

# Domestic and donor financing for tuberculosis care and control in low-income and middle-income countries: an analysis of trends, 2002–11, and requirements to meet 2015 targets



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## Summary

**Background** Progress in tuberculosis control worldwide, including achievement of 2015 global targets, requires adequate financing sustained for many years. WHO began yearly monitoring of tuberculosis funding in 2002. We used data reported to WHO to analyse tuberculosis funding from governments and international donors (in real terms, constant 2011 US\$) and associated progress in tuberculosis control in low-income and middle-income countries between 2002 and 2011. We then assessed funding needed to 2015 and how this funding could be mobilised.

**Methods** We included low-income and middle-income countries that reported data about financing for tuberculosis to WHO and had at least three observations between 2002 and 2011. When data were missing for specific country–year combinations, we imputed the missing data. We aggregated country-specific results for eight country groups defined according to income level, political and economic profile, geography, and tuberculosis burden. We compared absolute changes in total funding with those in the total number of patients successfully treated and did cross-country comparisons of cost per successfully treated patient relative to gross domestic product. We estimated funding needs for tuberculosis care and control for all low-income and middle-income countries to 2015, and compared these needs with domestic funding that could be mobilised.

**Findings** Total funding grew from \$1.7 billion in 2002 to \$4.4 billion in 2011. It was mostly spent on diagnosis and treatment of drug-susceptible tuberculosis. 43 million patients were successfully treated, usually for \$100–500 per person in countries with high burdens of tuberculosis. Domestic funding rose from \$1.5 billion to \$3.9 billion per year, mostly in Brazil, Russia, India, China, and South Africa (BRICS), which collectively account for 45% of global cases, where national contributions accounted for more than 95% of yearly funding. Donor funding increased from \$0.2 billion in 2002 to \$0.5 billion in 2011, and accounted for a mean of 39% of funding in the 17 countries with the highest burdens (excluding BRICS) and a mean of 67% in low-income countries by 2011. BRICS and upper middle-income countries could mobilise almost all of their funding needs to 2015 from domestic sources. A full response to the tuberculosis epidemic to 2015, including investments to tackle multidrug-resistant tuberculosis, will require international donor funding of \$1.6–2.3 billion each year.

**Interpretation** Funding for tuberculosis control increased substantially between 2002 and 2011, resulting in impressive and cost-effective gains. The increasing self-sufficiency of many countries, including BRICS, which account for almost half the world's tuberculosis cases, is a success story for control of tuberculosis. Nonetheless, international donor funding remains crucial in many countries and more is needed to achieve 2015 targets.

**Funding** None.

## Introduction

Tuberculosis remains a major global health problem despite the availability of treatment that is curative in about 90% of cases. In 2011, there were an estimated 8.7 million cases of tuberculosis and 1.4 million deaths.<sup>1</sup> Tuberculosis is the second leading cause of death from an infectious disease worldwide (after HIV, which caused an estimated 1.7 million deaths in 2011).<sup>2</sup> Reduction of the burden of tuberculosis disease requires adequate and sustained financing for many years.

Global targets to reduce cases of, and deaths from, tuberculosis have been set for 2015.<sup>1</sup> The tuberculosis-related target in the Millennium Development Goals is

that incidence should be falling by 2015. The Stop TB Partnership set targets to halve prevalence and mortality rates by 2015 compared with 1990. In 2006, WHO launched the Stop TB Strategy, its recommended approach to achievement of the 2015 targets.<sup>3</sup> That same year, the Stop TB Partnership published its Global Plan to Stop TB, which was based on the Stop TB Strategy and set out the actions and funding needed between 2006 and 2015 for a full response to the tuberculosis epidemic, with the overall goal of meeting the 2015 global targets for reductions in cases of, and deaths from, tuberculosis.<sup>4</sup> An update of this plan for the years 2011–15 was released in 2010.<sup>5</sup> Key components

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of the plan include increasing the number of patients detected and treated according to WHO's recommended strategy, from 5.8 million in 2011, to 6.9 million by 2015 (which would be equivalent to more than 80% of projected incident cases in that year); ensuring that all previously treated patients and all new patients with known risk factors for multidrug-resistant (MDR) tuberculosis are tested for MDR tuberculosis by 2015 (including with recently endorsed rapid tests such as Xpert MTB/RIF); enrolment of all patients with confirmed MDR tuberculosis (projected to be around 300 000 in 2015) into second-line treatment; HIV testing of all patients with tuberculosis; and prompt starting of antiretroviral therapy (ART) in all HIV-positive patients with tuberculosis. By 2011, the incidence of tuberculosis was falling globally and mortality and prevalence had fallen by 41% and 36%, respectively, since 1990.<sup>1</sup>

In the past decade, major national and international efforts have been made to finance and implement proper tuberculosis control to reach the 2015 targets. Actions include the establishment of the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) in 2002, and UNITAID in 2006, as new financing mechanisms to fight three of the leading infectious causes of death in developing countries. However, economic problems in donor countries since 2007 have put pressure on external resources, and scrutiny of value for money has increased.<sup>6</sup>

External financing for malaria and future funding needs for HIV have been assessed.<sup>7-9</sup> The first estimates of global funding needs for tuberculosis were published in 2002,<sup>10</sup> and, since 2003, WHO's yearly global tuberculosis reports have included financing analyses of 22 countries with the highest burdens of tuberculosis—the so-called high-burden countries (HBCs)—that account for about 80% of the world's cases of the disease and drive global epidemiological and financial trends in tuberculosis.<sup>1</sup> These countries are Afghanistan, Bangladesh, Brazil, Burma, Cambodia, China, Democratic Republic of the Congo, Ethiopia, India, Indonesia, Kenya, Mozambique, Nigeria, Pakistan, the Philippines, Russia, South Africa, Tanzania, Thailand, Uganda, Vietnam, and Zimbabwe.

We present new analyses of tuberculosis financing based on data from a decade of global financial monitoring at WHO. We assess trends in domestic and international donor funding between 2002 and 2011 in low-income and middle-income countries, both overall and for eight country groups. We then examine whether increased funding has been associated with progress in tuberculosis control and explore value for money in terms of the cost per patient successfully treated. We conclude by appraising domestic capacity to mobilise the resources needed until 2015, and the resulting balance needed from international donors, to inform mobilisation and allocation of national and international resources for global tuberculosis control in 2013 and future years.

## Methods

### Background

WHO began monitoring government and international donor financing for tuberculosis in 2002, which built on a system that was established in 1995 for yearly collection of data from national tuberculosis control programmes (NTPs) of member states.<sup>11</sup> All data are stored in WHO's global tuberculosis database. The standard methods used to compile, review, validate, and analyse these financial data have been fully described elsewhere.<sup>11,12</sup> The appendix contains a detailed explanation of the methods used, including those specific to our analyses.

Each year, WHO requests data from low-income and middle-income countries about funding for NTPs by category of expenditure and source of funding, and funding gaps by category of expenditure, in US dollars. Categories of expenditure on tuberculosis comprise: first-line drugs; NTP staff; programme management and supervision activities; laboratory supplies and equipment; advocacy, communications, and social mobilisation; community-based care; private-public mix approaches; tuberculosis and HIV collaborative activities; the Practical Approach to Lung Health; operational research including surveys; outpatient visits; and hospital admissions. Categories of expenditure on MDR tuberculosis are: second-line drugs; other items specifically for programmatic management of patients with MDR tuberculosis; hospital admissions; and outpatient visits. Funding sources are national or local government, loans (both classified as domestic funding), grants from the Global Fund, and grants from other donors (donor funding).

WHO staff use methods to review and validate data that have remained consistent since 2002. These methods include routine checks for plausibility and consistency (including validation checks that are built into the online reporting system), discussions with country respondents to resolve queries, and triangulation with other data sources (eg, detailed budgets prepared with WHO tuberculosis budgeting instruments,<sup>13</sup> economic evaluations,<sup>14,15</sup> the Global Fund, the Organisation for Economic Co-operation and Development Creditor Reporting System) to review the data. Particular attention has always been given to the 22 HBCs (appendix).

### Analysis

Among all 154 low-income and middle-income countries, we defined eight country groups according to tuberculosis burden, political and economic profile, income level, and geography. These groups were not always mutually exclusive. We divided the HBCs into two groups: Brazil, Russia, India, China, and South Africa (BRICS), which have a high, and increasing political and economic, profile; and the 17 HBCs excluding BRICS. We defined three additional groups on the basis of the income classification of the World Bank—specifically, low-income countries, middle-income countries, and

See Online for appendix

For the online reporting system see <http://www.stoptb.org/tme>

upper-middle-income countries. The final three groups were Africa, Asia, and other regions. Data for at least 3 years were required for our analyses (appendix) and countries were included or excluded accordingly.

When data were missing for a country in a specific year, we used country-specific linear regression models based on funding in the previous year, the number of patients treated, or gross domestic product (GDP) per person as predictors, to impute values (appendix). From the linear regression models, uncertainty bands were calculated for predicted values.

In a few countries (China and Russia are prominent examples), funding for tuberculosis reported by NTPs includes funding for all staff, infrastructure, and other inputs necessary for hospital admissions and outpatient visits during tuberculosis treatment, because care is provided in tuberculosis-specific hospitals and clinics that have dedicated budgets. In most countries, however, the funding used for inpatient and outpatient care for patients with tuberculosis is not captured in funding reported by NTPs. For these countries, we estimated the funding used for inpatient and outpatient care of patients by multiplying the number of outpatient visits and days of inpatient care per patient (reported by NTPs to WHO

each year) by country-specific estimates of their unit cost available from the WHO-CHOICE database<sup>16</sup> and then by the total reported number of patients with tuberculosis.

We assumed that the costs of inpatient and outpatient care were fully financed by domestic sources in middle-income countries. In some low-income countries, international donor funding could help to support inpatient and outpatient care, but amounts are not routinely reported either for tuberculosis specifically or the health sector in general (national health accounts do not include this specific breakdown). In probabilistic uncertainty analyses, we specified a uniform distribution for the share of funding for inpatient and outpatient care provided from domestic sources in low-income countries, with the percentage of NTP funding that was domestically financed (23%) as a minimum and 100% as a maximum.

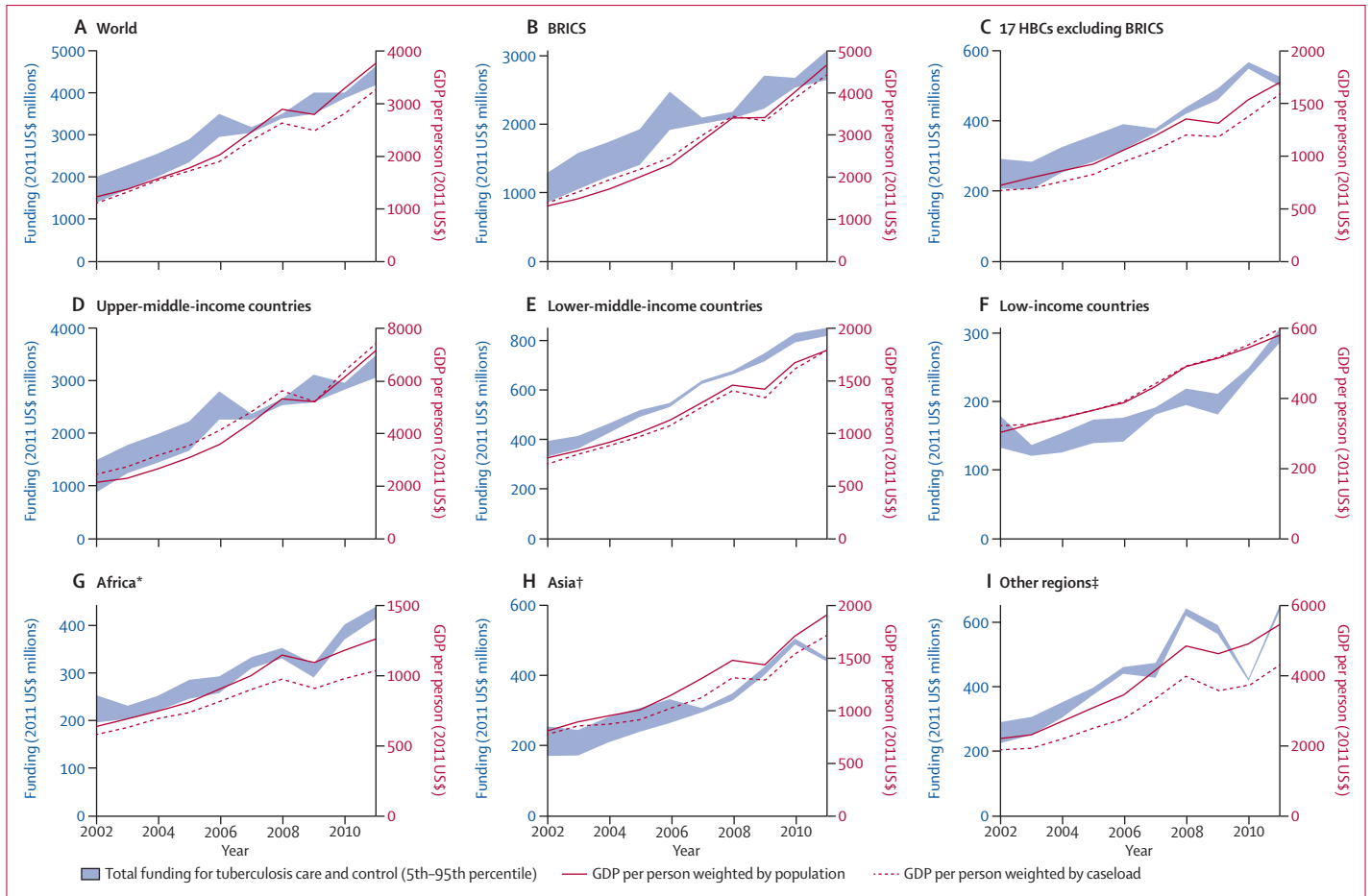
To measure trends in real terms, we used the GDP implicit price deflator from the USA to convert all values to constant 2011 US dollars. We then aggregated country-specific results for eight country groups defined according to income level, political and economic profile, geography, and tuberculosis burden.

We compared absolute changes in total funding (in real terms) with absolute changes in the total number of

	Low-income countries (22% of burden)	Lower-middle-income countries (49% of burden)	Upper-middle-income countries (23% of burden)	BRICS (45% of burden)	17 high-burden countries excluding BRICS (37% of burden)
Africa	Benin, Burkina Faso, Burundi, Central African Republic, Chad, Democratic Republic of the Congo, Eritrea, Ethiopia, The Gambia, Guinea-Bissau, Kenya, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Rwanda, Sierra Leone, Somalia, Togo, Uganda, Tanzania, Zimbabwe	Cameroon, Cape Verde, Republic of Congo, Côte d'Ivoire, Djibouti, Egypt, Ghana, Lesotho, Morocco, Nigeria, São Tomé and Príncipe, Senegal, Sudan, Swaziland, Zambia	Botswana, Gabon, Namibia, South Africa, Tunisia	South Africa	Democratic Republic of the Congo, Ethiopia, Kenya, Mozambique, Nigeria, Tanzania, Uganda, Zimbabwe
Asia	Bangladesh, Burma, Cambodia, Nepal	Bhutan, India, Indonesia, Kiribati, Laos, Marshall Islands, Micronesia, Mongolia, Pakistan, Papua New Guinea, Philippines, Solomon Islands, Sri Lanka, Timor-Leste, Tonga, Vanuatu, Vietnam	China, Malaysia, Palau, Thailand, Tuvalu	India, China	Afghanistan, Bangladesh, Burma, Cambodia, Indonesia, Pakistan, Philippines, Thailand, Vietnam
Other	Afghanistan, Haiti, Tajikistan	Armenia, Bolivia, El Salvador, Georgia, Guatemala, Guyana, Honduras, Nicaragua, Paraguay, Moldova, Syria, Uzbekistan, West Bank and Gaza Strip, Yemen	Argentina, Brazil, Bulgaria, Colombia, Dominican Republic, Ecuador, Iran, Jamaica, Jordan, Latvia, Lebanon, Panama, Romania, Russia, Suriname, Venezuela	Brazil, Russia	
Excluded	Comoros, Guinea, Kyrgyzstan, North Korea	Albania, Belize, Fiji, Iraq, Samoa, South Sudan, Ukraine	Algeria, American Samoa, Angola, Antigua and Barbuda, Azerbaijan, Belarus, Bosnia and Herzegovina, Chile, Costa Rica, Cuba, Dominica, Grenada, Kazakhstan, Libya, Lithuania, Maldives, Mauritius, Mexico, Montenegro, Peru, Saint Lucia, Saint Vincent and the Grenadines, Serbia, Seychelles, Macedonia, Turkey, Turkmenistan, Uruguay		

Low-income countries had gross national incomes (GNIs) of US\$1025 or less per person in 2011, lower-middle-income countries had GNIs between \$1026 and \$4035 per person in 2011, and upper-middle-income countries had GNIs between \$4036 and \$12 475 per person in 2011. 11 countries whose income is not categorised by the World Bank were excluded: Anguilla, Aruba, Bonaire Saint Eustatius and Saba, British Virgin Islands, Cook Islands, Montserrat, Nauru, Netherlands Antilles, Niue, Tokelau, and Wallis and Futuna.

**Table 1: Country groups according to income level, political and economic profile, geography, and global tuberculosis burden in 2011**

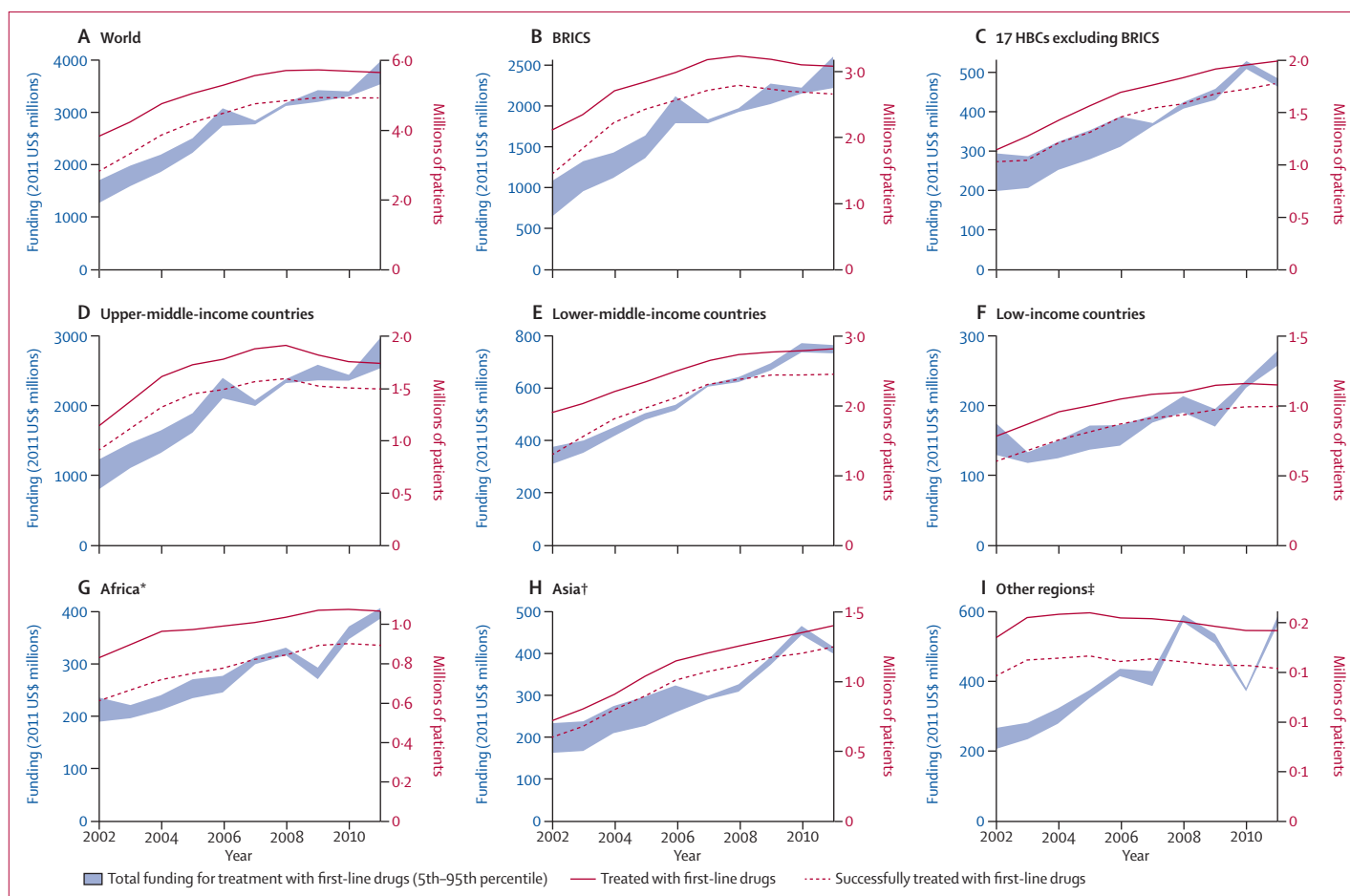


**Figure 1: Total funding for tuberculosis care and control from government and international donor sources and GDP per person weighted by population and caseload worldwide (A), and in BRICS (B); the 17 other HBCs (C); upper-middle-income (D), lower-middle-income (E), and low-income (F) countries; Africa (G); Asia (H); and other regions (I)**  
 Data are for 104 low-income and middle-income countries, 2002–11. Total funding includes funds received directly by NTPs and funds used for outpatient visits and inpatient care within general health-care systems that are not channelled through the NTP. For GDP per person weighted by caseload, an individual country's contribution is weighted according to share of tuberculosis cases in the same country group. GDP=gross domestic product. BRICS=Brazil, Russia, India, China, South Africa. HBCs=high-burden countries. NTP=national tuberculosis programme. \*Excludes South Africa. †Excludes India and China. ‡Excludes Brazil and Russia.

patients successfully treated (which was calculated from the number of patients with tuberculosis and rates of treatment success officially reported by countries).<sup>1</sup> We also assessed the cost per successfully treated patient and made cross-country comparisons of how this indicator was related to GDP per person (a proxy for the cost of non-traded inputs, mainly labour) and the caseload of patients with tuberculosis (because economies of scale might be realised in countries with many patients).

We used datasets from the Global Plan to Stop TB 2011–2015 in combination with country-specific planning and budgeting work with nine countries in January, 2013, to estimate funding needs for tuberculosis care and control to 2015.<sup>17</sup> Because trend data were not needed for this analysis, we could include all low-income and middle-income countries. The only major exclusion from the estimates was ART for HIV-positive patients with tuberculosis because funding for ART does not typically flow through NTPs and, as part of work

undertaken in 2013 to inform replenishment meetings held by the Global Fund, WHO, UNAIDS, and other partners agreed that funding needs for ART for HIV-positive patients with tuberculosis should be included in estimates of HIV resource needs to avoid double-counting. We then compared funding needs with the domestic funding that could be mobilised. We considered two scenarios. The first scenario was that tuberculosis funding could increase (from a 2011 baseline) in line with International Monetary Fund (IMF) forecasts for growth in total government expenditures.<sup>18</sup> The second scenario had the same assumptions as the first, but also assumed that countries that currently underperform in domestic financing relative to their income level (ie, their ability to pay) and disease burden reach the level of the median performer by 2020. These scenarios were chosen to be fully consistent with the methods previously used to assess the potential to mobilise domestic funding for prevention, treatment,



**Figure 2:** Total funding from government and international donor sources for treatment of drug-susceptible tuberculosis and numbers of patients with tuberculosis treated with first-line drugs worldwide (A), and in BRICS (B); the 17 other HBCs (C); upper-middle-income (D), lower-middle-income (E), and low-income (F) countries; Africa (G); Asia (H); and other regions (I). Data are for 104 low-income and middle-income countries, 2002–2011. Total funding includes that for drug and non-drug costs channelled through national tuberculosis programmes and for hospital care and outpatient visits in general health-care systems but excludes costs of second-line drugs for treatment of patients with multidrug-resistant tuberculosis. Treatment success for 2011 has not yet been reported; we assume it is equal to that in 2010. BRICS=Brazil, Russia, India, China, South Africa. HBCs=high-burden countries. \*Excludes South Africa. †Excludes India and China. ‡Excludes Brazil and Russia.

and care of HIV.<sup>9</sup> Further details are provided elsewhere,<sup>17</sup> and additional information is available from KF upon request. We used Stata (version 12.1) for all analyses.

### Role of the funding source

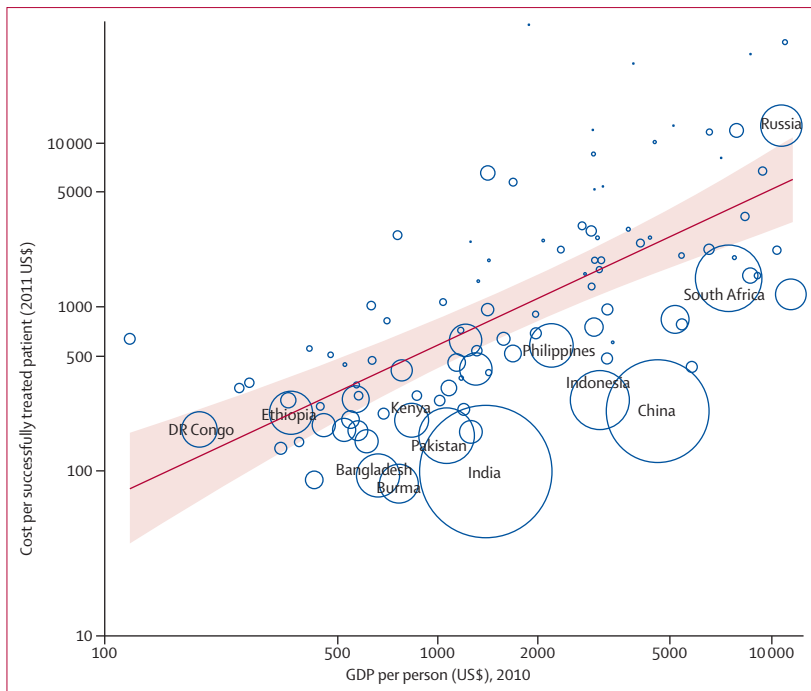
No donor had any role in the decision to prepare this Article, the analyses and writing, or the decision to submit for publication. The corresponding author had access to all data and had final responsibility for the decision to submit for publication.

### Results

We were able to include 104 of 154 low-income and middle-income countries in our analyses (table 1). 50 countries were excluded because the number of observations was too small (<three) to use in our imputation models. The 104 included countries had 94% of the world's estimated tuberculosis cases and 88% of the world's

estimated cases of MDR tuberculosis in 2011.<sup>1</sup> In these countries, the mean number of observations per country (out of a maximum of ten) was 7.3 (SD 0.23); it was 8.3 (0.71) for the 22 HBCs. 83 had six or more observations and, for most countries, between seven and ten observations were available (appendix). 14 of the 22 HBCs had ten observations each (including China and India, which accounted for 36% of global cases of tuberculosis in 2011)<sup>1</sup> and five had nine observations each. Country-year combinations for which financing data were missing (284 of 1040 [27%]) accounted for 13% of reported tuberculosis cases during the study (ie, data were missing mainly from countries with a small share of cases).

In the 104 low-income and middle-income countries included in our analyses, total tuberculosis funding (domestic and international donor sources) grew in real terms from \$1.7 billion in 2002, to \$4.4 billion in 2011 (figure 1). The increases ranged from 100% in



**Figure 3: Cost per successfully treated patient with tuberculosis relative to GDP per person, by country**  
Data are for 104 low-income and middle-income countries. Countries with more than 100 000 cases per year are labelled. The area of the circle is proportional to the caseload. The shaded area represents the 99% CI. Costs per successfully treated patient are based on the 2008–10 case-weighted mean. Both axes are on a log scale. GDP=gross domestic product.

low-income countries to 177% in upper-middle-income countries. Increases in funding were accompanied by increases in the number of people successfully treated for tuberculosis, from 2.8 million in 2002, to 5.0 million in 2011; 43 million people were treated between 2002 and 2011 (figure 2). The cost per patient successfully treated was \$100–500 in most of the highest-burden countries (figure 3). More than 70% of the variation between countries was explained by GDP per person and the size of the caseload of patients with tuberculosis ( $p < 0.0001$  for both variables).

Domestic funding rose from \$1.5 billion in 2002, to \$3.9 billion in 2011 (figure 4). Both categories of domestic funding (ie, that channelled through NTPs and that for inpatient and outpatient care) increased worldwide and in six of the eight country groups (appendix). The exceptions were the 17 HBCs excluding BRICS, and Asian countries excluding India and China, in which funding channelled through NTPs fell between 2010 and 2011. As a share of total funding, domestic funding dropped by 6–10% in low-income and lower-middle-income countries (appendix). Domestic funding increased more slowly (62–170% in 10 years) than did GDP per person (figure 1), which rose by 90–249% between 2002 and 2011 (the rise was slowest in low-income countries and fastest in upper-middle-income countries). Loans accounted for a small proportion ( $\leq 5\%$ ) of total domestic funding each year (data not shown).

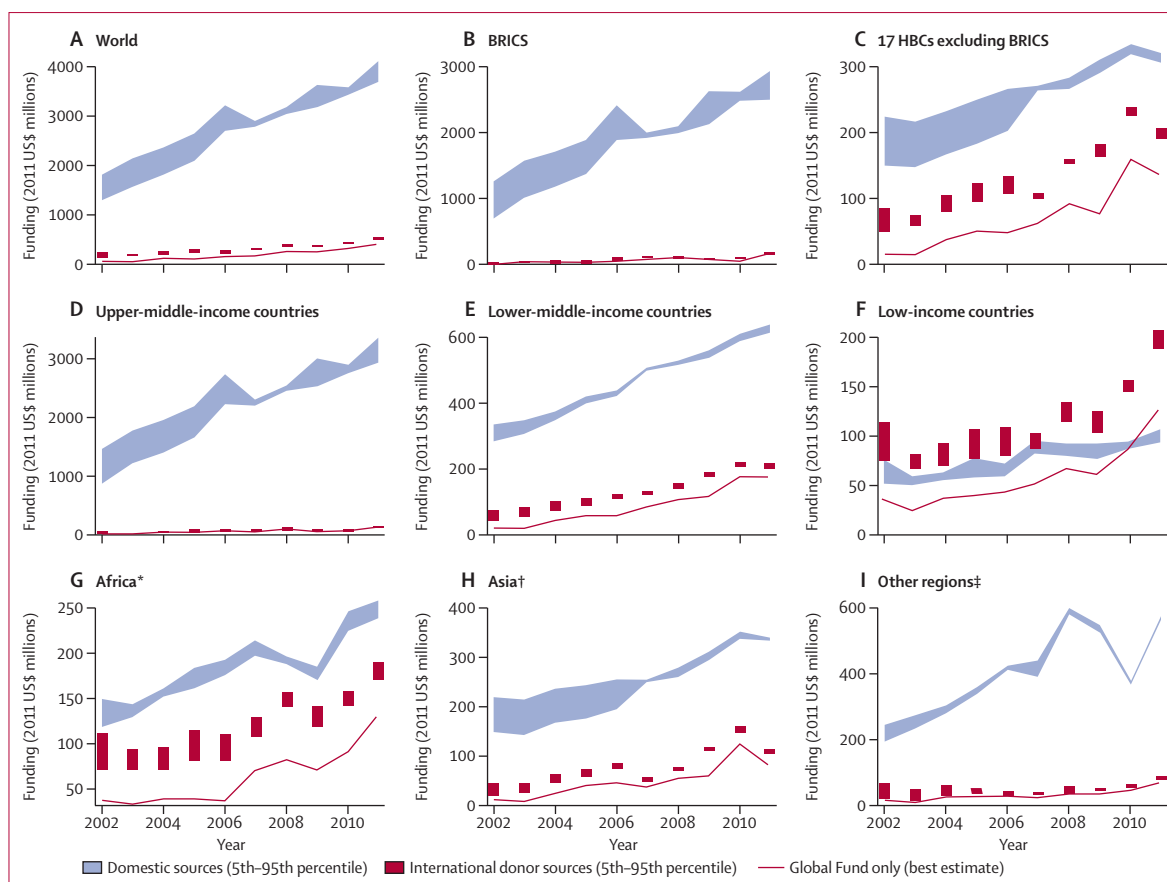
Most of the increase in total domestic funding (\$1.7 billion [71%]) was accounted for by BRICS (which account for 45% of the world's cases of tuberculosis) and other middle-income countries in Asia, Latin America, and Europe (figure 4). In view of the magnitude of domestic funding in these country groups (69–98% of total funding per year) and BRICS in particular (>95% of total funding per year), domestic funding dominated total funding for tuberculosis globally (88–92% per year).

Donor funding grew from \$0.2 billion in 2002, to \$0.5 billion in 2011 (figure 4), and accounted for a strikingly high proportion of total funding in some country groups. By 2011, donor funding represented 39% of total funding in the 17 HBCs excluding BRICS, which account for 37% of the world's tuberculosis cases, 42% of funding in African countries excluding South Africa, and 67% of total funding in low-income countries (25 of which are in Africa; table 2). Although donor funding accounted for a small proportion (3–5% in 2011) of total funding in upper-middle-income countries and BRICS, absolute amounts were large—eg, \$153 million in BRICS in 2011 (29% of all donor funding). The Global Fund accounted for 64% of all donor funding during 2002–11, reaching a high of 80% (\$0.4 billion) in 2011.

Most funding was used for diagnosis and treatment of drug-susceptible tuberculosis (appendix). Small amounts were used for diagnosis and treatment of MDR tuberculosis, although funding started to increase in BRICS, upper-middle-income countries, and countries in Europe and Latin America around 2006.

Despite growth in tuberculosis funding, NTPs were not able to mobilise all the funding that they estimated to be needed (figure 5). Funding gaps (ie, the difference between assessments by NTPs of funding needs for tuberculosis care and control and the actual amount of funds mobilised) persisted, and increased from \$257 million in 2002, to \$563 million in 2011. Funding gaps decreased only in BRICS, upper-middle-income countries, and countries outside Africa and Asia.

Figure 6 shows the funding needed for a full response to the tuberculosis epidemic in all low-income and middle-income countries to reach targets set in the Global Plan to Stop TB, compared with the funding that could be mobilised from domestic sources. The gap between the funding needed to 2015 and the funding that could be mobilised from domestic sources is even larger than the funding gaps reported by NTPs (figure 5). By 2015, an annual yearly gap of \$1.6 billion is estimated in the second scenario and \$2.3 billion in the first scenario. BRICS and upper-middle-income countries could mobilise almost all the requisite resources from domestic sources, whereas, especially in low-income countries, the 17 HBCs excluding BRICS, and Africa (excluding South Africa), international donor funding will be needed.



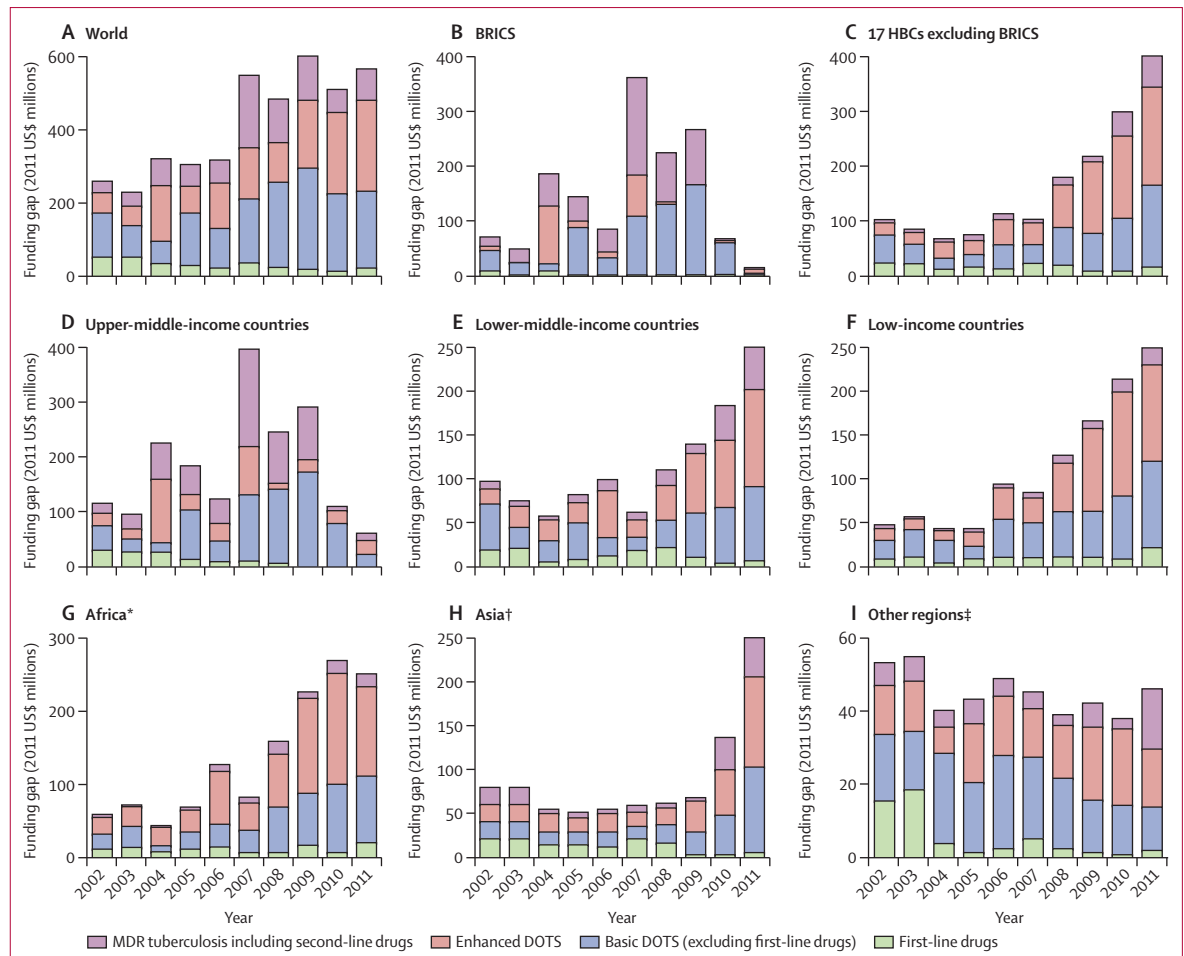
**Figure 4:** Funding for tuberculosis care and control from domestic sources, international donors, and the Global Fund specifically worldwide (A), and in BRICS (B); the 17 other HBCs (C); upper-middle-income (D), lower-middle-income (E), and low-income (F) countries; Africa (G); Asia (H); and other regions (I)

Uncertainty bands for domestic funding show uncertainty in years for which one or more countries did not report funding data or a breakdown of funding by source, and uncertainty about the extent to which inpatient and outpatient care for tuberculosis patients in general health-care systems are domestically funded in low-income countries. In probabilistic uncertainty analysis, the proportion of funding for inpatient and outpatient care funded from domestic sources in low-income countries was assumed to follow a uniform distribution, ranging from the proportion of funding for national tuberculosis programmes from domestic sources to 100%. BRICS=Brazil, Russia, India, China, South Africa. \*Excludes South Africa. †Excludes India and China. ‡Excludes Brazil and Russia.

	2002-11				2011			
	Donor funding (US\$ millions)	Donor funding as % of total funding	Global Fund contributions as % of donor funding	Global Fund contributions as % of total funding	Donor funding (US\$ millions)	Donor funding as % of total funding	Global Fund contributions as % of donor funding	Global Fund contributions as % of total funding
World	3075	10	64	6	523	12	80	10
BRICS	730	4	74	3	153	5	90	5
17 high-burden countries (excluding BRICS)	1303	34	54	18	199	39	69	27
Upper-middle-income countries	650	3	75	2	114	3	93	3
Lower-middle-income countries	1307	22	67	15	212	25	85	21
Low-income countries	1105	60	54	32	196	67	69	46
Africa excluding South Africa	1168	39	54	21	180	42	74	31
Asia excluding India and China	738	23	64	15	107	24	75	18
Other regions excluding Brazil and Russia	424	10	71	7	81	12	85	11

Figures are best estimates. Global Fund refers to the Global Fund to Fight AIDS, Tuberculosis and Malaria. BRICS=Brazil, Russia, India, China, South Africa.

**Table 2:** Funding received for tuberculosis care and control from international donor sources, 2002-11



**Figure 5:** Funding gaps reported by NTPs by major category of expenditure worldwide (A), and in BRICS (B); the 17 other HBCs (C); upper-middle-income (D), lower-middle-income (E), and low-income (F) countries; Africa (G); Asia (H); and other regions (I)

Data are for 104 low-income and middle-income countries, 2002–11. Basic DOTS (excluding first-line drugs) includes NTP staff, programme management and supervision, laboratory supplies, hospital stays, and clinic visits. Enhanced DOTS includes collaborative tuberculosis and HIV activities; advocacy, communications, and social mobilisation; community-based care; private–public mix approaches; the Practical Approach to Lung Health; operational research; surveys; and other miscellaneous items. DOTS is the basic package that underpins the Stop TB Strategy. NTP=national tuberculosis programme. BRICS=Brazil, Russia, India, China, South Africa. HBCs=high-burden countries. MDR=multidrug-resistant. \*Excludes South Africa. †Excludes India and China. ‡Excludes Brazil and Russia.

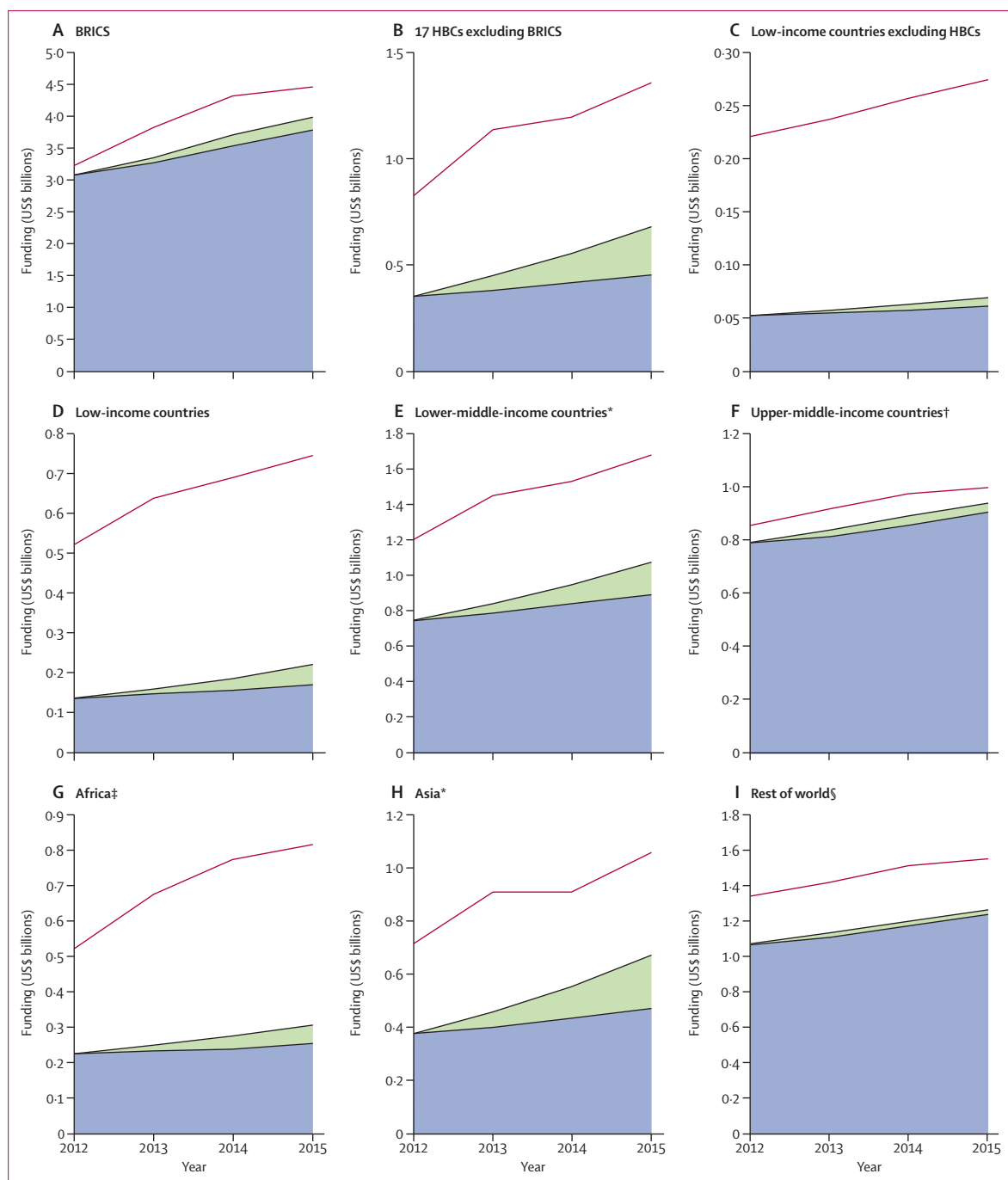
## Discussion

Our study is, to our knowledge, the first to assess long-term trends in government and international donor funding for care and control of tuberculosis in low-income and middle-income countries (panel). It shows that funding grew substantially between 2002 and 2011, and that the number of people successfully treated for tuberculosis greatly increased (at a low cost per patient). Domestic funding has underpinned progress in BRICS and European, Latin American, and upper-middle-income countries, and these countries are increasingly self-sufficient. Other countries remain highly dependent on international donor funding. Donor funding remains essential to safeguard and build on recent gains in tuberculosis control in these countries. Furthermore, despite growing investments, the yearly gap between the funding needed for a full response to the tuberculosis

epidemic and the funding available could exceed \$2 billion per year by 2015.

Our study has several strengths and limitations. We excluded 50 low-income and middle-income countries (which account for 4% of tuberculosis cases globally) from trend analyses because data were unavailable or too incomplete (including Kazakhstan, which reported funding of \$0.2 billion in 2011), and country–year combinations for which data were imputed accounted for 13% of tuberculosis cases. Further efforts are needed to improve data for tuberculosis financing. However, in an analysis<sup>19</sup> of global financing for public health in developing countries, 25–44% of data were imputed. Inclusion of these extra countries that account for only 4% of tuberculosis cases worldwide probably would not change our main results (or interpretations thereof).





**Figure 6:** Forecast of funding that could be mobilised from domestic sources compared with funding needed for a full response to the global tuberculosis epidemic in BRICS (A); the 17 other HBCs (B); low-income countries excluding HBCs (C); low-income (D), lower-middle-income (E), and upper-middle-income (F) countries; Africa (G); Asia (H); and the rest of the world (I)

The blue band represents scenario 1, which shows domestic funding that could be mobilised if domestic funding increases from a 2011 baseline at the same rate of growth as International Monetary Fund forecasts of growth in total government expenditures. The green band shows additional resources that could be mobilised, compared with scenario 1, if current underperformers (relative to income level and disease burden of tuberculosis) improve at a consistent rate to reach the level of the median performer by 2020. Amounts of total funding available from domestic sources in 2011 differ from those displayed in previous figures because all low-income and middle-income countries were included, not only the 104 for which trends in tuberculosis funding could be estimated since 2002. Of total funding required (red line), about 60% is for the core elements of tuberculosis care and control (DOTS, the basic package that underpins the Stop TB Strategy), 25% is for treatment of multidrug-resistant tuberculosis, 10% is for rapid tests and associated laboratory strengthening, and 5% is for collaborative tuberculosis-HIV activities. Funding needs allow for inflation. BRICS=Brazil, Russia, India, China, South Africa. HBCs=high-burden countries. \*Excludes India and China. †Excludes Brazil, Russia, and South Africa. ‡Excludes South Africa. §Excludes Brazil and Russia.

**Panel: Research in context****Systematic review**

We searched PubMed in January, 2012, with several combinations of the search terms "health", "financing", "global", and "trends"; "global", "financing", "trends", and "tuberculosis"; "financing", "international donor", and "tuberculosis"; and "financial", "monitoring", and "tuberculosis". Searches in which the term "tuberculosis" was substituted for HIV and malaria were also done. We reviewed financing data included in global reports published by WHO's tuberculosis and malaria programmes, UNAIDS, and the Institute of Health Metrics and Evaluation. Our search of PubMed identified one previous study that included data for trends in domestic and donor financing for tuberculosis, covering the years 2002–07.<sup>12</sup> We did not identify any study of global trends in domestic and international donor funding for tuberculosis covering the decade 2002–11. A repeat search on March 25, 2013, did not identify any subsequent studies. The main source of information for the analyses published in this Article was data provided in routine reports submitted to WHO by the national tuberculosis programmes of member states. These reports are submitted as part of yearly data collection organised by WHO's Global TB Programme. Financial data have been gathered since 2002, and particular attention is given to low-income and middle-income countries. Our second source of information was estimates of unit costs for outpatient visits and bed days in hospital available from a global database managed by WHO's health financing department. The analyses presented in this paper were restricted to the 104 countries for which data of sufficient completeness and quality were available. These countries account for 94% of the world's tuberculosis cases and 88% of the world's cases of multidrug-resistant tuberculosis.

**Interpretation**

Funding for tuberculosis care and control grew substantially between 2002 and 2011, and impressive and cost-effective gains were delivered. We noted striking contrasts in funding patterns between countries. The increasing self-sufficiency of countries such as Brazil, Russia, India, China, and South Africa (BRICS), where almost 50% of the world's tuberculosis cases occur, is a success story for tuberculosis control. However, international donor funding remains essential to safeguard and build on gains in many countries. In high-burden countries outside BRICS and in all low-income countries, international donor funding accounted for between a quarter and two-thirds of total funding by 2011. International donor funding for tuberculosis is much less than the funding allocated for HIV and malaria. The yearly gap between the funding needed for a full response to the tuberculosis epidemic and that available could exceed US\$2 billion by 2015. Despite growing investments in tuberculosis overall, more funding is needed to reach 2015 global tuberculosis targets.

We could not include analysis of out-of-pocket expenditures (which might be large in some countries, notably before diagnosis) and insurance schemes (which are of increasing relevance, especially in middle-income countries), which would increase total reported spending on tuberculosis. Unfortunately, these data are not routinely compiled for tuberculosis specifically. We have also missed some donor funding for technical assistance provided directly to international agencies and donor funding provided directly to non-governmental organisations, although these amounts are usually small compared with the total funding available to NTPs and are unlikely to affect global trends. We did not include funding for development of drugs, diagnostic tests, or vaccines, which is monitored by others and amounted to \$0.65 billion in 2011.<sup>20</sup> Unlike some other studies,<sup>7</sup> in our analysis we assessed both domestic and donor funding.

Other data sources and studies are broadly consistent with our results. For example, the total funding for tuberculosis provided by grants from the Global Fund that was reported by countries to WHO during 2002–11 is nearly identical to yearly disbursement figures reported by the Global Fund for the same set of countries.<sup>21</sup> Total donor funding from the Fund and bilateral agencies reported by the Institute of Health Metrics and Evaluation<sup>22</sup> was slightly higher than that reported in our analysis, probably because we excluded some countries that receive donor funding and missed funding not channelled through NTPs.

Between 2002 and 2011, 43 million people were successfully treated for tuberculosis at a unit cost of usually \$100–500 per person, which translates to less than \$1250 per death averted (case fatality without treatment is about 40%)<sup>23</sup> and less than \$100 per year of life saved (assuming that at least 12.5 years of life are saved for every averted death). For an intervention to be deemed highly cost-effective, the suggested benchmark is a cost per year of life saved less than GDP per person.<sup>24</sup> GDP per person is more than \$100 in even the poorest countries. On this basis, investments in tuberculosis control have been highly cost-effective, which has previously been suggested elsewhere.<sup>25–27</sup> If the price of second-line drugs for treatment of MDR tuberculosis (currently around \$2500–6000 per patient) could be lowered, and more outpatient-based models of care for tuberculosis and MDR tuberculosis adopted in some regions (notably eastern Europe and central Asia), the cost-effectiveness of treatment of both tuberculosis and MDR tuberculosis could be further improved and funding requirements lowered in some settings.

Our findings show that much more funding is needed for a full response to the tuberculosis epidemic in low-income and middle-income countries. Most funding has been spent on diagnosis and treatment of drug-susceptible tuberculosis. Compared with 2011, additional funding of around \$2–3 billion per year is needed to reach the 2015 targets set in the Global Plan to Stop TB, including those for detection and treatment of MDR tuberculosis, implementation of interventions that jointly address the coepidemics of tuberculosis and HIV, and increased uptake of innovations such as rapid tests. Clearly more domestic resources could be mobilised (possibly around \$6.5 billion by 2015). BRICS and upper-middle-income countries (mostly in Europe and Latin America) in particular can become increasingly, or, in some cases, fully, self-sufficient.

Insurance schemes might have an increasing role in some countries. They might become the main source of funding for diagnosis and treatment of MDR tuberculosis in China. International donor funding is crucial to fill the remaining gap of around \$1.6 billion per year. Tripling of donor investments in tuberculosis compared with those in 2011 might seem unrealistic. However, donor funding for tuberculosis remains small compared with

investments in HIV (\$8.2 billion in 2011)<sup>2</sup> and is about 25% of that allocated for malaria.<sup>28</sup> These observations are a challenge to do better at resource mobilisation for tuberculosis care and control, globally and nationally.

#### Contributors

KF and MR conceived the idea for the paper. CF developed and did the analyses with broad guidance from KF. KF wrote the Article with input from CF. All authors reviewed and commented on analyses and text, offered suggestions for improvement, and agreed the final version. KF had first line-responsibility for WHO's financial monitoring of tuberculosis 2002–04, AP for 2005–09, and both CF and AP for 2009–11; KF provided overall guidance since 2005. MR was responsible for establishing financial monitoring of tuberculosis in WHO in 2002, and provided broad guidance to this work 2002–11.

#### Conflicts of interest

We declare that we have no conflicts of interest.

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