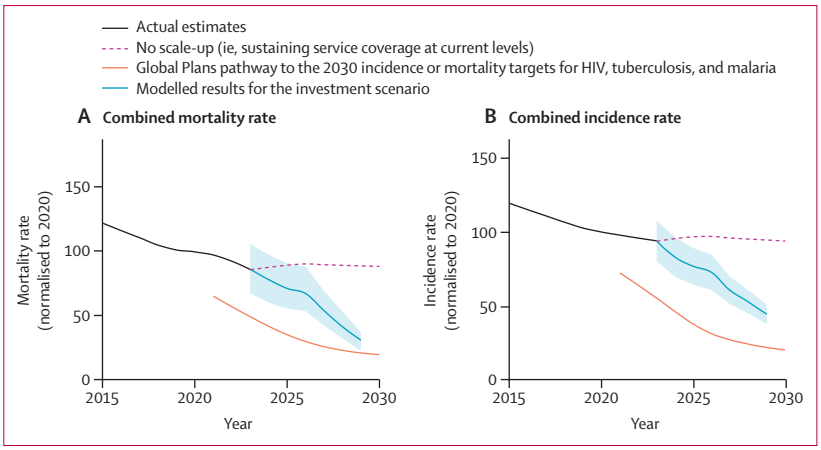


*Figure 2:* **Projections of the potential impact on the mortality rate (A) and incidence rate (B) for HIV, tuberculosis, and malaria (all disease combined)**
Data were normalised to 100 in 2020 for each disease and then combined with equal weighting across the three diseases. The modelled results for the investment scenario include shading indicating the 95% uncertainty range. Estimates for malaria are for sub-Saharan African countries and data for tuberculosis mortality exclude people with tuberculosis and HIV. Mortality rate is the number of deaths per person-year. Incidence rate is the number of new infections or cases per person-year at risk.

## Results

The total resources required to achieve the level of service demanded by the global plans for each disease in the Global Fund's portfolio of countries in the period 2027–29 will be $140·6 billion. Of this, $59·8 billion (42·5%) is needed for HIV, $51·5 billion (36·6%) is needed for tuberculosis, and $29·3 billion (20·8%) is needed for malaria. Over the same period, the projected domestic resource availability is $69·7 billion. Within this amount, $68·2 billion covers non-vaccine interventions, of which $28·8 billion (42·2%) is for HIV (70% in Africa and 16% in southeast Asia), $31·9 billion (46·8%) is for tuberculosis (31·9% in Africa and 48% in southeast Asia), and $7·6 billion (11·1%) is for malaria (71·0% in Africa and 23·6% in southeast Asia; appendix p 8). Over the same period, the projected non-Global Fund external resources are $23·6 billion. Within this amount, $16·2 billion (68·6%) is for HIV, $2·6 billion (11·0%) is for tuberculosis, and $4·8 billion (20·3%) is for malaria. Together with the $18·0 billion that the Global Fund is asking for as part of its eighth replenishment, $111·3 billion (79·2%) of the total resource needs would be met by resources that are projected to be available under this investment scenario (figure 1).

Overall, the investment scenario projects that, between 2027 and 2029, 23 million lives could be saved, and the aggregated mortality rate could be reduced by 64% (95% uncertainty interval [UI] 58–74) across the three diseases from 2023 to 2029 (figure 2A). This is a reduction from 2·3 million deaths in 2023 to 920 000 deaths in 2029. This impact on the aggregated mortality rate under the investment scenario is very close to the ultimate 2030 global plan targets (a difference between the target in 2030 and the projection for the end of 2029 of between 1·5% and 15·5% of the normalised aggregated mortality rate). The same projections show that under the investment scenario, 400 million new infections and cases could be averted between 2027 and 2029. The overall incidence rate could be reduced by 54% (UI 46–60) across the three diseases by 2029 compared with 2023 levels (figure 2B). This is a reduction from 271 million infections or cases in 2023 to 119 million in 2029. Although combined target for incidence in 2030 in the global plans would be missed, the gap between the target and the projection would be substantially reduced and would be smaller at the end of 2029 than at any previous time.

Our projections show that the targets for deaths from complications of advanced HIV and new HIV infections could be met under the investment scenario (figure 3A, B). From 2023 to 2029, the number of new HIV infections would be reduced by 66% (UI 59–73), the number of deaths from complications of advanced HIV would be reduced by 59% (50–67), and, the HIV incidence rate among adolescent girls and young women in most affected countries would be reduced by 51%. In the investment scenario for 2029, there would be 28·9 million people receiving treatment for HIV, which would be equal to a treatment coverage level of 90%.

For tuberculosis (figure 3C, D), projected progress towards the global plan targets for numbers of deaths and cases would be more limited by 2030 under the investment scenario. However, progress towards the 2035 targets is projected to become substantial. The delayed acceleration in the reduction of tuberculosis is due to reliance on new technologies (including a new vaccine[10]) that are assumed to become available from 2029 onwards. Between 2023 and 2029, the number of tuberculosis cases would be reduced by 26% (UI 22–30)

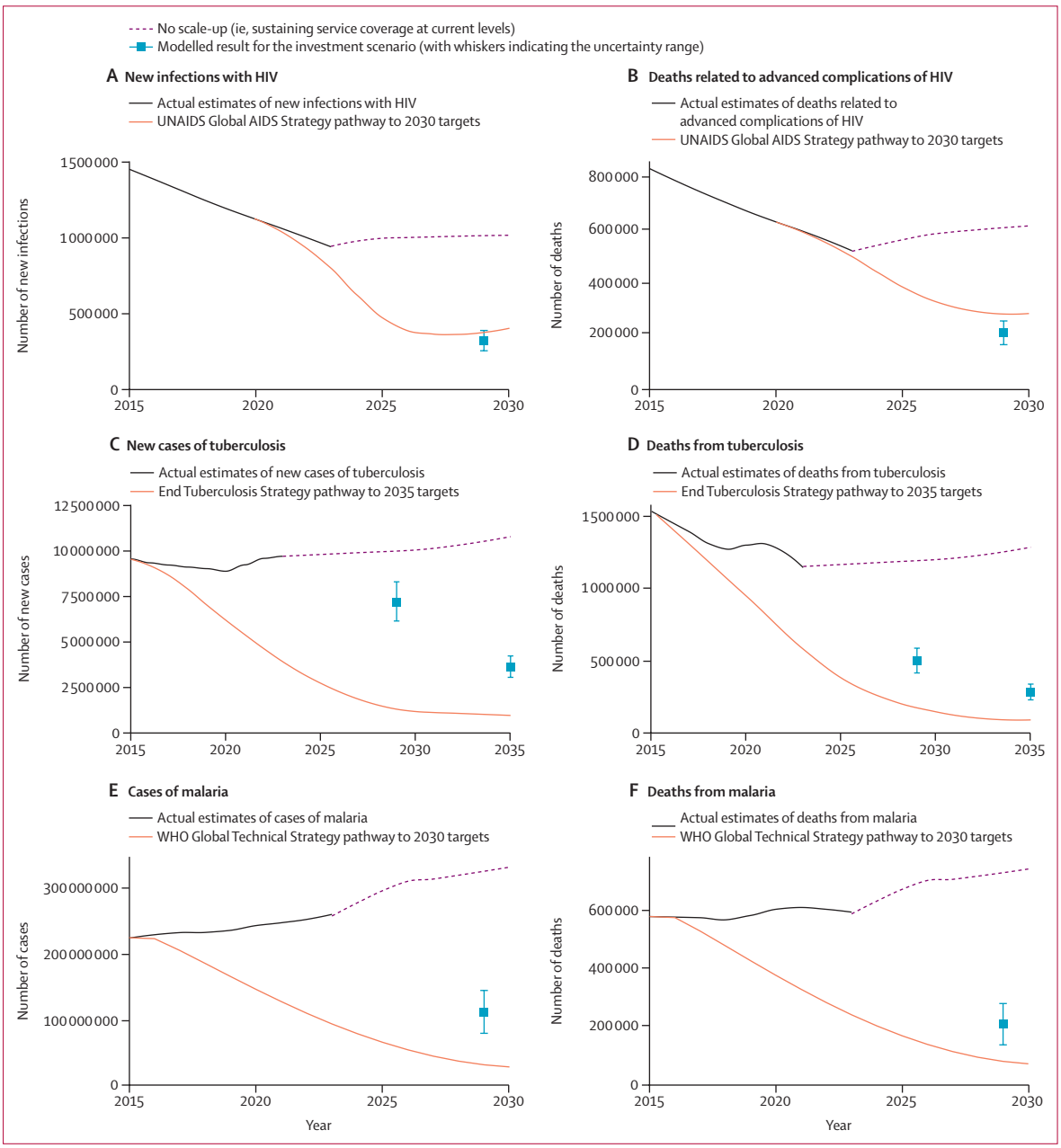


***Figure 3:*** **Projections of the potential impact on HIV, TB, and malaria**
Projected potential impact on new infections with HIV (A), deaths from advanced complications of HIV (B), new cases of tuberculosis (C), deaths from tuberculosis (D), cases of malaria (E), and deaths from malaria (F). The data in (D) include all deaths from tuberculosis, irrespective of HIV status.

and the number of deaths from tuberculosis (including among individuals with HIV) would be reduced by 57% (54–60). In the investment scenario for 2029, 46·8 million people would be provided with first-line treatment and 1·1 million people would receive second-line treatment—equal to a treatment coverage of 95%.

For malaria (figure 3E, F), our projection for the investment scenario suggests there is the potential for enormous progress towards the global plan targets for numbers of deaths and cases, following a stall in progress in recent years. This trend is driven by the assumed increased frequency and efficiency of bednet distribution and the scaling up of vaccines. From 2023 to 2029 under the investment scenario, the number of malaria cases would be reduced by 57% (UI 45–70) and the number of malaria deaths would be reduced by 65% (53–77). In the investment scenario for 2029, 59% of people would be sleeping under a long-lasting insecticide-treated bednet in sub-Saharan Africa; and, between 2027 and 2029, 263 million cases of malaria would be treated.

In contrast, under the no-scale-up scenario (in which there is no scaling up of services after the end of 2023), the number of deaths and cases each year would increase over time for all three diseases (figure 3). Under this scenario, there would be an additional 3·1 million new HIV infections and 1·7 million deaths from complications of advanced HIV between 2024 and 2029, 6·2 million new cases of tuberculosis and 1·8 million deaths from tuberculosis, and 700 million cases of malaria and 1·6 million deaths from malaria, compared with the investment scenario. These projected numbers are tantamount to reversing the progress that has been made and sending the three epidemics back to levels last seen in 2021 (for deaths from complications of advanced HIV) or 2018 (for deaths from tuberculosis), and to levels of deaths from malaria that have never been recorded. This resurgence in deaths from malaria would be driven mostly by rapid population growth in the countries most affected and by rebounds in malaria cases, which can occur even under constant intervention levels (due to new cohorts having been less exposed and therefore contributing to a lower overall population immunity).[30]

Modelled levels of coverage for key prevention and treatment services in each region are shown in the appendix (p 27). Under the investment scenario, programmes disproportionately benefit countries where life expectancy has been impacted to the greatest extent by these three diseases, potentially reducing inequality in life expectancy across countries by an additional 7% between 2023 and 2029.

Under the investment scenario, the projected decline in these three diseases would prevent the need for 189 million hospital days and 572 million outpatient visits between 2027 and 2029, reducing the effective cost of providing primary health care by $1·1 billion (figure 4). 72·0% of these savings would be in sub-Saharan Africa, where the freed-up resources are likely to have the greatest impact on patients suffering from conditions other than HIV, tuberculosis, and malaria.

The projected impact on health in each disease would have a monetised intrinsic value 19 times the size of the resources being utilised (ie, there is a 1:19 return on investment for investments that combat HIV, tuberculosis, and malaria). Thus, an $18·0 billion Global Fund replenishment would generate $323·0 billion of value between 2027 and 2029. The additional contribution to economic activity that the increases in health would allow would amount to $60·0 billion in the same period—that is $3·50 in direct economic benefits for every $1·00 invested.

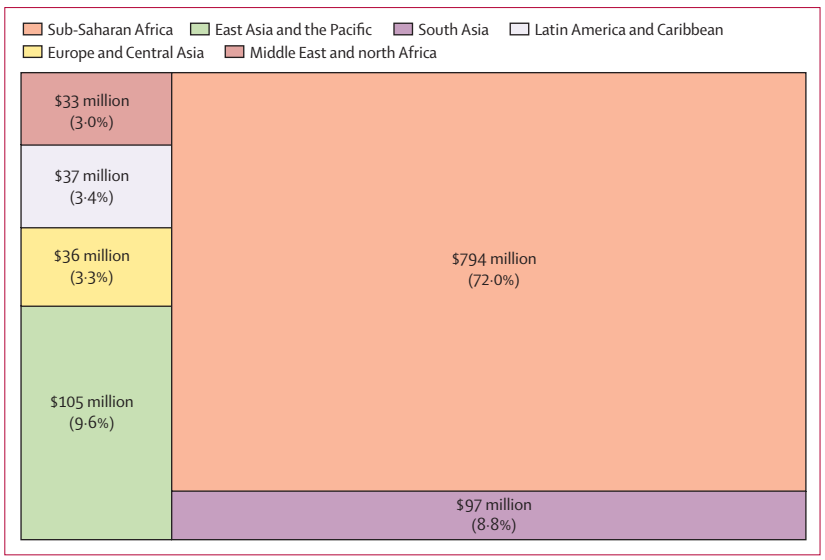


*Figure 4:* **Estimated cost savings (in US$) from reduced inpatient and outpatient health-care visits due to a decreased burden of HIV, tuberculosis, and malaria (comparing the investment scenario and the no-scale-up scenario) in 2027–29 in countries eligible for Global Fund support, by region**

## Discussion

In this study, we aimed to examine the progress that can be made in the coming years in combatting HIV, tuberculosis, and malaria towards meeting the 2030 targets of the SDGs, and show what would be needed to achieve this progress. We found that enormous progress can still be made by 2030, leading to targets for mortality reduction almost being met. We also found that the value of these health gains would be many times greater than the resources invested. This impact can only be realised, however, if funding needs are met (including from international donors), funding is allocated optimally within and between countries, and prevention and treatment services continue to be scaled up, alongside new technologies, as soon as they become available. However, without such advances and with a stall in the scale up of services, our findings suggest we will see backwards trajectories in the fight against these three diseases, as epidemics resurge and population growth magnifies burden.

Domestic (ie, national) financing is the most sustainable way to resource HIV, tuberculosis, and malaria programmes. In our projections, domestic financing is the major source (63%) of funding for programmes, and these estimates suggest that domestic funding for HIV, tuberculosis, and malaria will grow by $13 billion (an increase of 23%) for the period 2027–29 compared with the period 2024–26.[31] In contrast, the Global Fund's target replenishment in 2027–29 was kept the same as in 2024–26,[31] and external financing was assumed to stay constant in real terms. Nevertheless, the contribution of external financing remains crucial, at 37% of projected resources. Moreover, these proportions do not convey the intricate way in which these different sources of funding are combined in a country to deliver services: for example, in a given country, facilities might be funded nationally, staff might be funded by bilateral development assistance, and medicines might be funded through grants from the Global Fund. For this reason, these calculations do not attempt to estimate what proportion of programmes'

impact can be attributed to each funding source, but rather acknowledge that the totality of resource inputs contribute jointly to this impact.

Investments in HIV, tuberculosis, and malaria can also help strengthen health-care systems, promoting resilience and pandemic preparedness. First, as shown in this study, reducing the burden of these three diseases will also reduce the need for stretched and fragile health-care systems to provide health care for people living with these diseases. Second, investments that build human resources for health, strengthen supply chains, and improve surveillance will also have indirect benefits for health security and whole health-care systems.[2,32] The impact of such investments on health has been shown for Malawi,[33] with a model estimating that if the expansion of Malawi's services for HIV, tuberculosis, and malaria is combined with investment in more health-care workers and stronger medicine supply chains, there would be an approximately 35% greater impact on the three diseases, compared with the expansion of services for these diseases alone. The total impact of such a programme (ie, scaling up HIV, tuberculosis, and malaria control and strengthening health-care systems) was estimated to have substantial health benefits beyond these three diseases (as much as for three diseases) due to the improved care that would become possible for other conditions. Thus, there is real bidirectional synergy between combating the three diseases and health system strengthening: stronger health-care systems reduce other disease burdens and accelerate progress against HIV, tuberculosis, malaria, and progress against HIV, tuberculosis, and malaria, itself helps health-care systems by freeing up resources.

The projections in this study are not intended to be a forecast but rather to offer an evidence-based scenario showing what is possible in terms of combatting HIV, tuberculosis, and malaria, factoring in prevailing epidemiological data, possibilities for programme scale-up (including the introduction of new technologies), and the availability of funding. Therefore, every assumption made is either rooted in real data or is a reasonable expectation, and although these projections are optimistic (in assuming that everything does go right), they do not contain anything that is not, in our view, possible.

Although the flat assumption for external financing for programmes might once have seemed conservative, the current outlook for external investments in these programmes is now highly uncertain, especially for the period 2027–29.[5] In particular, statements from several major donors have signalled that funding for overseas aid overall might decrease and an abrupt series of changes in the US bilateral funding hints at how far-reaching such changes could become. Other modelling studies have quantified the consequences for health that could result from these changes.[34,35] Nevertheless, resources projected to be available in this investment scenario are widely diversified. The ultimate impact on programmes and health overall will depend on how any changes are made and the extent of these changes, alongside compensatory actions by governments, the private sector, and other donors. However, every dollar less than the amounts of funding projected here will lead to less impact and move countries further away from the goal of controlling these epidemics.

Models of these three complex diseases must rely on simplifying assumptions regarding the epidemiology of the diseases, the effectiveness of certain programme elements, and their cost (appendix pp 8–9). Nevertheless, the models used in this study have been widely applied[14,16,36] and their findings have been adopted at the centre of the global plans relied on by technical partners.[9–11] Our definition of impact is intended to reflect the true aim of programmes to balance reducing the number of deaths and reducing the risk of infection. However, other definitions (eg, maximising impact over a longer period or a focusing only on reducing incidence) would also be reasonable and could lead to different results. The assumption of optimal use of resources means that the impact projected in this study is as great as it could be (under this narrow definition) and the pattern of service scale-up will deviate from that in the global plans. In particular, the investment scenario allows services for HIV to be scaled up fully by 2027 (rather than increasing gradually through to 2030), which explains why the impact is as great as in the HIV global plan,[9] despite funding needs not being fully met. Of course, were the actual implementation to fall short of these ideals, then the impact on the epidemic would be smaller. We also acknowledge that the concept of ascribing a monetary value to health gains—whether through intrinsic or instrumental valuations—is fraught with difficult assumptions. Nevertheless, it gives a powerful indication of the value that is created through generating health, which would otherwise be hidden.[28,29] The fact that this analysis could not look at the impact made on reducing inequality in health outcomes within countries (which is likely to also be important) is also a limitation.[37]

As the 2030 target date for the SDGs draws near, our calculations show that the potential for historic achievements in the global response to HIV, tuberculosis, and malaria is within reach. The case for continued investments is compelling, underscored by the value these investments generate for the people affected and the economies of the countries in which they live, alongside the contribution that is made to reducing global inequalities in life expectancy. These investments also clearly synergise with health-system strengthening, such that investments in health-care systems catalyse the impact of services for HIV, tuberculosis, and malaria and the resulting reductions in burden, which alleviate pressure on health-care systems. At the same time, a lack of progress at this crucial juncture would presage a return to the high rates of death due to these infectious diseases seen in the past. The determination of which future will be realised falls immediately to individuals who can secure

sustained investments towards combatting these three diseases through the ongoing expansion of domestic resources for programmes, the preservation of external financing, and a successful eighth replenishment of the Global Fund.

#### Contributors

TBH, NAM, MS, RG, MH, and JH designed the analysis in collaboration with all other authors. RG, MS, and MH assembled all the relevant data and coordinated inputs from all authors. SR and MG did the projections of resource availability. JS, CP, and PW did the epidemiological modelling. SR did the analyses of health inequality and return-on-investment. JSS did the analysis of cost savings for primary health care. RG, MS, and MH generated the results from these inputs and created the figures. TBH and JH wrote the first draft of the manuscript and all authors reviewed and edited the final version of the manuscript. All authors had full access to and verified all the data in the study. All authors had final responsibility for the decision to submit for publication.

#### Declaration of interests

TBH, NAM, and SR received personal fees from the Global Fund to Fight AIDS, Tuberculosis and Malaria in relation to this work during 2024. PW, JS, and CP received fees from the Global Fund to their institutions in relation to this work. MH, MS, MG, FM, RG, and JH are employees of the Global Fund, the funder of this study. Outside of this work, NAM also reports funding to his institution from WHO, the Gates Foundation, the US Centers for Disease Control and Prevention, the US Council of State and Territorial Epidemiologists, and the National Institutes of Health; and PW reports funding to his institution from the Gates Foundation, Wellcome Trust, Clinton Health Access Initiative, WHO, and Médecins sans Frontières. PW also reports personal fees from the Global Fund outside of this study. All other authors declare no competing interests.

#### Data sharing

The data used are from publicly available sources (appendix pp 1–23). The epidemiological models used to create these projections are also open source: Goals Model (part of the Spectrum Package by Avenir Health); Global TB Portfolio Model; and malariasimulation.

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