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ABSTRACT

Introduction Tuberculosis (TB) remains a significant health burden in 25 low- and middle-income countries. Despite TB being more cost-effective to prevent and treat its funding is disproportionately lower than that of HIV. This study aims to assess the economic costs of TB versus HIV and evaluate the returns on investment in TB prevention compared to HIV.

Methods The study uses a microfoundations behavioural model to estimate the economic costs of TB and HIV on households and the economy. We combine data from the WHO Global Tuberculosis Report, the Institute for Health Metrics and Evaluation's Global Burden of Disease dataset and Demographic Household Surveys among others. The analysis accounts for lost earnings and healthcare expenses in the short and long term.

Results The findings indicate that active TB cases result in significant economic losses, with US$13.7 billion in current annual losses, US$17.2 billion in future losses and US$5.7 billion in medical expenses, for a total of US$36.6 billion. In contrast, HIV causes US$5.5 billion in current losses, US$20.9 billion in future losses and leads to medical expenses of US$6.1 billion for a total of US$32.5 billion. There is substantial across-country heterogeneity in the composition of these costs.

Conclusion The economic impacts of TB are at least as large as those of HIV, with higher returns on investment in TB prevention. These results advocate for increased funding for TB relative to funding for HIV in these countries because the returns to incremental funding for TB are greater than those for HIV at current funding levels.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Tuberculosis (TB) remains a significant health burden in 25 low- and middle-income countries.
⇒ Despite TB being more cost-effective to prevent and treat, its funding is disproportionately lower than that of HIV.

WHAT THIS STUDY ADDS

⇒ The study uses a microfoundations behavioural model to estimate the economic costs of TB and HIV on households and the economy.
⇒ We consider costs from disabling illness and death, both current and to the next generation.
⇒ We find that costs from TB (US$36.6 billion per year) are comparable to those from HIV (US$32.5 billion per year).

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Since treatment and prevention costs are significantly lower for TB than HIV, our findings advocate for increased funding for TB to at least match that of HIV in these countries.

INTRODUCTION

Tuberculosis (TB) poses a significant disease burden in 25 low- and middle-income countries (LMICs), comparable to that of HIV in these countries. Despite TB prevention and treatment being more cost-effective (in terms of cost per health outcome), its funding is merely a fraction of HIV's, fluctuating between 10–20% since 2000.[1] This study aims to assess the economic costs of TB versus HIV and evaluate the returns on investment in TB prevention compared with HIV in high-TB-burden countries.

Our study countries are among those with the highest prevalence of TB including Afghanistan, Bangladesh, China, Democratic Republic of Congo, Ethiopia, India, Indonesia, Kenya, Kyrgyz Republic, Malawi, Mozambique, Nigeria, Pakistan, Philippines, South Africa, Tajikistan, Tanzania, Uganda, Ukraine, Vietnam, Zambia and Zimbabwe (figure 1). Altogether, these countries host 4.3 billion people, around half the world's population, ranging from 6.6 million (Kyrgyz Republic) to 1.4 billion (China), with a median of 50 million people. These are mostly poor countries, with median GDP (gross domestic product) per capita at US$1555, from US$497 (Afghanistan) to US$10 343 (China). TB incidence per 100 000 people ranges from 58 (China) to 615 (South Africa), while HIV incidence per 1000 people ranges from 0.01 (Bangladesh) to 4.70 (Mozambique). Median values are 211 per 100 000 people for TB and 0.32 per 1000 people for HIV. See online supplemental appendix 1 for further details.

The study focuses on three core questions: the economic impact of TB and HIV on households and the economy, the comparative

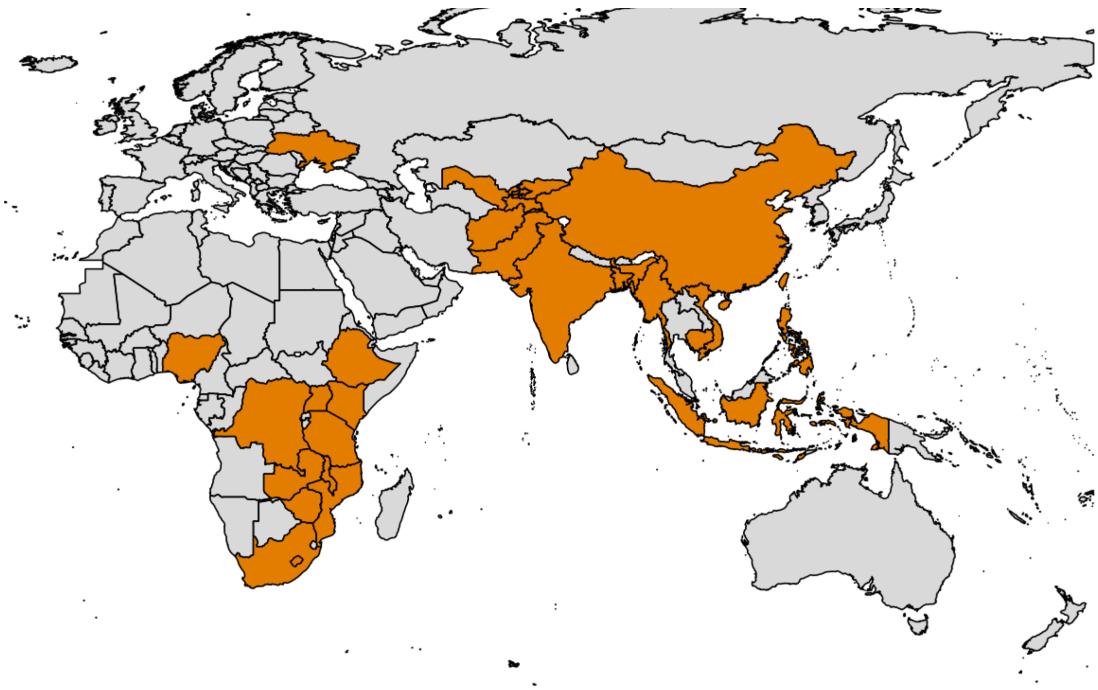

Figure 1 Geographical scope. Note: 24 USAID TB priority countries and China (our analysis excludes Cambodia, Myanmar and Uzbekistan due to data availability. The list of countries is presented in online supplemental appendix A1). TB, tuberculosis; USAID, US Agency for International Development.

returns on reducing TB and HIV burdens and the investment returns in TB versus HIV prevention (see online supplemental appendix 2 for a discussion on the health case for investing in TB). Introduce a microfoundations behavioural model to estimate the economic costs to households from TB and HIV morbidity and mortality, emphasising real economy monetary losses over the intrinsic value of health, unlike the commonly used value of statistical life (VSL) method.[2–4]

Previous studies predominantly employed VSL to assess economic impacts, a method based on individual willingness to pay to avoid death, thereby focusing on health loss rather than monetary consequences of disease prevention failure.[2] In contrast, our approach mirrors assessing the economic impact of events like Hurricane Katrina through tangible losses (eg, property damage, lost income) rather than valuing lost lives or suffering. This methodology aligns closely with the information government bodies, such as the US Treasury or ministries of finance, need to evaluate the need for disaster assistance or disease prevention investments, focusing on tangible economic effects and household poverty implications.

We define economic costs as the sum of lost net earnings and healthcare expenses, considering various factors such as labour, household and government health expenditures, savings, assets, schooling, children's health and nutrition, and their future earnings impact, as well as the potential influence on labour markets, economic growth and fiscal performance. The study highlights the need for equal prioritisation of TB alongside HIV, given its comparable economic and health consequences. However, it acknowledges the challenge in direct comparison due to differing metrics and data availability for TB and HIV, noting HIV's role as a significant risk factor for TB, complicating the assessment further. To address these complications, we performed a set of sensitivity analyses and find that our main conclusion holds under a wide variety of scenarios.

Conceptual framework

Our conceptual framework is depicted in figure 2 based on the approach by Gertler and Gruber.[5] Primary infections may lead to active TB and HIV disease, which in turn leads to secondary infections. An active case reduces an individual's labour supply and increases medical expenditures, thereby decreasing household disposable income. To mitigate the impact on income, households adopt various coping strategies: increasing labour participation, liquidating assets or borrowing.[5–12] All these strategies can potentially lead to or exacerbate poverty.

Concurrently, disease impacts investment in children's education and nutrition, with the potential for long-term poverty if the primary earner dies, sometimes resulting in children dropping out of school, being sent to foster homes or girls marrying early.[13–17] Such decreased investment in children's welfare can perpetuate poverty in the subsequent generation.

The broader economic impacts include potential reductions in the aggregate labour supply, potentially increasing wages but decreasing productivity and dampening demand for goods and services, all of which can hinder economic growth. Additionally, increased poverty can lead to higher government spending on social safety nets and medical care, with governments from the study

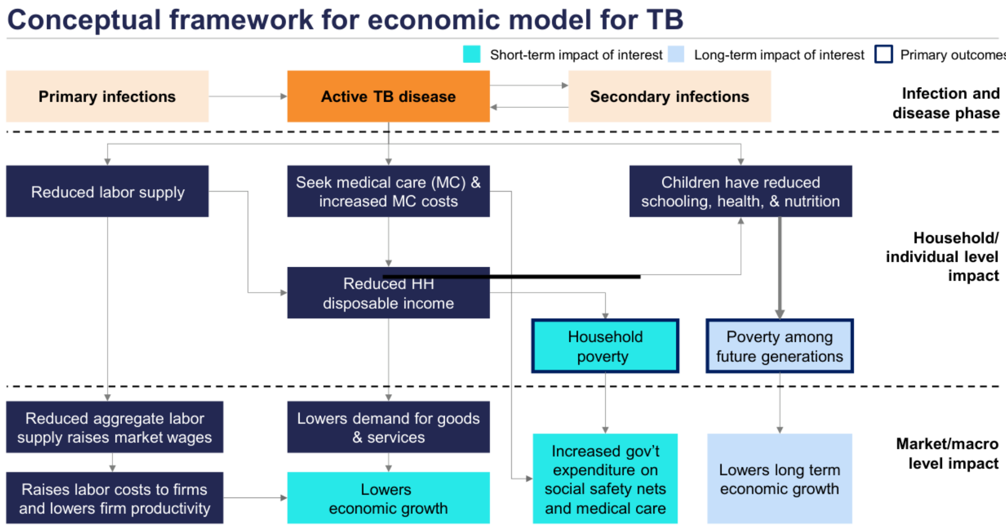

Figure 2 Conceptual framework for the economic costs of TB and HIV. gov't, government; HH, household; TB, tuberculosis.

countries bearing the majority of TB treatment costs (with the exception of India).

Our model, developed in more detail in online supplemental appendix 6, aims to illustrate the pathways through which active disease affects both short-term outcomes (household poverty, economic growth, government expenditure) and long-term impacts (intergenerational poverty, reduced economic growth. The methodology and variables for these analyses are detailed in Materials and methods. We estimate what in economics is called a 'reduced form' relation which is the net effect of disabling illness and death on the outcomes of interest (household consumption and future earnings). This circumvents the need to account for each of the potential coping mechanisms employed by the household. Given the wide variety of contexts, measuring the mechanisms is complex and since it is not the main purpose of this study it is an interesting avenue for future research. This is discussed in more detail in online supplemental appendix A6.

MATERIALS AND METHODS

Epidemiological data

We collected epidemiological data on TB and HIV incidence, prevalence, mortality rates and illness duration at the national level, broken down by gender, age and TB type. Our primary sources were the WHO Global Tuberculosis Report[18] for incidence rates, mortality and case fatality ratios categorised by age and gender, and the Institute for Health Metrics and Evaluation's (IHME) Global Burden of Disease dataset[19] for incidence, prevalence, mortality, disability-adjusted life years (DALYs), years lived with disability and years of life lost data by age and sex.

We primarily used the WHO Global TB Report estimates, which encompass all active TB forms, including HIV-associated cases. These estimates, sourced from national health ministries, are regularly updated with new data and methods. From the report, we obtained TB incidence rates, mortality, and case fatality ratios by age groups (0–14, 25–44, 15–64 and 65+) and gender at the national level for 24 US Agency for International Development TB priority countries and China. IHME data were used when WHO data were not available. Medical expenses were obtained from IHME's Financing Global Health dataset.[20]

Neither WHO nor IHME publish estimates on the TB or HIV distribution by socioeconomic status (SES). However, WHO-supported surveys in 20 countries include TB distribution by education, household size and HIV status, along with patients' self-reported household income and employment status before and during treatment.[21] The data lack a breakdown by national income quintiles and comparison to national education distributions.

WHO and IHME also do not provide estimates on absenteeism or productivity loss related to TB and HIV, duration of illness or post-treatment disability. Illness duration could be approximated by comparing IHME incidence and prevalence figures. Due to inconsistent TB prevalence reporting and the lack of comprehensive prevalence surveys, we chose not to rely on IHME prevalence figures. Instead, we assumed a constant average illness duration across countries, adjusting this assumption in our sensitivity analysis. This was a necessary simplification due to data limitations.

The WHO surveys report average facility visits and hospitalisation duration. For a conservative estimate of workdays lost per TB case, we assumed each visit or hospital day equalled one workday lost. After censoring the range to eliminate outliers, the average came to 40.5 days. If that is the lower bound, as it does not consider days of work missed due to being in isolation while still infectious or days missed due to feeling sick, it compares favourably to the base case estimate of 60 days used in our analysis. We acknowledge the variation in absenteeism determinants like hospitalisation duration and illness severity across countries.

Online supplemental appendices 3–5 provide detailed information on the study variables and data sources.

Key behavioural parameters

We executed a thorough literature search of quantitative studies delineating potential causal links between health shocks, parental death and economic outcomes. Our search was conducted in PubMed, EconLit and Google Scholar, spanning peer-reviewed studies and the grey literature. Details can be found in online supplemental appendix 7. Our inclusion criteria were: (1) analysis of the economic consequences of a health shock or death, (2) the affected individual is of working age (15–64) and (3) use of longitudinal data or repeated cross-sections.

We excluded studies focusing on the economic effects of COVID-19, since most of the economic costs stem from the lockdowns rather than the disease itself. We excluded cross-sectional studies to avoid unobservable variable bias.

The definition of 'health shock' varied across studies, from specific illnesses like HIV to broader health conditions. We addressed this by analysing studies collectively to estimate the economic loss per day of disabling illness. After an evaluation of titles, our initial pool of approximately 1700 studies was narrowed down to 406 which went on to full-text review. From these, 48 studies met our criteria, covering 29 countries from 1985 to 2019. online supplemental appendix 5 reports details on the search results.

From our review of the literature, we found four main results:

1. One day of adult disability due to illness results in a 1 percentage point decrease in household consumption.
2. An adult's death causes a 30 percentage point decrease in household consumption per year over 5 years.
3. A long-term parental disability due to illness increases the probability a child will leave school by 3 percentage points.
4. A parent's death due to illness increases the probability a child will leave school by 8 percentage points.

Aggregation at the economy level

Effect of disabling illness on current consumption

We estimate the cost of a TB-related disability episode per household as:

$$c_{1i} = \alpha \times DD \times Y_i \times hh_i \tag{1}$$

Where:

- α is the effect of a day of disability from Main results.
- DD represents the disability's duration.
- Y_i denotes per capita household income in country i.
- hh_i is the country's average household size.

In absence of data on the actual time that people are not working after a diagnosis of active TB, we assume a 90-day disability period, conservatively estimating when they would be permitted to return to work from treatment guidelines. We model a 45-day period in the sensitivity analysis. We use $Y_i \times hh_i$ as the average household income, we determine the cost per TB case in each country. We calculate the national cost by multiplying this with the TB incidence among adults aged 15–64, considering gender and the proportion of female-led households:

$$N_{1i} = IncidenceFemales_i \times s_i + IncidenceMales_i \times \left(1 - s_i\right) \tag{2}$$

$IncidenceFemales_i$ is the number of active TB cases among females in the 15–64 age group, net of deaths (ie, subtracting the number of TB-related deaths in the group). $IncidenceMales_i$ is the corresponding figure for males, and s_i is the share of female-headed households in the country according to the Demographic Household Survey.

The total country cost is:

$$TC_{1i} = N_{1i} \times c_{1i} \tag{3}$$

Effect of death on current consumption

We estimate the cost of a TB-related death episode per household as:

$$c_{2i} = \beta \times \sum_{t=1}^{5} \left(\delta^{t-1} \times Y_i \times hh_i\right) \tag{4}$$

where β is the effect of a health-related death. According to Beegle *et al*,[12] death reduces household consumption by 30% over a 5-year period. Thus, we incorporate these effects over the 5 years. Y_i represents the per capita household income in country i, and hh_i denotes the average household size in that country. We apply an intertemporal discount rate (δ) of 3% per year, a standard in this type of analysis. To estimate the cost at the country level, we multiply this by the incidence of TB among adults aged 15–64, differentiated by gender and then weight it by the proportion of female-led households.

$$N_{2i} = DeathFemales_i \times s_i + DeathMales_i \times \left(1 - s_i\right) \tag{5}$$

Total country costs are given by:

$$TC_{2i} = N_{2i} \times c_{2i} \tag{6}$$

Effect of parental disabling illness on children's future earnings

In this section, we estimate the reduction in a child's schooling after an episode of severe parental illness. We then incorporate this loss into the Mincerian model estimated by Montenegro and Patrinos[22] to compute the lifetime lost wages.

First, we calculate the loss in schooling after an episode of severe parental illness, denoted as s_{1ji} for a child whose parent is in age and gender group j (men 15–24, women 15–24, men 25–34 and so on) in country i:

$$s_{1ji} = \kappa \times \left(Schooling_{ji} - ExpectedSchooling_i\right) \tag{7}$$

Here, κ represents the probability of a child dropping out of school due to a severe illness. According to literature, this probability is estimated to be 3%. Lacking individualised schooling data, we conservatively assume that at the shock's onset, each child is in the grade appropriate for their age. To ascertain the expected schooling, we segment the country by gender and age groups and consider the highest average schooling level. It is worth noting that this is a conservative estimate because younger groups are usually more educated than their older counterparts.

Subsequently, we multiply s_{1ji} by the return on schooling in the respective country (ρ_i) and average per capita household income, and sum it over a 45-year span. This procedure assumes that children start their work from ages 20 through 65. We apply an annual discount rate of 3%:

$$c_{3ji} = s_{1ji} \times \sum_{t=1}^{45} \delta^{t-1} \rho_i \times Y_i \tag{8}$$

Where Y_i is household per capita income in country i, as before. To finalise, we aggregate at the country level:

$$TC_{3i} = \sum_{j=1}^{J} c_{3ji} \times N_{3ji} \times NCh_{3ji} \tag{9}$$

For national-level aggregation, we multiply individual costs by the count of affected children. To determine this count, we consider the number of episodes of severe adult illness in the country for each age and gender group, N_{3ji}, multiply it by the average number of children that each adult of the same group has, NCh_{3ji}, and then sum it across all groups.

Effect of parental death on children's future earnings

In this section, we construct the estimated schooling reduction due to TB-related deaths. This loss is then used in the Mincerian model by Montenegro and Patrinos[22] to compute the lifetime lost wages. We start evaluating the schooling loss after an episode of severe parental illness, represented as s_{2ji} for a child whose parent is in age and gender group j (men 15–24, women 15–24, men 25–34 and so on) in country i:

$$s_{2ji} = \gamma \times \left(Schooling_{ji} - ExpectedSchooling_i\right) \tag{10}$$

Here, γ represents the probability of a child discontinuing school in response to parental death. Literature estimates this likelihood to be 8%. As before, due to the absence of individualised schooling data, we conservatively assume that every child is in the appropriate grade for their age at the time of the shock. For expected schooling, the country is segmented by gender and age groups, and the highest average schooling is used as expected schooling. Since younger generations tend to be more educated than older ones, this is a conservative estimate.

We then multiply s_{2ji} by the country's schooling return and sum over a 45-year period, with the conservative assumption that children start working from age 20 until 65. A 3% annual discount rate is consistently applied:

$$c_{4ji} = \sum_{t=1}^{45} \delta^{t-1} \rho_i \times s_{2ji} \times Y_i \tag{11}$$

To conclude, we aggregate the results for all individuals in the country:

$$TC_{4ji} = \sum_{j=1}^{J} c_{4ji} \times N_{4ij} \times NCh_{4ij} \tag{12}$$

To aggregate these findings at the national level, we multiply individual costs by the number of impacted children. This number is derived by multiplying the number of deaths in the country for each age and gender group, N_{4ji}, with the average number of children an adult in the same group typically has, NCh_{4ji}. These results are then aggregated across all groups.

RESULTS

Main results

Under our working assumptions, TB led to an estimated loss of US\$36.6 billion per year in our study countries. Morbidity from TB cases causes US\$3.7 billion in losses from reduced consumption, and an additional US\$11.6 billion from lost schooling (figure 3). We present the main results here and detailed results in online supplemental appendix 8. Fatal TB cases further generate losses of US\$10 billion in reduced consumption and US\$5.6 billion from lost schooling, with medical expenses adding another US\$5.7 billion annually. The country with the largest costs from TB is India, with losses of around US\$9.8 billion that account for 27% of the total costs, followed by China, with losses of US\$5.1 billion. Results by country are reported in online supplemental appendix A8.1.

In turn, the morbidity from HIV cases causes US\$2 billion in losses from reduced consumption, and an additional US\$17.7 billion from lost schooling. Deaths from HIV account for an additional US\$3.5 billion in reduced consumption and US\$3.2 billion from schooling, with annual losses estimated at US\$5.4 billion currently and US\$20.9 billion in the future. Medical expenses for HIV tally up to US\$6.1 billion per year. South Africa bears the largest share of these costs, with losses amounting to US\$16.3 billion, which represents 50% of the costs in the countries under study. Results by country are reported in online supplemental appendix A8.2

Figure 4 presents the proportion of TB costs at the household-level, excluding medical care costs. This proportion varies significantly across countries, reflecting differences in educational attainment, financial returns to education, fertility rates, average income and disease age distribution. For example, the current cost of TB ranges from 24% in Zimbabwe to 88% in Afghanistan. When total medical expenses are considered (online supplemental figure A8.4), the variability in the proportion of total TB impact costs is even greater, ranging from 3% in Indonesia to over 80% in Ukraine and the Kyrgyz Republic.

Online supplemental figure A8.7 in the appendix illustrates the household economic impact of HIV in various countries, considering both the current generation and the next. Significant variability is observed in the proportion of total economic impact caused by the impact of

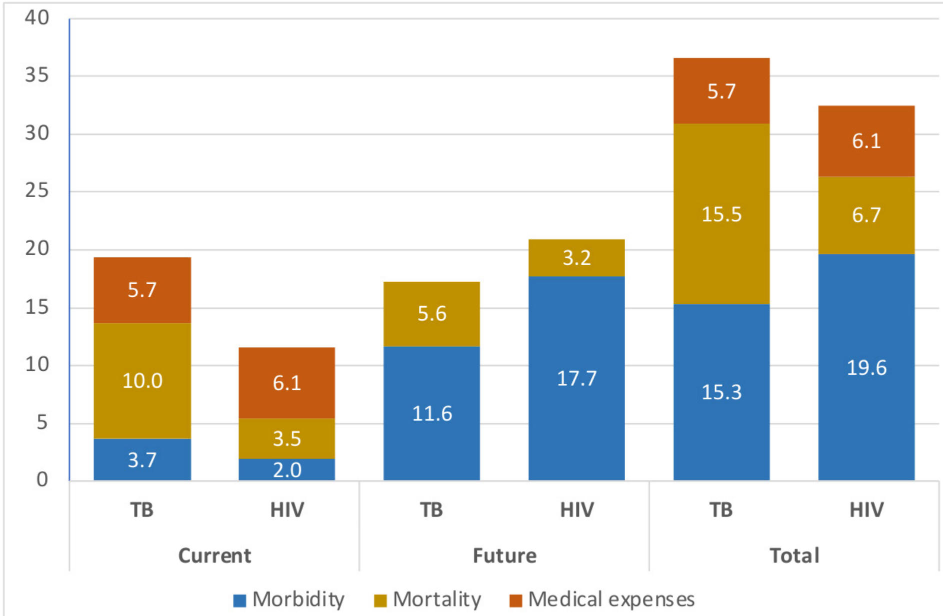

Figure 3 Aggregate economic losses, TB and HIV (billions US$). Notes: Each bar is the estimated economic losses from TB and HIV, using the formulas detailed in Materials and methods, aggregated across all the study countries, in billion US$ of 2023. Current losses include the effect of adult illness and death on consumption, and medical expenses. Future losses include the effect of parental illness and death on lost wages. 'Total' is the sum of current and future losses. TB, tuberculosis.

illness and death on current consumption in these countries. In two-thirds of the countries, the impact on the next generation is larger than the impact on current consumption. In Afghanistan, the impact on current losses is more than 90% of total costs, while in Nigeria, Tanzania, Uganda, Zambia, Malawi, Zimbabwe, South Africa and Kenya the impacts on current losses are under 20% of total losses.

Online supplemental figure A8.8 in the appendix adds total HIV medical expenses (of household and government) to the household economic losses. There is a wide variation in medical expenses among the listed countries.

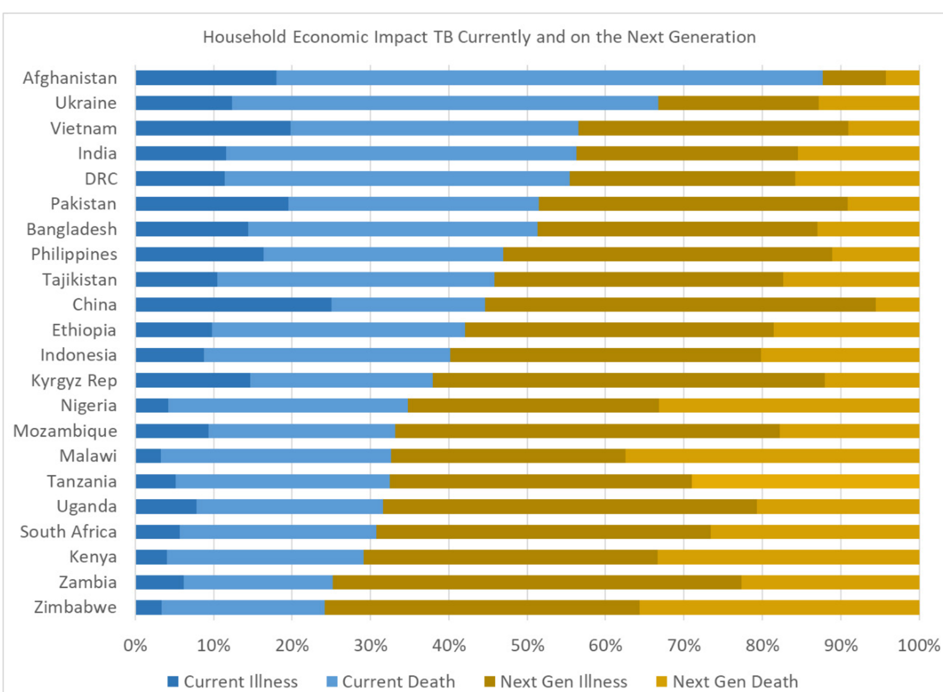

Figure 4 Household economic impact of TB for current versus next generation, by country. Notes: Each bar decomposes economic losses from TB for each country in four components: the effect of adult illness on consumption, the effect of adult death on consumption, the effect of parental illness on lost wages and the effect of parental death on lost wages. DRC, Democratic Republic of Congo; Gen, generation; Rep, Republic; TB, tuberculosis.

In Ukraine, medical expenses account for 70% of the country's economic losses from HIV. In Congo, Tajikistan and Malawi the share is over 50%. In Nigeria, Indonesia, Pakistan and the Philippines, the share is under 10%.

In online supplemental appendix 9 we show that our results are robust under different assumptions on duration of illness, discount rate and assuming parental illness has no effect on children. Online supplemental appendix 10 leverages data from India to show that economic costs are borne by the poorest households in the country.

Cost-effectiveness analysis

The literature on the cost-effectiveness analysis (CEA) of TB interventions has seen limited progress, despite a highlighted need by the 2017 Disease Control Priorities (DCP3) to enhance TB control beyond what is achievable through standard Directly Observed Treatment, Short-course (DOTS) strategies.[23] While specific TB interventions like Xpert screening and active case finding among people living with HIV have been studied, broader analysis on the incremental costs and benefits of expanding TB programmes is sparse. However, with the exception of the WHO-CHOICE (World Health Organization - CHOosing Interventions that are Cost - Effective) publication discussed in online supplemental appendix 12, we have not found additional work on the marginal or incremental costs and benefits of expanding TB programmes above their current scale.

We are not convinced by the WHO-CHOICE results that suggest that in East Africa almost all of the benefit associated with investing in TB prevention and control with currently available interventions have already been realised. Consequently, this discussion leverages DCP3 insights to examine the economic benefits of TB and HIV death prevention versus their costs. Most CEA research focuses on health outcomes measured in DALYs or healthy life years, often overlooking the translation of these benefits into tangible productivity gains. Due to this gap, our analysis concentrates on the economic implications of death prevention.

Figure 5 reports the economic losses per death, the cost of averting a death and the net savings from doing so for TB and HIV. The cost of preventing and treating TB is substantially lower than for HIV, primarily because treatment of TB is time-limited and that for HIV is life-long. Consequently, the economic return on investments in TB prevention and treatment is substantially higher than for HIV. Preventing one death from TB, for example, averts an average economic loss of US$12 480, with the cost of prevention estimated at US$1313, resulting in net savings of US$11 167. This contrasts sharply with HIV, where the cost of preventing a death exceeds the economic savings. Thus, the net estimated savings for TB prevention are estimated at US$3421 in low-income countries (LICs) and US$12 113 in lower-middle-income countries, versus net costs for HIV at US$13 709 and US$28 094, respectively. This difference holds in LICs and LMICs.

CONCLUSIONS

We developed a microfoundations behavioural model to estimate the economic costs to households associated with morbidity and mortality from active TB and HIV. We estimated the model using parameters estimated using rigorous methods and country level epidemiological data. Based on these results, we conclude that there is a strong economic case for investing in the prevention and treatment of TB, especially when comparing its estimated economic losses to those from HIV. The total estimated economic losses from active TB in affected households for the 22 high-TB-burden countries studied is US$36.6 billion compared US$32.5 billion for HIV in those same countries.

Moreover, the cost of preventing and treating TB is substantially lower per person with active disease than for HIV primarily because treatment of TB is time-limited, and that for HIV is life-long. Thus, the expected economic return to additional investment in preventing and treating active TB is substantially higher than that for HIV. Each TB case is less expensive to treat, which means that indeed less investment is needed per case of TB. However, TB prevalence is so much larger than HIV in these countries that country-wide economic losses from TB are roughly equal to those of HIV (under the current investment in TB and HIV). This suggests that investment to prevent and treat TB should be increased in our study countries.

These results do not, in themselves, justify reducing the investment in HIV; rather, *they underscore that increasing the investment in TB is economically justified. Moreover, the economic case for increased investment in TB is even stronger than for HIV.* The withdrawal of the USA from global health funding has impacted all disease areas—but HIV less so than TB. Our main finding implies that TB should be comparatively privileged at least in these 22 high-TB-burden countries. Globally, HIV is likely to command a higher proportional share of investment because the HIV burden outside these countries is likely greater than that of TB.

There are four main reasons to be cautious about the results of our analysis. First, our estimates focus on the economic losses at the household level, yet it is possible that a loss for one household could correspond to a gain for another. This scenario is particularly relevant in the 22 countries we studied, many of which have labour markets characterised by excess supply. Consequently, when an individual exits the labour market due to infection, their role might be filled by an unemployed person, potentially resulting in no net loss to the economy but rather a redistribution of income from infected individuals to healthy ones.

Second, our analysis is based on the assumption of one infected individual per household. However, if infections cluster within households, the economic costs could be significantly higher. The extent to which TB or HIV affects multiple household members varies, and cross-country data to clarify this aspect is lacking. While HIV

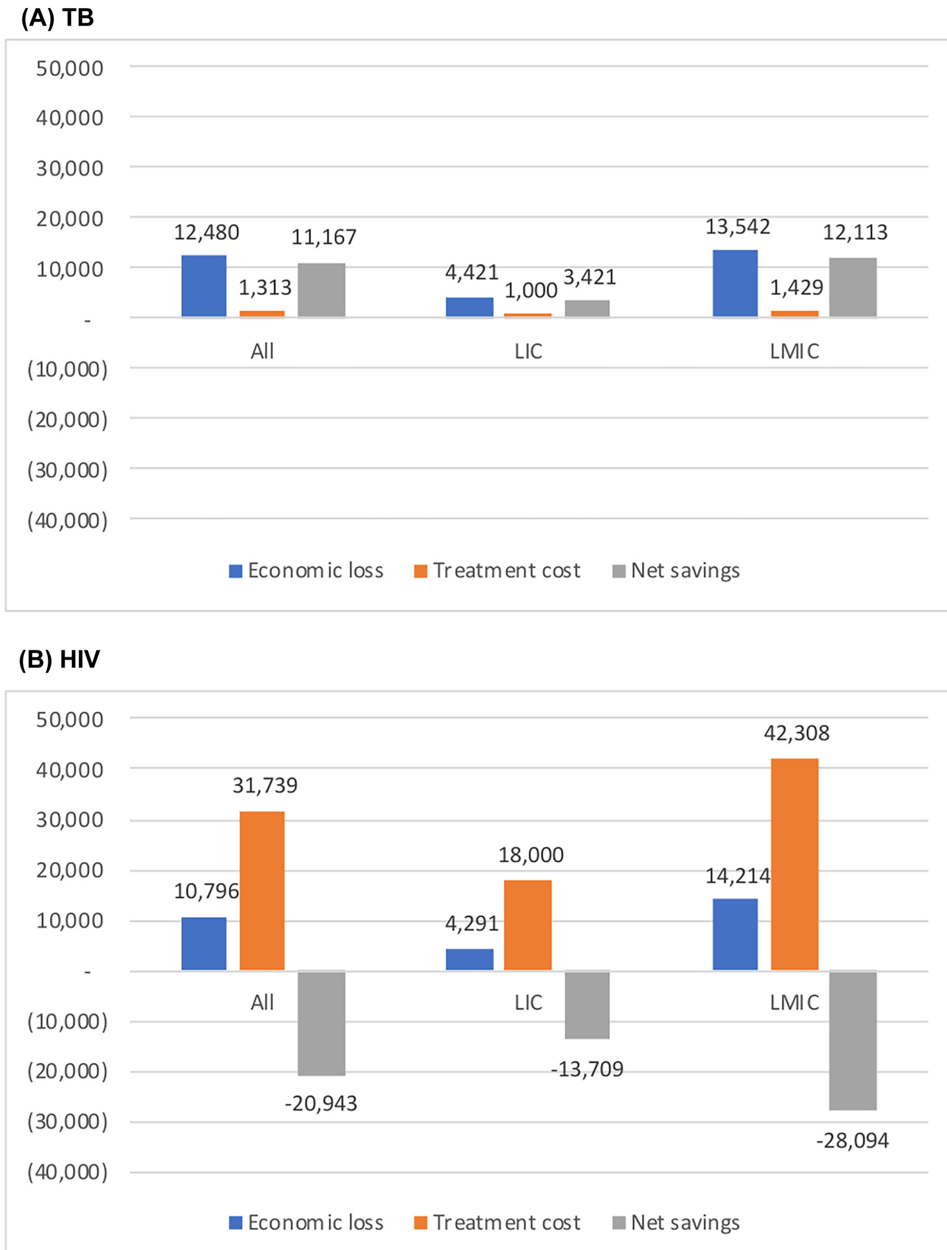

Figure 5 Economic loss per death, cost per death averted and net savings from averting a death (US$). Notes: Economic losses per death are calculated from the model in Materials and methods. Costs per death averted are obtained from DCP3 (2017).[1] Net savings is the difference between these two quantities. DCP3, 2017 Disease Control Priorities; LIC, low-income countries; LMIC, low- and middle-income countries; TB, tuberculosis.

transmission within couples and from mother to child is well-documented, TB could potentially infect all household members, although with a lower probability of transmission.

Additionally, the impact of lost wages is not uniform across the population; it varies by wage rates, SES and the degree to which households are protected from the loss of wages due to illness (whether they have sick leave). The poor or near poor, who are less likely to have such protections, are also more likely to be adversely affected. While we could not estimate the distributional impacts due to data limitations, available evidence suggests that TB disproportionately affects the poor and near-poor due to factors like nutrition and crowding, a pattern less observed with HIV. If so, then the difference between TB and HIV in household impact on poverty will be even greater than we estimate.

Furthermore, we assumed a constant number of absenteeism days due to TB and HIV across and within countries, an oversimplification given the variations in diagnosis delays, treatment quality and durations of disabling disease. Such factors lead to diverse outcomes in terms of disease duration and levels of chronic disability post-treatment, particularly for TB.

Despite the aforementioned limitations, we tried to make conservative assumptions. The last four limitations suggest that the impoverishing impact on affected households is likely to be greater than what we have estimated even though the net effect on the national economy may be less because of the offsets mentioned in our first limitation.

Lastly, it is concerning that, despite the global focus on health equity and the prominence of TB and HIV as leading causes of mortality from infectious diseases, robust data on the socioeconomic distribution of these diseases' impacts remain sparse. To genuinely measure the impact of diseases and control programmes on health equity, it is imperative to routinely collect data on the socioeconomic characteristics of affected individuals, including education and income, and to assess household-level impacts, considering out-of-pocket health costs and protections against income loss.

Contributors All authors conceived of the presented idea, developed the theory and performed the computations, discussed the results and contributed to the final manuscript. PG is the guarantor.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

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