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The global economic impact of anti-microbial resistance

KPMG LLP

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Extracted from a report prepared by KPMG LLP in the UK, derived from research commissioned by the Wellcome Trust, as part of an independent review into anti-microbial resistance supported by the Department of Health and the Wellcome Trust.

Contents

1 Executive summary

There has been increasing concern about the harm anti-microbial resistance (AMR) could cause to people and to the world economy, with rising AMR levels partially exacerbated by the overuse of antibiotics.

This report aims to quantify some of the consequences of higher AMR levels, looking at the impact different AMR scenarios could have on the economies of 156 countries by 2050. Economic impact was captured through an increased level of mortality and some of the estimated rise in morbidity and their impact on GDP, as a result of a smaller labour force and lower productivity respectively.

Given the complexity involved in estimating the full impact of AMR, the analysis was limited to a selection of three bacteria and three diseases with reasonable incidence and coverage and with relevant available data. These were *Staphylococcus aureus* (best known in its methicillin resistant form – MRSA), *Escherichia coli* (widely known as *E. coli*), and *Klebsiella pneumoniae*, HIV, Tuberculosis and Malaria.

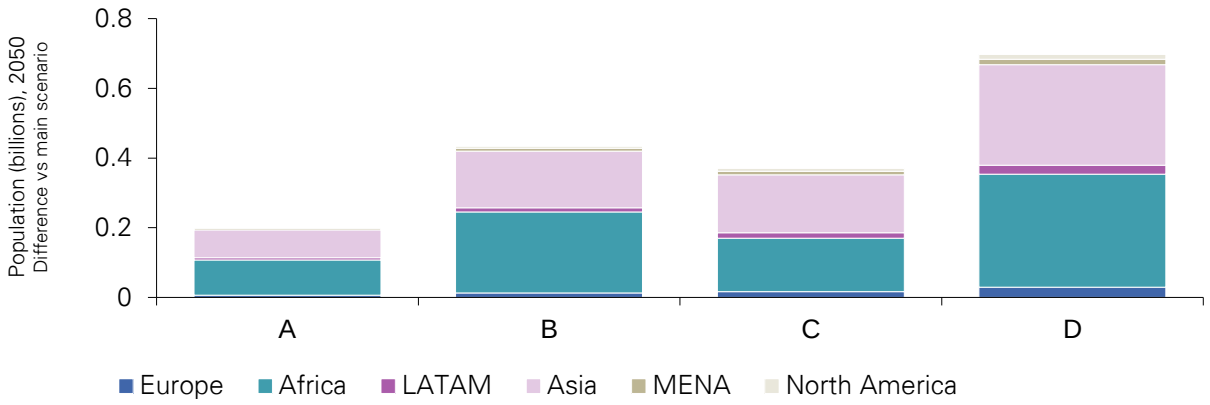
The analysis also excluded a noteworthy part of the effect of morbidity and other secondary health effects, as well as wider economic effects from the analysis. As a result, projections in this report are likely to underestimate the full impact.

Economic impact projections used four potential AMR scenarios:

- Scenario A - an absolute increase in current rates of resistance by 40%
- Scenario B - 100% resistance rate applied across all countries
- Scenario C - Doubling of current infection rates for the three bacteria, HIV and Tuberculosis, and an absolute rise in current rates of resistance by 40%
- Scenario D - Doubling of current infection rates for the three bacteria, HIV and Tuberculosis, and 100% resistance rate in all countries

The impact on world population is expected to be significant, with world population projected to be lower by just under 700 million in Scenario D in 2050, as highlighted in Chart 1 below.

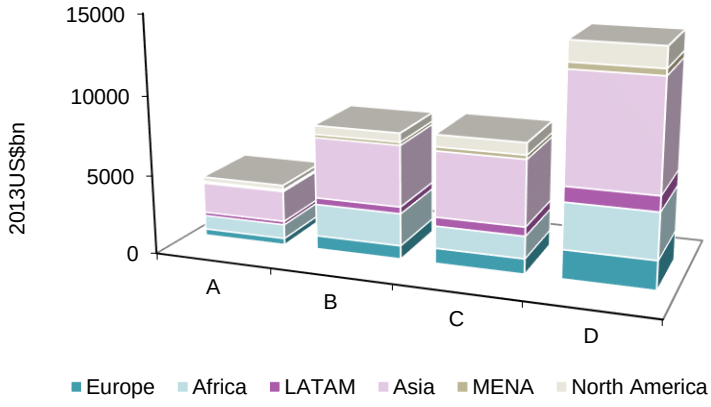
Chart 1: Estimated reduction in world population in 2050 under each scenario



Source: KPMG analysis

Scenario D is projected to cause world GDP to be $US14,228 billion lower in 2050[1] as highlighted in Chart 2 below, the equivalent of more than the whole economies of China, Russia and India wiped out together based on their current size, or the whole continent of Africa disappearing based on its projected size in 2050 in our baseline scenario. The largest relative economic impact is projected to be suffered by Africa with a fall in GDP of US$2,895 billion in 2050 in Scenario D, representing 20% of the region's total economic output.

Chart 2: Potential loss in GDP under different scenarios in 2050



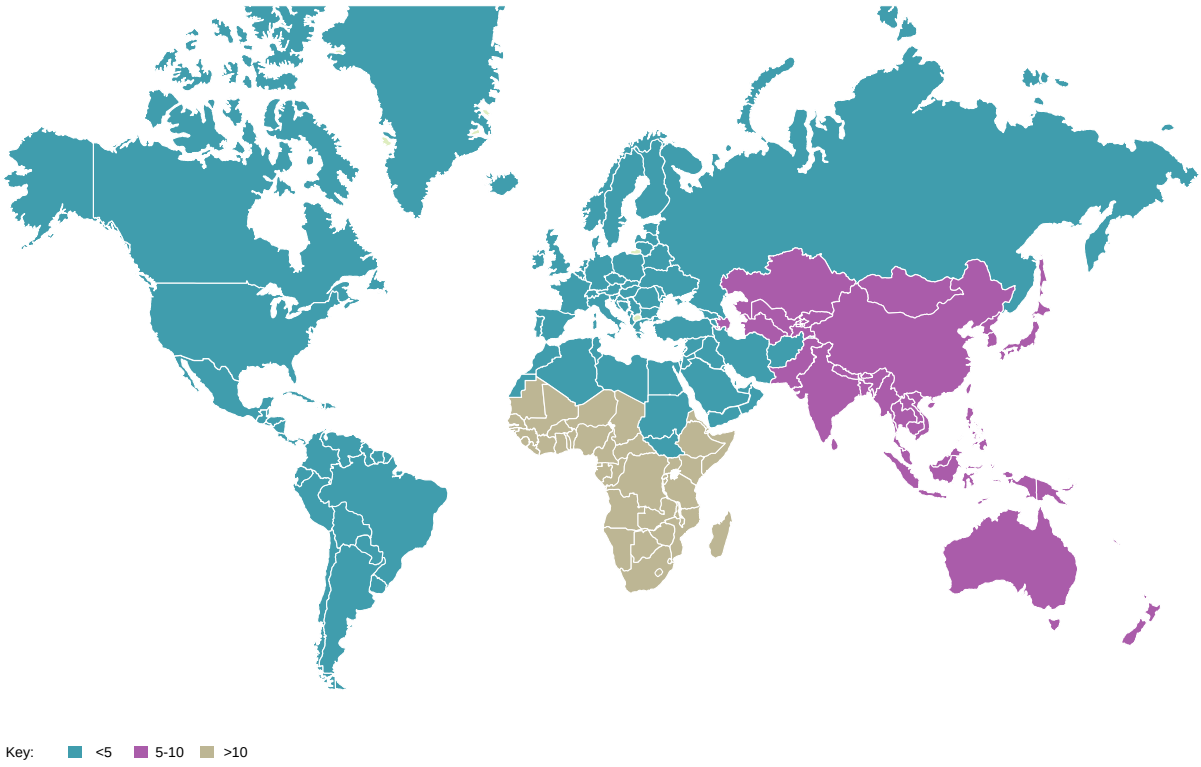
Source: KPMG analysis

[1] Measured in 2013 US$.

The impact of higher AMR is unlikely to be spread equally, with those more vulnerable likely to pay the highest price, as low income countries suffer the biggest proportionate loss of population and economic output.

As highlighted in Chart 3 below, Africa is projected to be significantly affected by our most severe AMR scenario, Scenario D, followed by Asia. World GDP is projected to be 6.08% lower in 2050 in this scenario, and variations in loss are projected to be large.

Chart 3: Potential loss in GDP in Scenario D; % fall compared to baseline scenario in 2050



Source: KPMG analysis

The rise in AMR and its potential real damage to society and to the world economy should encourage the development of new antibiotics and increase efforts to ensure future social and economic impacts are minimised.

2 Preface and acknowledgements

In 1945 Alexander Fleming received the Nobel Prize for the invention of Penicillin, the world's first antibiotic. During his acceptance speech, Fleming warned of the dangers that bacteria could evolve and may with time become resistant to Penicillin and render the drug ineffective. Almost seventy years on, with multiple different types of antibiotics now in existence, Fleming's warnings are being fully realised. The world has not created a novel class of antibiotics in more than 25 years, and bacteria are becoming increasingly resistant to those that exist. As this publication goes on to discuss there is a real danger that the world may soon face a situation where antibiotics fail, people die of what are currently considered mild infections and that routine operations can no longer take place.

In July of this year the British Prime Minister established the Anti-Microbial Resistance Review (the "Review") to examine ways to reduce anti-microbial resistance (AMR); this is co-funded by the UK Government and the Wellcome Trust. The Review has a global outlook and seeks to examine how the world as a whole can deal with AMR. It is investigating ways to improve the drug pipeline in order to facilitate the creation of new, more effective antibiotics, to examine the best ways to conserve existing antibiotics and decrease unnecessary resistance building up. Its recommendations are independent of both the UK Government and the Wellcome Trust.

The Anti-Microbial Resistance Review commissioned KPMG to carry out research into the potential global economic impact of AMR.

Acknowledgements

We are very grateful to the following organisations for their invaluable contributions to the analysis:

- European Centre for Disease Prevention and Control
- World Health Organisation
- Centres for Disease Control and Prevention
- London School of Hygiene and Tropical Medicine
- University College London Hospitals
- Public Health England
- UK Department of Health
- Wellcome Trust
- People's Hospital, Peking University, Beijing
- University of Sao Paulo
- Federal University of Rio Grande Sol and Rio de Janeiro
- Brazilian Ministry of Health
- ANVISA – Brazilian Health Surveillance Agency
- KPMG in Australia
- KPMG in South Africa
- KPMG in India
- KPMG in China
- KPMG in Brazil

3 Introduction

AMR is becoming a growing health issue on a global scale.

AMR is the natural process of bacteria and other infectious agents adapting to the antibiotics treating them, which causes antibiotics to have a limited effective lifespan and requires new antibiotics to be developed in order to successfully treat resistant agents.

Over the past few decades we have witnessed an increase in AMR levels, partially exacerbated by overuse of antibiotics.

At the same time, a shortage of new antibiotics arriving in the market is leading to microbial resistance which causes relatively minor and common infections to inflict increasing harm on our society and on the global economy.

3.1 Main objectives

Rising resistance levels across the world represent real costs to society.

Loss of life and reduced quality of life, as a result of more prolonged and more severe illnesses, will exert a toll on societies across the world. At the same time, a reduced labour force, together with potential measures to contain infections through diminished cross-border movements, could see economic output significantly curtailed. As AMR rises, additional changes to behaviours and practices are likely to emerge, which will impact our way of life, welfare and wealth.

It is important to understand the scale of AMR's threat so measures can be taken to combat it before it escalates further. However, given that the impact of AMR on society is potentially vast and diverse assessing the overall impact of AMR is highly complex.

This report aims to quantify some of the consequences of rising AMR. It focuses on a number of key bacteria and diseases affected by AMR and looks at the economic impact on 156 countries that different AMR scenarios could have as a result of increased mortality levels reducing each country's labour force and productivity.

Estimations in this report therefore only capture some of the impacts AMR could have on the world economy and its citizens. The full impact is likely to be far higher.

3.2 Further areas to explore

3.2.1 Coverage of microbial causes of disease

The analysis focused on three bacteria with resistance to specific antibiotics:

- *Staphylococcus aureus* which is a bacteria that can cause disease, particularly if there is an opportunity for the bacteria to enter the body. It can cause mild to life-threatening illnesses such as wound infections, joint infections, pneumonia and blood stream infections. Methicillin resistant *Staphylococcus aureus* (MRSA) is a particularly difficult to treat infection.
- *Escherichia coli* (better known as *E. coli*) is a bacteria that normally lives in the intestines. Some types can cause intestinal infections leading to diarrhoea, abdominal pain and fever. More severe cases can lead to bloody diarrhoea, dehydration and kidney failure.

- *Klebsiella pneumoniae* is a bacteria that can cause different types of infections, including pneumonia, bloodstream infections, wound or surgical site infections, and meningitis.

In addition, the following well known and widespread diseases were also covered:

- Human Immunodeficiency Virus (HIV), that causes the acquired immunodeficiency syndrome (AIDS), a condition in humans in which progressive failure of the immune system allows life-threatening opportunistic infections and cancers to thrive.
- Tuberculosis (TB), a widespread and in many cases fatal infectious disease caused by various strains of mycobacteria. TB typically attacks the lungs but can also affect other parts of the body.
- Malaria, a mosquito borne infectious disease caused by parasitic protozoan which can cause fever, fatigue, vomiting, headaches and is sometimes fatal.

This selection was based on the availability of current AMR rates and infection rates.

Further analysis, as data becomes available, could incorporate all possible global microbial causes of disease and resistance to their treatments.

3.2.2 Secondary healthcare costs

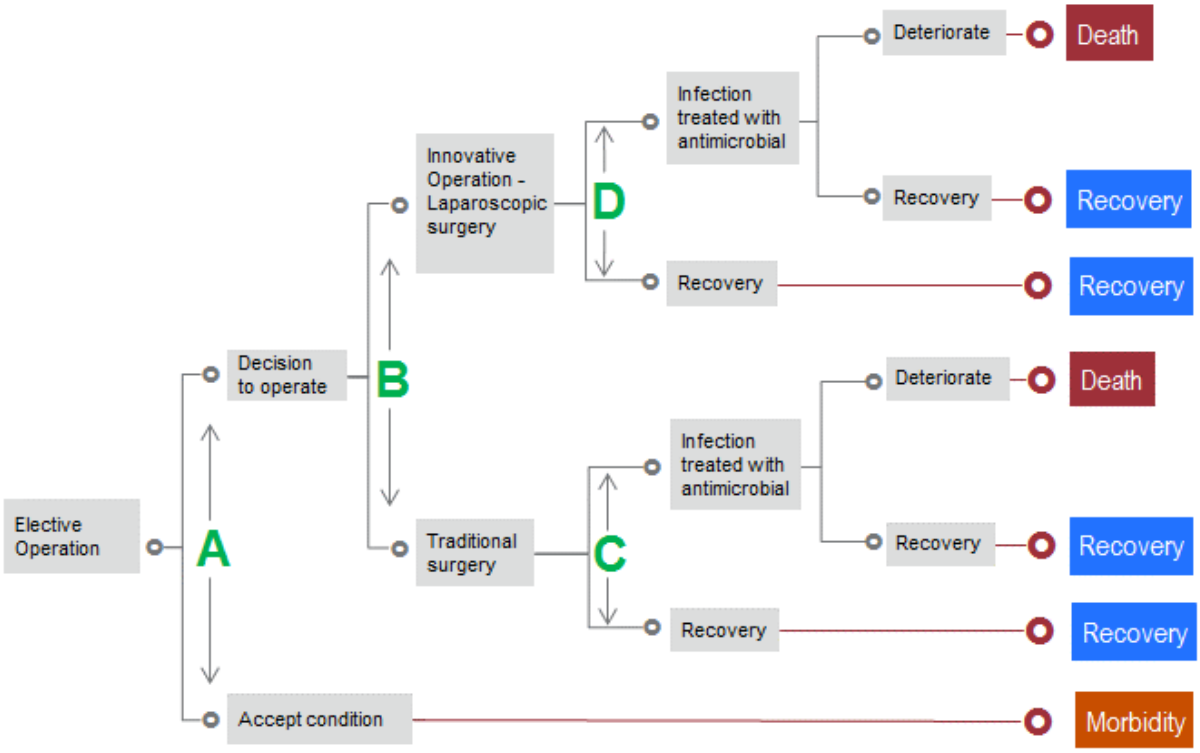
The analysis outlined in this report focused on the changes to each country's GDP based on the changes to productivity and to its labour force as a result of varying AMR rates.

With continued rising AMR there may develop a future scenario where the risk of developing an infection, which is untreatable due to AMR, during an elective healthcare treatment outweighs the risk of not having the treatment in the first place. That is, it may be 'safer' to live with a managed longer term morbidity than to risk an operation if the chance of developing an untreatable resistant infection is high. These secondary effects, if they materialise, could significantly add to health costs through prolonged treatment costs and further reduce future GDP as more people are unable to work.

An increase in AMR may also change the supply and demand of healthcare across high, middle, and low income countries.

Chart 4 below provides an example of an elective treatment in a high income country, with the following potential impact:

Chart 4: Supply and demand effects of increase in AMR



- **Changes in demand:** the decision node at point A represents the decision to undertake surgery or to accept a permanent level of discomfort and morbidity. As AMR increases, an increased number of patients is expected to decide against surgery. All other things being equal, rates of morbidity are expected to rise within the community as a result.
- **Changes in supply:** the decision node at point B represents the decision to have a traditional operation or an innovative operation such as laparoscopic surgery, which involves a lower risk of infection. Point C would have an increased risk of infection compared to point D, and therefore as AMR increases the number of innovative surgeries and other alternative treatments are expected to rise.

3.2.3 Economic impact

The analysis captures the impact of increased AMR on the labour force and human capital, and the consequent effect on economic output under alternative AMR scenarios.

Other economic relationships are likely to be affected by the AMR scenarios, which have not been modelled here due to the complexity involved and the uncertain nature and scale of the behaviours that increased AMR levels could trigger.

These include changes in trade and cross border transit patterns, as well as potential local substitution effects in production.

4 Analysis

The analysis in this report looks to capture the impact AMR could have on the world economy.

Given the complexities involved, the impact measured was limited to the three key bacteria and three major diseases listed above, which are likely to be globally affected by rising AMR levels.

The analysis captured the impact increased levels of mortality could have on world GDP levels through their effect on the labour force and productivity, but excluded potential additional effects as a result of changes in behaviours and practices, such as potential reduced trade and cross border transit.

As such, estimates published in this report are likely to underestimate the total impact AMR could have on the world economy.

As part of the analysis, data was collected from a variety of sources to capture the current global prevalence of AMR, and future AMR scenarios were then developed in consultation with experts in order to capture the potential future AMR paths to 2050.

Future AMR scenarios were then transformed into alternative labour force scenarios which were incorporated into a long term global economic growth model to arrive at long term GDP projections for 156 countries under different AMR scenarios.

4.1 Methodology

The approach used to capture the global impact of AMR on the global economy involved four phases:

- Assessment of the current health costs associated with AMR
- Estimation of potential future AMR scenarios
- Analysis of the potential impact AMR scenarios could have on productivity
- Projections of long term economic growth under the different AMR scenarios

The first two phases centred on the health costs associated with AMR, and focused primarily on the change in mortality levels expected under each scenario. These estimates were transformed into adjusted labour force projections for each country.

The second part of the analysis, comprising phases 3 and 4 above, looked to translate the health costs of AMR in terms of increased mortality into economic impact.

The results of the analysis comprise projections of GDP to 2050 in 156 countries. These outline the impact the different AMR scenarios could have on the world economy, as well as on individual regions and countries.

A more detailed description of the methodology used in this analysis is presented below.

4.1.1 Capturing AMR impact on health

Infectious diseases are one of the main causes of death globally and the development of resistance to certain infectious disease treatments compounds this issue, with increasing AMR being seen globally for many diseases.

In order to assess the economic impact of AMR, its health impact was estimated through rising global mortality rates under possible future scenarios of increased AMR.

The analysis presented in this report centred on three bacteria and related antibiotics, using data provided by the European Centre for Disease Prevention and Control (ECDC) and the World Health Organisation (WHO):

- *Staphylococcus aureus* resistance to Methicillin, commonly known as Methicillin resistant *Staphylococcus aureus* (MRSA)
- *Escherichia coli* resistance to third generation Cephalosporins
- *Klebsiella pneumoniae* resistance to third generation Cephalosporins

Reflecting the global nature of this analysis, the following diseases were also incorporated into the assessment, due to the high rate of mortality and in particular resistance to treatments of these diseases in low and middle income countries:

- Malaria
- HIV
- Tuberculosis

4.1.1.1 Mortality calculations

Estimations of mortality were carried out using total number of estimated infections in each country and multiplying those by countries' resistance rates, which resulted in an estimated number of infections that are resistant to treatment.

An adjustment rate, representing attributable mortality rate was then applied to determine patient mortality per country of those patients with resistance to the treatment.

Chart 5: Mortality calculations

4.1.1.2 Infection scenarios

An anti-microbial database[2] was used as part of the analysis. It provides data on the number of infections and level of AMR for all countries within the EU, Norway and Iceland. The data was available for a range of bacteria and a corresponding antibiotic for which the bacteria may have a level of resistance. The laboratories in the countries providing information to the database serve a variety of health-care institutions (e.g. university or specialised hospitals; general and district hospitals;

[2] ECDC, Antimicrobial resistance interactive database, 2012.

rehabilitation centres; nursing homes). However, sample sizes and coverage vary considerably between countries, with the latest available data from 2012.

Data from the database on the number of bloodstream infections for the bacteria and antibiotic group of interest was extracted.

The number of infections due to the selected antibiotic-resistant bacteria from the three other main body sites (respiratory tract, skin and soft tissue and urine), was estimated by applying correction factors corresponding to the relative distribution of infections from these body sites compared to bloodstream, as reported in published literature and applied by the ECDC and EMEA in their analysis[3]:

Table 1: Correction factor from original data obtained for bloodstream infections

Bacteria	Antibiotic group	Lower respiratory tract infection	Skin and soft tissue infection	Urinary tract infection
Staphylococcus aureus	Methicillin	1.25	5.25	0.75
Escherichia coli	Third gen. cephalosporins	1.19	0.33	1.19
Klebsiella pneumoniae	Third gen. cephalosporins	1.19	0.33	1.19

The level of population coverage varies between countries in the anti-microbial database. Many countries report data through large national surveillance systems, which results in high national coverage, but others report from a smaller sample of data, such as through local laboratories and hospitals.

In order to control for potential biases in the data, and to allow for consistent sampling across all countries, a reporting denominator was applied which accounted for the population size. Not all laboratories and hospitals provide a reporting denominator. In addition, some participating laboratories and hospitals could be densely located in some of the large cities with overlapping catchment areas, which may result in artificially increased estimated coverage, and a lower incidence rate.

Data on infection rates for the three bacteria of interest was unavailable for the remaining countries covered by this study and these were extrapolated from the average EU infection rate and applied per country based on its population size.

The infection data used included infections contracted outside the hospital setting, which aligns with the situation in low and middle income countries, where the ratio of community to hospital acquired infections may be higher.

Infection rates for Malaria, HIV and TB were sourced from the Global Burden of Disease Study[4].

Following consultations with experts in Malaria, the prevailing view was that a rise in resistance to Malaria treatments would result in a material increase in incidence. The approach selected to

[3] ECDC and EMA, The bacterial challenge: time to react, 2009.

[4] Murray *et al*, Global, regional and national incidence and mortality for HIV, TB and malaria 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013, Lancet, 2014 Sep 13; 384(9947):1005-70.

approximate this effect was to model some convergence in current incidence rates within geographical regions.

Countries were grouped into the following regions:

- Middle East and North Africa (MENA)
- Africa (excluding North Africa)
- Europe
- North America
- Latin America
- Southern, South-Eastern and Eastern Asia, together with Oceania
- Central Asia

Those countries whose current incidence rate was lower than their region's average were assigned the population weighted average for each region.

Countries whose current incidence rate was higher than the average in their region kept their current incidence level unchanged.

The regional convergence-based incidence rate for Malaria was applied to all countries with lower current incidence rate than their region's average across the four scenarios.

For the three bacteria, HIV and Tuberculosis, future infection scenarios were modelled as:

- Current rates of infections remain constant to 2050
- Doubling of current infection rates for the three bacteria, HIV and TB between 2014 and 2050

4.1.1.3 Resistance rate scenarios

Latest available resistance rates for the bacteria and antibiotic combinations for the EU, Norway and Iceland were obtained from ECDC database[5]. Resistance rates for the same bacteria and antibiotic combinations for the remaining countries were obtained from the WHO[6]. In those countries where data on the resistance rate was unavailable, a simple average for the region was assumed.

The current multi-drug resistance rates for TB per world region was sourced from the WHO TB Database[7]. The current Artemisinin resistance rates for Malaria was sourced from published literature and is confined to certain countries in South East Asia and Africa[8]. The current antiretroviral resistance rates for HIV was informed by the WHO HIV drug resistance report[9].

[5] ECDC, Antimicrobial resistance interactive database, 2012.

[6] WHO, Anti-microbial Resistance Global Report on Surveillance, 2014.

[7] WHO, Tuberculosis database, 2011.

[8] Ashley *et al*, Spread of Artemisinin Resistance in *Plasmodium falciparum* Malaria. N Engl J Med 2014; 371:411-423.

[9] WHO, HIV drug resistance report, 2012.

Future AMR resistance scenarios were modelled as:

- an increase in current rates of resistance by 40%
- 100% resistance rate across all countries

These scenarios were applied across the bacteria and diseases covered by the analysis to represent a medium and high change in resistance rates globally. Scenarios were partially based on examples of countries with current resistance rates that are already at similar levels, implying that as global AMR increases, these could apply in all countries across the world.

For simplicity the resistance rate was assumed to be constant for each of the different future scenarios as they are extrapolated through to 2050. Future scenarios therefore assumed a sharp initial rise of resistance which remained at the new level up to 2050.

4.1.1.4 Attributable mortality rate

Attributable mortality applied in this analysis corresponds to the percentage of deaths that are attributable to infection which is resistant to treatment as compared with infection with a susceptible infection when all other causes of death have been controlled for.

Attributable mortality rate was applied to estimates of the number of bacterial infections in order to estimate the number of extra deaths due to the antibiotic resistant bacteria analysed. It was sourced from ECDC/EMEA[10]:

Table 2: Attributable mortality rate

Bacteria	Antibiotic group	Bloodstream infections	Lower respiratory tract infection	Skin and soft tissue infection	Urinary tract infection
Staphylococcus aureus	Methicillin	9.8%	7.0%	1.4%	0.2%
Escherichia coli	Third gen. cephalosporins	30%	21%	4%	1%
Klebsiella pneumoniae	Third gen. cephalosporins	30%	21%	4%	1%

Attributable mortality rates per world region used for TB AMR were sourced from WHO[11] and shown in Table 3 below:

Table 3: Attributable mortality rates for resistance to TB treatment

Africa	28.3%
America	15.9%
Eastern Mediterranean	20.1%
Europe	23.9%
South East Asia	25.4%
Western Pacific	16.3%

[10] ECDC and EMA, The bacterial challenge: time to react, 2009.

[11] WHO, Tuberculosis database, 2011.

For Malaria, attributable mortality due to resistance was applied based on consultation with experts, allowing for a fatality rate for those with malaria of 1.5% to be used in the analysis.

For HIV, attributable mortality due to resistance was consulted with relevant experts, and a rate of 15% was applied in the analysis.

4.1.1.5 Short term morbidity

Short term morbidity resulting from AMR was estimated as the extra length of hospital stay. An adjustment factor to the total number of AMR infections was applied in order to estimate this effect.

The extra length of hospital stay for each infection was estimated as the difference between average length of stay for patients infected with bacteria that are resistant to the antibiotic, and patients infected with bacteria that are not resistant to the antibiotic.

Chart 6: Short term morbidity calculations

The extra length of hospital stay was calculated allowing for other factors affecting length of hospital stay and varied depending on the main body sites where infection occurred (i.e. blood stream, respiratory tract, skin and soft tissue, or urine). It was sourced from ECDC/EMEA[12].

Table 4: Extra length of hospital stay in days

Bacteria	Antibiotic group	Bloodstream infections	Lower respiratory tract infection	Skin and soft tissue infection	Urinary tract infection
Staphylococcus aureus	Methicillin	8.0	9.4	5.0	6.1
Escherichia coli	Third gen. cephalosporins	11.0	11.0	11.0	11.0
Klebsiella pneumoniae	Third gen. cephalosporins	11.0	11.0	11.0	11.0

Due to limited availability of data, analysis focused on the three bacteria analysed and covered only the EU, Iceland and Norway.

4.1.1.6 Financial impact of AMR

As resistance rates increase, the burden on health systems is expected to increase globally through efforts to treat those with resistance, with associated additional treatments costs, emanating from expensive alternative treatments, increased use of combination therapy and increased length of stay in hospital.

[12] ECDC and EMA, The bacterial challenge: time to react, 2009.

The costs are likely to vary depending on the structure of the health system in each country, with the largest impact expected in high income countries where health treatment costs are higher and more patients are expected to be covered by the formal health system.

In this report, the costs due to additional hospital stay in high income countries was estimated by applying the average cost of a hospital day in Europe to the extra length of hospital stay due to resistance to treatments for the three bacteria analysed.

4.1.2 Capturing AMR impact on economic output

The analysis looked to capture the impact anti-microbial resistance would have on economic output through changes in productivity as well as changes to the size of the labour force.

4.1.2.1 Production function

Projections of real economic output to 2050 under the different AMR scenarios were prepared using a production function approach.

Under this approach, GDP at PPP (Y) was modelled as a function of inputs of capital (K) and labour (L) and a residual scale factor (A), also referred to as Total Factor Productivity (TFP).

In this model human capital was included in the determinants of TFP, rather than as a distinct input alongside capital and labour, or as a labour-augmenting factor. TFP was therefore adjusted within the Life Expectancy category to reflect the AMR scenarios as outlined above.

The production function used in the analysis was of the standard Cobb-Douglas form, which imposes constant returns to scale, with $\propto=1/3$:

$$Y=AK^{\propto} L^{1-\propto}$$

This can be rewritten in terms of labour and the capital-output ratio as follows:

$$Y=(A(K/Y)^{\propto})^{1/1-\propto} L$$

Historical data on capital stocks at PPP was obtained from the Penn World Table (PWT). Some datasets absent from the PWT were estimated by using IMF data on gross capital formation, accounting for depreciation based on data from a comparator country.

The future evolution of countries' capital stock was modelled in terms of the capital-output ratio (K/Y). In line with other studies, no systematic relationship was found between this ratio and the level of GDP per capita or per worker. The K/Y ratio was therefore projected on the basis of the recent level and trend in the ratio for each country, with the trend component declining to zero in the first ten years of the projection period and the K/Y ratio stabilising after that point. K/Y ratios in 2013 ranged from 1.1 at the 5th percentile to 5.0 at the 95th, with a median of 3.1 and a mean of 3. The distribution over the projection period was slightly narrower.

Average long-term growth for the US economy was projected at 2.1%, based on examination of US historical TFP and economic growth. US TFP was projected accordingly.

Projections of TFP of the other countries were modelled as a process of convergence towards that of the US, where the speed of convergence was based on the 2013 TFP scores generated by the TFP model, with a fixed effect included to represent specific factors affecting different country groups.

Total GDP was then projected according to the output equation, incorporating the projected values for the capital-income ratio, labour, and TFP score under each scenario.

4.1.2.2 Productivity

Productivity was modelled using a Total Factor Productivity (TFP) model, which captured key productivity drivers grouped into five pillars:

- Macroeconomic stability
- Economy's openness to catch up in technology and best practice
- Quality of infrastructure
- Human capital
- Strength of public institutions

Each pillar included data on key areas affecting business and economic performance, as outlined in Table 5 below:

Table 5: Components of the TFP model

Pillar	Data
Macro stability	■ Government deficit ■ Government debt
Open to catch up	■ FDI stock ■ Total trade
Infrastructure	■ Quality of road, rail, port and air transport ■ Technology readiness – mobile and internet users, secure internet servers ■ Financial institutions – availability of financial services
Human capital	■ Educational – average years of schooling and assumed rate of return ■ Life expectancy
Institutions strength	■ Regulatory quality ■ Judicial independence ■ Transparency of government policymaking ■ Government effectiveness ■ Corruption ■ Business rights – property and intellectual property rights

Weights used to aggregate the series, sub-series and pillars were derived from the results of econometric analysis in conjunction with results of previous studies and business surveys output.

The life expectancy series in the TFP model was used as a proxy to measure the physical quality of human capital. Adjustments were made to each country's life expectancy score in order to account for a deterioration in the physical quality of human capital as a result of a more elevated incidence of AMR. The adjustment to TFP's life expectancy data was done in the following way:

For each country *i* a yearly additional mortality due to AMR was calculated at m_i, while the life expectancy was L_i.

Probability of survival to the age of L was therefore calculated as:

$$(1 - m_i)^{L_i}$$

While the probability of not surviving to the age of L was:

$$1 - (1 - m_i)^{L_i}$$

It was assumed that the expected age at death from an AMR disease was distributed evenly over the lifetime of the individual so the expected age at death was $\frac{L_i}{2}$.

Therefore, the new life expectancy, AdjL, was given by:

$$AdjL_i = [1 - (1 - m_i)^{L_i}]\frac{L_i}{2} + (1 - m_i)^{L_i}L_i$$

This simplifies to:

$$AdjL_i = [1 + (1 - m_i)^{L_i}]\frac{L_i}{2}$$

m_i was adjusted to reflect the four AMR scenarios, producing a separate life expectancy estimate for each scenario.

Two key assumptions were made in calculating AMR's impact on life expectancy:

- L is non-stochastic, implicitly assuming that people in a country with expectancy L all live to L years and then die; unless AMR is present and they die before reaching L. The effect of this assumption is difficult to evaluate.
- expected age at death from AMR was L/2. This arrived at an estimated age that may be too low in a number of countries, as the elderly generally face higher risks from disease.

However, the estimations above did not take directly into account the increased rates of morbidity due to elevated resistance rates, with higher rates of anti-microbial resistance also likely to reduce the working life of individuals in affected economies, which will serve to reduce the quality of human capital and therefore act in the opposite direction.

4.1.2.3 Labour force

The remaining impact on the economy was modelled through a change in the labour force.

Labour input, both historical and projected to 2050 under our main scenario, was based on the working age population (15-64), and was sourced from the UN. Current total population figures and projections were also taken from this source.

In order to assess the effect of AMR on the economic output of a country, the labour force was adjusted in line with the mortality rate of the country due to AMR.

Projections of both the labour force and the total population used in the base scenario were therefore adjusted as follows:

$$AdjLF_{i,t} = LF_{i,t}(1 - m_{i,t})^t$$
$$AdjP_{i,t} = P_{i,t}(1 - m_{i,t})^t$$

Where LF represents the labour force, P population, and $m_{i,t}$ mortality rate.

4.2 Data

4.2.1 Desk based review

An extensive desk based review of current literature on the healthcare aspects of AMR across high, medium, and low income countries was carried out in order to identify prevalence, epidemiology, resistance rates and care costs.

This included use of the KPMG global network to access information on projects relating to AMR surveillance systems. A number of countries have surveillance programmes in place, however these seem limited to higher income countries.

Key reports summarising European and global AMR rates, along with infection rates in some instances, were identified:

ECDC and EMA Joint Technical Report[13]

The report gives an account of the data that would allow reasonable predictions of the gap between bacterial resistance in the EU and the likely availability of new treatments that would be effective against multidrug resistant bacteria in the near future. It utilises data from the European Anti-microbial Resistance Surveillance System (EARSS) to calculate current resistance rates and prevalence of pathogenic infections.

WHO anti-microbial resistance report[14]

The report examines, for the first time, the current status of surveillance and information on AMR, in particular anti-bacterial resistance, at a country level worldwide. The report provides information primarily for public health policy makers and managers, and for the wider medical and public health community, as a support for informing strategic actions and programme planning.

Global, regional and national incidence and mortality for HIV, TB and malaria[15]

The study provides a consistent and comprehensive approach to disease estimation for 1990-2013, and an opportunity to assess whether accelerated progress has occurred since the Millennium Declaration.

4.2.2 Expert input

Where data was not available through desk based research, in particular on global infection rates for the bacteria selected, specific requests were made for data from relevant experts in some of the larger economies.

Table 6 lists the experts contacted in order to inform estimates of current impact and to provide input on the suitability of the proposed future AMR scenarios, including verification of infection rates, attributable mortality, and average length of hospital stay for patients with resistance. The information received is outlined in section 4.2.3.

[13] ECDC and EMA, The bacterial challenge: time to react, 2009.

[14] WHO, Anti-microbial Resistance Global Report on Surveillance, 2014.

[15] Murray *et al*, Global, regional and national incidence and mortality for HIV, TB and malaria 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013, Lancet, 2014 Sep 13; 384(9947):1005-70.

Table 6: Experts contacted	
Name	**Organisation**
Benido Impouma	WHO Regional Office for Africa
Professor John Rex	Global Medicines Development, AstraZeneca
Professor Lisa J White	Mahodil-Oxford Tropical Medicine Research Unit, Thailand
Alejandro Corso	Latin American Network for the Surveillance of Antimicrobial Resistance (ReLAVRA)
Professor Jae-Hoon Song	Samsung Medical Center, Sungkyunkwan University Asia Pacific Foundation for Infectious Diseases (APFID)
Dr Flavia Rossi	Univesity of Sao Paulo, incorporating data from: Brazilian Ministry of Health ANVISA Federal University of Rio Grande Sol and Rio De Janeiro
Professor Hui Wang	People's Hospital, Peking University, Beijing
Professor Ramanan Laxminarayan	Center for Disease Dynamics, Economics & Policy
Dr Amit Chatterjee	KPMG in India
Joubert Krugel	KPMG in South Africa

4.2.2.1 Experts' workshop

A workshop was held with a selection of experts to gain their input and guidance on the development of potential future AMR scenarios, with the aim of establishing three scenarios of how AMR may develop across the world between now and 2050 in the absence of any progress in tackling AMR.

The scenarios included a low (conservative), medium (realistic) and high (pessimistic) increase in resistance. Three additional scenarios, capturing the doubling of infection rates were also developed.

The experts attending the workshop were:

Professor Piero Ollario – World Health Organisation

Professor Richard Smith – London School of Hygiene and Tropical Medicine

Professor Peter Wilson – University College London Hospitals

Professor Neil Woodford – Public Health England

Professor Alan Johnson – Public Health England

Stephen Dobra – Department of Health, UK

4.2.3 Countries and regions focus

We conducted additional desk based research to uncover more detailed information and experiences encountered in some of the larger low and middle income countries.

4.2.3.1 Brazil

The experts contacted from Brazil confirmed that the scenarios developed for the analysis would be relevant to Brazil due to the prevalence of AMR being a global concern. According to Flávia Rossi[16] Brazil, and Latin American countries more generally, have higher levels of bacterial resistance among most of the key bacteria compared with Europe and the United States, particularly among non-fermentative gram-negative bacilli and extended-spectrum β-lactamase (ESBL)–producing Enterobacteriaceae, but also among some gram-positive organisms (including *Staphylococcus aureus*).

According to data from 2010[17], Brazil is facing an increase in infections caused by *Klebsiella pneumoniae*, with the overall 30-day mortality rate being 42% in 2010[18] and the average length of stay in hospital for those with resistance between eight and 14 days[19].

The first five *Staphylococcus aureus* that were resistant to vancomycin were found in Brazil in 2010[20]. Rates of MRSA were up to 60% and were related to an endemic Brazilian clone. Infections caused by MRSA were no longer unique issues associated with the hospital environment and were becoming a growing problem in the Brazilian community. To date, the risk factors associated with MRSA infections have not fully been established in the community and the influx of outpatients in health facilities could affect in-hospital epidemiology of this bacteria.

The scarcity of prevalence studies is a limiting factor of knowledge of local epidemiology or deaths related to community acquired MRSA. An important aspect that can facilitate knowledge of the existence of these circulating strains is the laboratory cultivation of infections of skin and soft tissue in primary care. Due to scarcity of data, there were no data available on cases of MRSA being currently treated in Brazil.

4.2.3.2 China

Information on China was provided by Professor Wang[21]. Professor Wang explained that AMR was a large issue in China and outlined some of the resistance rates they were experiencing:

- *Escherichia coli*: 60~70% resistance rate to third generation cephalosporins. 70% resistant to Fluoroquinolones.
- *Klebsiella pneumoniae*: 40% resistance rate to third generation cephalosporins. 30% resistant to Fluoroquinolones, 10% to carbapenem.

[16] Flávia Rossi, Pathology Department, DLC_LIM 03, Hospital das Clínicas da Universidade de São Paulo, São Paulo, Brazil.

[17] Source: ANVISA.

[18] M.D. Bergamasco *et al*, Infection with Klebsiella pneumoniae carbapenemase (KPC)-producing K. pneumoniae in solid organ transplantation, 2012.

[19] Source: ANVISA.

[20] See Note 13 above.

[21] Professor Wang, Director of Clinical Lab, People's Hospital, Peking University.

- MRSA accounted for 46.9% of all the *Staphylococcus aureus*. The prevalence of MRSA in abdominal infections (55.2%) and respiratory infections (54.4%) were higher than that in blood stream infections (35.0%).

Professor Wang confirmed that the AMR future scenarios used in this analysis would be relevant to China and stated that unfortunately no data was available for the current infection rates of these bacteria in China, nor the average length of stay in hospital for those with AMR.

The attributable mortality rate for patients with AMR for each of these bacteria was not specifically available but generally, the overall mortality is 20-30%, with some higher than 50%. This would support the use of the attributable mortality values applied in this analysis, as shown in section 4.1.1.4, and may even underestimate the situation globally.

4.2.3.3 India

Experts contacted[22] stated that AMR was a very sensitive issue in India and data availability across hospitals may not be complete and therefore impossible to comprehensively collate. However, estimations were provided based primarily on experience in the field. Experts were unable to comment on the current infection rates in India but did add that the majority of Gram negative infections were contributed by *Escherichia coli*, *Klebsiella pneumoniae* and *Acinetobacter.* While *Staphylococcus* infections were generally seen in the hospital setting and in skin and soft tissue infections from the community.

In terms of resistance, a high level of resistance in *Klebsiella* to third 3rd generation cephalosprins and even carbapenems have been detected. The projected resistance rates for *Escherichia coli* to 3rd generation cephalosporins and fluoroquinolones in India appeared reasonable as per the data outlined in the proposed scenarios in the analysis, although these rates may be even higher in hospital settings.

The prevalence of MRSA in hospitals vary from 25 – 60%. Moreover, there was preponderance of infections due to Gram negatives in the hospitalised patients. Gram positives were more common in skin and soft tissue infections from the community. Not much population based studies were available regarding community acquired MRSA.

This information from India would seem to support the choice of bacteria in this analysis and their resistance to treatments applied globally.

4.3 Assumptions and limitations of the analysis

This report presents best-efforts estimates of the health and economic effects of rising AMR levels. It is likely that any such exercise will necessarily involve large margins of error due to limitations in data surveillance and availability of relevant country level information.

The projections in this report are subject to considerable uncertainty arising from the problems outlined in this report and also due to the unusually high degree of uncertainty associated with the future path of AMR rates, combined with the response from society and the development of

[22] Provided by Dr Amit Chatterjee, KPMG India, in consultation with other local health experts.

technology. For this reason, the margins of error associated with these projections are inevitably large and therefore should be read and interpreted accordingly.

4.3.1 Data availability

The availability of infection data for the bacteria and diseases covered in this report was dependent on surveillance structures that are in place in each country.

There was a particular lack of data for infection rates in low and middle income countries for the bacteria selected and where this was the case, following the literature review and engagement of sector experts, the European average infection rates was applied to countries where specific data was not available.

As part of the scenarios, two alternative scenarios were modelled incorporating a doubling of current infection rates, which served to mitigate somewhat the uncertainties emanating from lack of current infection data in some of the countries.

4.3.2 Development of new anti-microbial medicines

Future AMR scenarios used in the analysis included an assumption that no further development of new anti-microbial drugs would take place between now and 2050.

The development of new effective anti-microbial treatments would allow for a decreased future AMR rate. The analysis partially accounted for this by presenting low and medium increases in AMR as alternative future scenarios.

4.3.3 Infection rate

With an increase in AMR it is feasible that infection rates will increase, as people with resistant infection may have more opportunities to pass this on to others.

On the other hand, an increase in AMR may eventually see decreasing future infection rates as global health systems develop, with better sanitation and infection control measures being implemented, and more emphasis is given to improved sanitation and hygiene due to the increased threat of infection.

The future AMR scenarios developed allowed for some sensitivity around the infection rate, applying a doubling of the future infection rate for the 40% and 100% future AMR scenarios as additional two scenarios, in order to allow for a possible future case where infection rates rise. The Malaria infection rate was also increased across the four scenarios, as outlined in the methodology section 4.1.1.2.

4.3.4 Economic scenarios

The modelling approach used in this analysis assumed that the current environment, including economic and business policies, would continue to evolve favourably as incomes rise.

The projections in the baseline economic scenario should therefore be viewed as potential future growth scenarios under such conditions rather than precise forecasts. Similar assumptions were used for the AMR scenarios.

5 Health impacts of AMR

AMR poses a threat to global public health as infections are developing that increasingly cannot be treated. The current health impacts include increased global mortality due to resistance to treatments, as well as short and long term morbidity experienced by patients with resistance.

The section below outlines some of the key incidences for the selected bacteria and diseases which are currently observed around the worlds, and serves to provide an indication of the base from which future AMR scenarios were developed.

In addition, estimates of the financial impacts of AMR on health services in those countries where relevant data was available were also presented below.

5.1 Current health impact

5.1.1 Global infection rates

TB, Malaria and HIV are amongst the leading causes of death in the world, with resistance to treatments of these diseases adding to the complexity of handling these diseases. These diseases were included in the analysis because of their global impact.

Infection rates per region are outlined below for the three diseases. There are currently high infection rates for TB and Malaria across Africa and South East Asia along with high incidence of HIV in Africa.

Table 7: Current number of infections by region for TB[23], HIV and Malaria[24], number of infections

World region	TB	HIV	Malaria
Africa	2,261,117	1,475,693	90,515,866
America	276,153	99,592	368,009
Eastern Mediterranean	650,710	30,282	3,873,418
Europe	353,127	74,489	1,231
South East Asia	3,456,040	95,619	67,769,063
Western Pacific	1,603,844	68,824	1,944,276

5.1.2 Global AMR rates

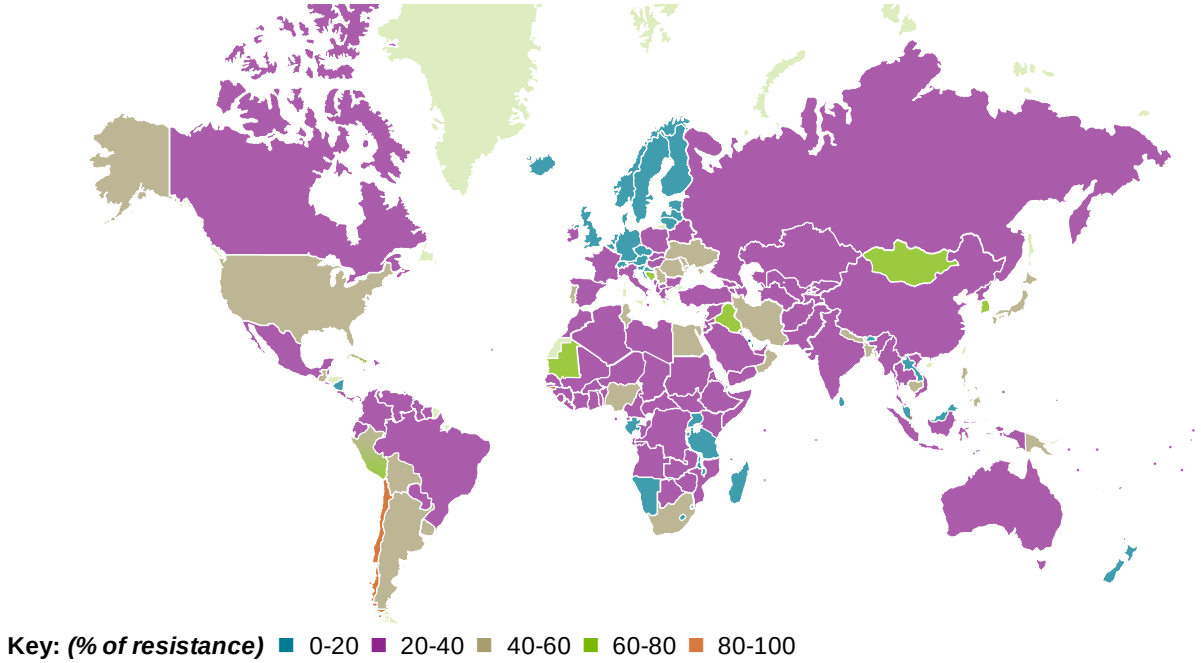
AMR is a real and current issue, with AMR rates for certain bacterial strains in some countries approaching 100%.

[23] WHO, Tuberculosis database, 2011.

[24] Murray *et al*, Global, regional and national incidence and mortality for HIV, TB and malaria 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013, Lancet, 2014 Sep 13; 384(9947):1005-70.

Chart 7 below depicts global resistance rates for *Staphylococcus aureus* to methicillin[25], showing high resistance rates in South America and in particular Chile and Peru.

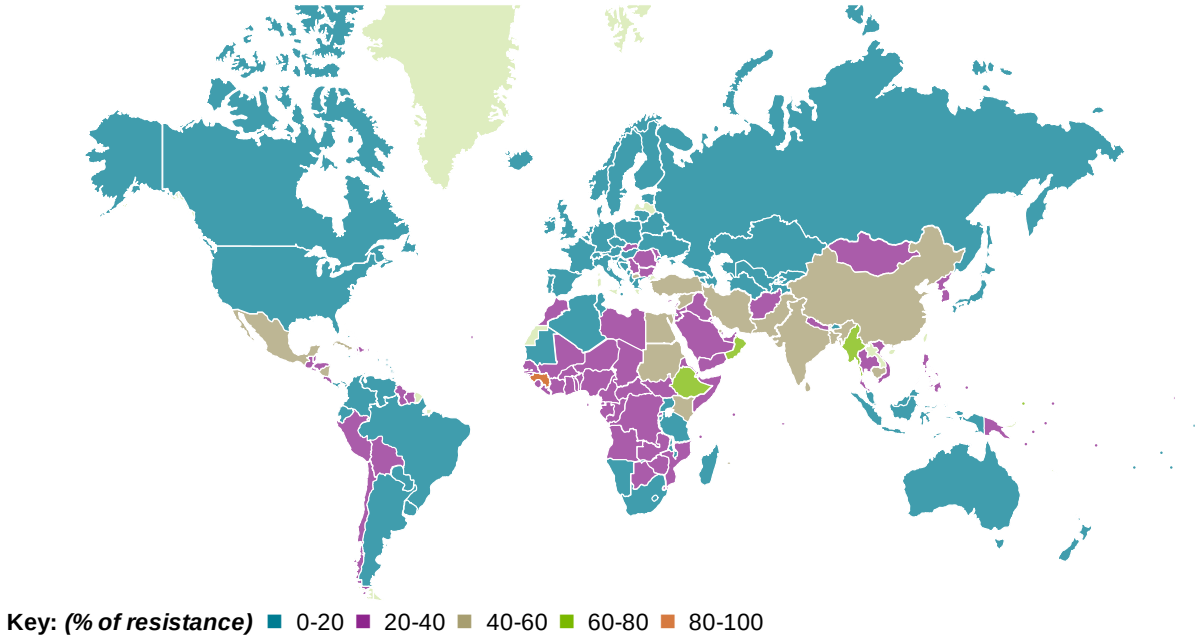
Chart 7: Global resistance rates for *Staphylococcus aureus* to methicillin



[25] Data sourced from WHO, Anti-microbial Resistance Global Report on Surveillance, 2014.

Chart 8 below highlights global resistance rates for *Escherichia coli* to third generation cephalosporins[26] and shows in particular relatively increased resistance in Africa with high resistance rates in India and China and higher rates of resistance being seen in Guinea, Ethiopia, Oman and Myanmar.

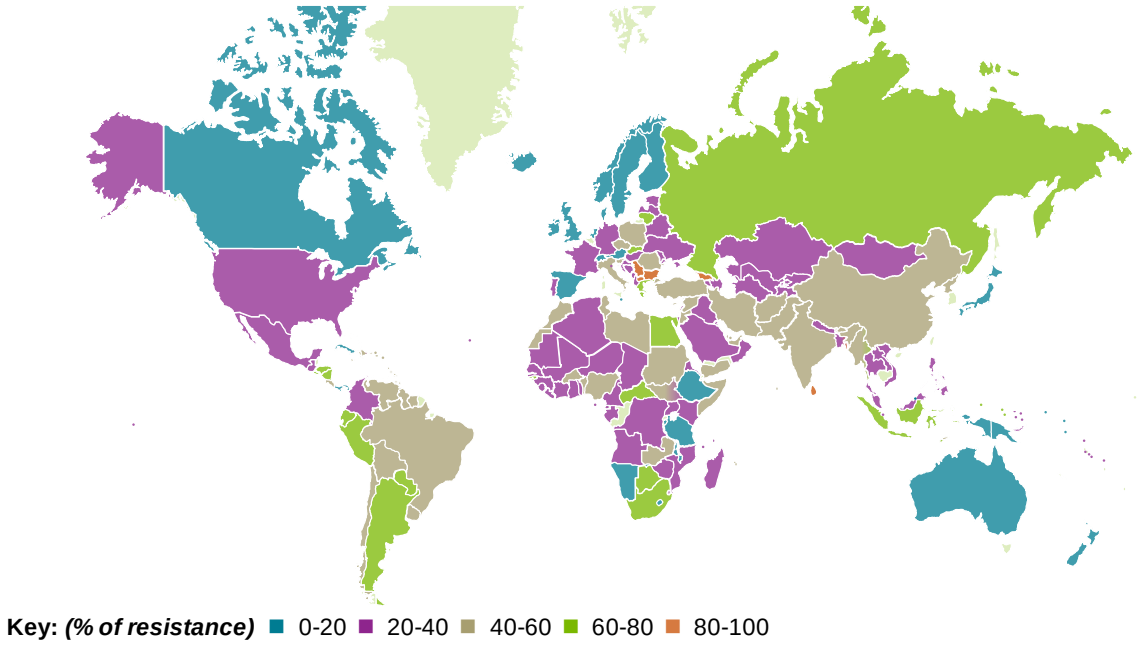
Chart 8: Global resistance rates for *Escherichia coli* to third generation cephalosporins



[26] Data sourced from WHO, Anti-microbial Resistance Global Report on Surveillance, 2014.

Chart 9 below highlights global resistance rates for to third generation cephalosporins[27] and shows high resistance in Russia, India, China and South America.

Chart 9: Global resistance rates for *Klebsiella pneumoniae* to third generation cephalosporins



[27] Data sourced from WHO, Anti-microbial Resistance Global Report on Surveillance, 2014.

5.2 Current financial impact

The financial impact on global health services of an increased AMR rate lies in the increased length of stay in hospital and care required for the patients. This will vary greatly globally, especially between low, middle and high income countries, due to the healthcare provisions in each country and the variation in the cost of providing these services, an example being the treatment of patients with multi drug resistant TB, where patients can undergo a two year treatment programme.

In this analysis, the burden of additional care was estimated using the extra length of hospital stay that those patients with AMR need. Due to restrictions on global data availability, the analysis was limited to the three bacteria analysed and covered only the EU, Iceland and Norway.

It is estimated that infections due to the three selected antibiotic-resistant bacteria resulted in approximately 4 million extra hospital days in 2012.

An estimate of the average cost of a hospital day was used from the European Commission[28] and converted to 2012 prices using the health component of the harmonised index of consumer prices (HICP)[29]. The average cost of a hospital day was estimated at €405.

This was then multiplied by the estimated extra number of hospital days, arriving at an estimated cost of approximately €1.6bn attributed to AMR in 2012.

5.3 Future AMR scenarios

Future AMR increases will raise the number of those dying from infections globally.

Four future AMR scenarios were developed in order to estimate the potential rise in mortality:

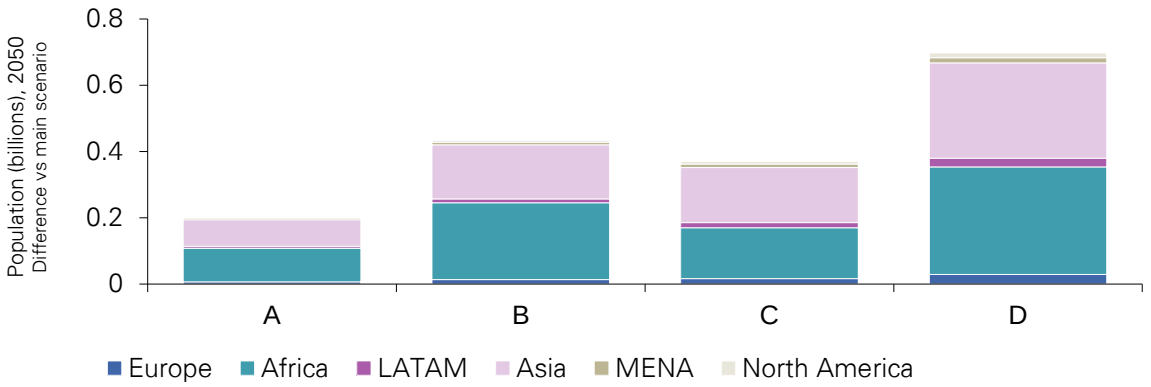
- Scenario A - an absolute increase in current rates of resistance by 40%
- Scenario B - 100% resistance rate applied across all countries
- Scenario C - Doubling of current infection rates for the three bacteria, HIV and TB, and an absolute increase in current rates of resistance by 40%
- Scenario D - Doubling of current infection rates for the three bacteria, HIV and TB, and 100% resistance rate applied across all countries

Chart 10 below illustrates the difference in 2050 population compared to the base scenario that is associated with the four future AMR scenarios, implying a projected increase in global mortality with rising resistance and infection rates.

The impact on world population is projected to be significant, with 700 million fewer people expected as a result of Scenario D in 2050.

[28]European Commission, Proposal for a Council Recommendation on patient safety, including the prevention and control of healthcare associated infections, 2008.
[29] European Commission, Harmonised Index of Consumer Prices, 2012.

Chart 10: Estimated reduction in world population by 2050 under each scenario

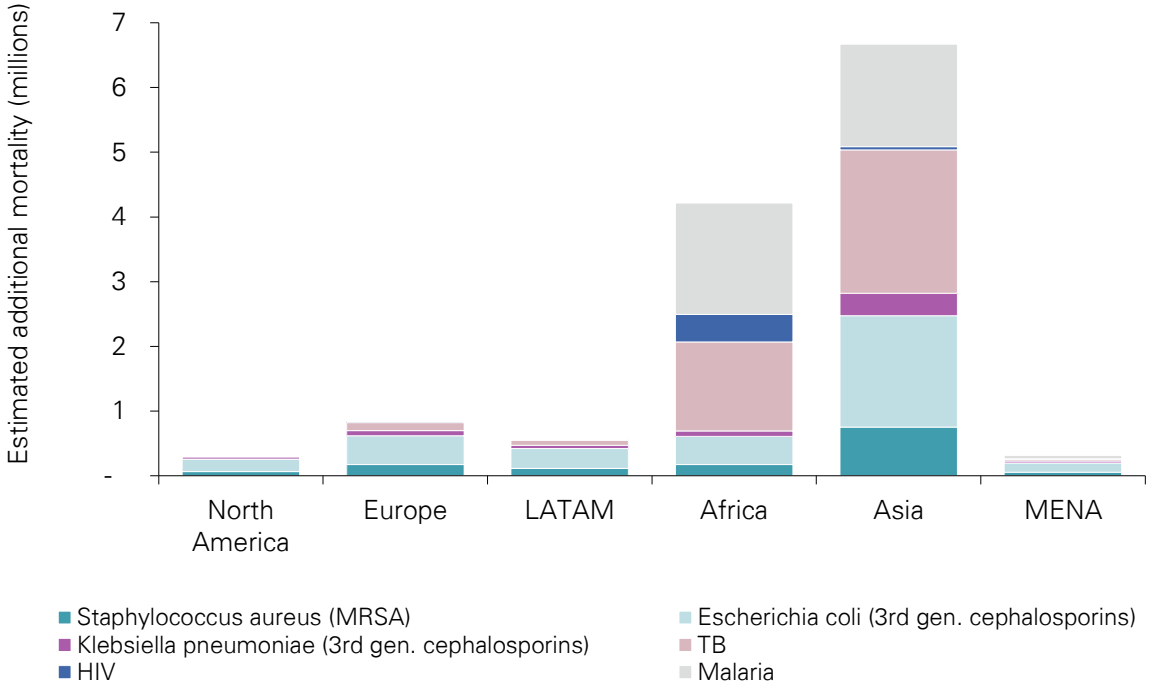


Source: KPMG analysis.

Chart 11 below outlines the effect Scenario D could have on current population in different geographical regions. This scenario results in a high mortality rate globally, in particular for TB and Malaria due to the already relatively high infection rates for these diseases in certain parts of the world such as Africa and South East Asia.

Some causes of death are prevalent in particular regions such HIV in Africa, whereas others are more widespread across the world such as *Escherichia coli* and *Klebsiella pneumoniae* infections.

Chart 11: Estimated additional mortality by region and infection for Scenario D in 2014



Source: KPMG analysis.

6 Potential future economic impact of AMR

6.1 Economic impact with constant infection rates

The current prevalence of AMR varies significantly across countries, as highlighted in Chapter 5 above. This is likely to cause divergence in the future incidence of AMR and in the economic costs associated with it.

In this section of the report the potential economic impact of alternative AMR scenarios is presented under alternative resistance scenarios, keeping infection rates constant.

Scenarios modelled were:

- Scenario A - an absolute increase in current rates of resistance by 40%
- Scenario B - 100% resistance rate applied across all countries

World GDP under the more severe scenario modelled, Scenario B, depicting an increase in resistance rates to 100%, is projected to be 3.4% lower by 2050 than under current resistance rates.

Average impact on GDP is expected to vary significantly across income groups, with low income countries projected to bear the biggest decline in output, followed by lower middle income countries.

Table 8 below also highlights the relatively low impact the AMR resistance scenarios are expected to have on average on the GDP of high income countries.

Table 8: Reduction in GDP in 2050 across different income group

	A	B
Low Income	5.13%	11.34%
Lower Middle Income	3.11%	6.62%
Upper Middle Income	1.41%	2.65%
High Income	0.95%	1.95%
World	1.66%	3.40%

Source: KPMG analysis.

The low scenario modelled, Scenario A, which represents resistance rates rising by 40%, is projected to see low and lower middle income countries experience the brunt of the impact on their economies.

The high scenario used in this section, incorporating resistance rates at 100% in all countries, is projected to see the impact on GDP more than double on average. Variations between countries were not driven under this scenario by divergent resistance rates since all countries were assumed to have reached 100% resistance.

There is generally a higher current rate of resistance in countries in the upper middle income group than in the high income group. Therefore, in scenarios with elevated resistance rates, the additional mortality does not rise by as much as in countries with low current rates of resistance.

Table 9 below summaries potential economic impact by region.

Africa is projected to be hit particularly hard, while all other regions with the exception of Asia are projected to undergo a fall below the world's average.

Table 9: Reduction in GDP in 2050 in different world regions

	A	B
Europe	1.01%	2.11%
Africa	6.28%	14.14%
LATAM	1.13%	2.16%
Asia	1.78%	3.52%
MENA	1.11%	2.09%
North America	0.73%	1.39%
World	1.66%	3.40%

Source: KPMG analysis.

6.2 Economic impact with doubling infection rates

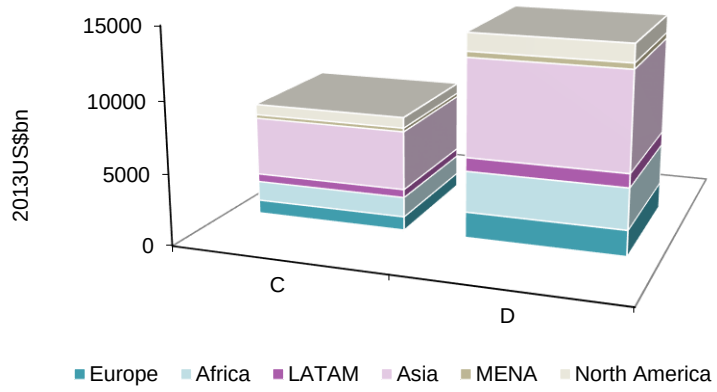
In this section of the report the potential economic impact of alternative AMR scenarios is presented using alternative resistance and infection scenarios.

Scenarios modelled were:

- Scenario C - Doubling of current infection rates for the three bacteria, HIV and TB, and an absolute increase in current rates of resistance by 40%
- Scenario D - Doubling of current infection rates for the three bacteria, HIV and TB, and 100% resistance rate applied in all countries

Chart 12 below highlights the impact these scenarios could have on the world economy. The most severe scenario modelled, Scenario D, is projected to see world GDP $US14,228 billion lower in 2050, the equivalent of more than the whole economies of China, Russia and India wiped out together based on their current size, or the whole continent of Africa disappearing based on its projected size in 2050 in our baseline scenario.

Chart 12: Potential loss in GDP under different scenarios in 2050



Source: KPMG analysis.

Table 10 highlights the proportional impact the two scenarios will have on GDP, with world output projected to be just over 6% lower by 2050 in Scenario D, with the poorest countries projected to experience the largest relative loss in GDP.

Table 10: Reduction in GDP in 2050 across different income group		
	C	D
Low Income	8.31%	16.49%
Lower Middle Income	5.69%	10.57%
Upper Middle Income	3.23%	5.12%
High Income	2.22%	4.04%
World	3.44%	6.08%

Source: KPMG analysis

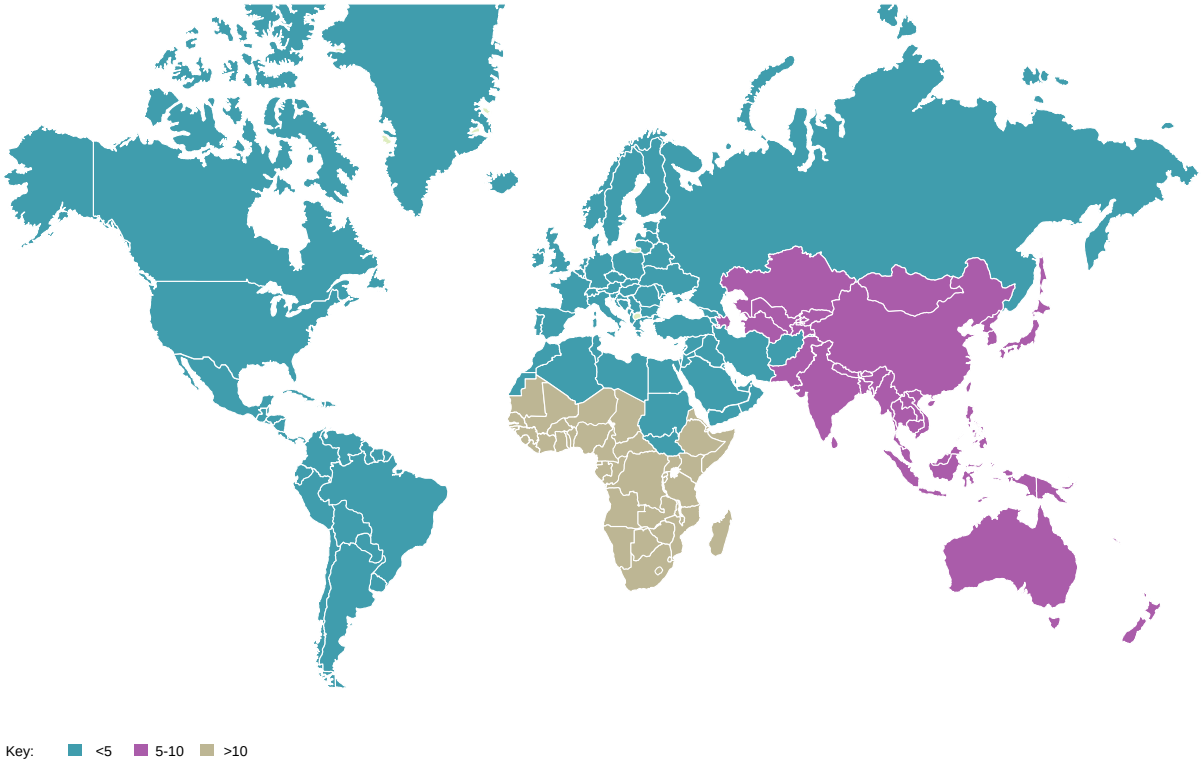
The largest relative economic impact is projected to be suffered by Africa, with a fall in GDP of US$2,895 billion under Scenario D in 2050, representing 20% of the region's total economic output, as highlighted in Table 11 below.

Table 11: Reduction in GDP in 2050 in different world regions		
	C	D
Europe	2.39%	4.51%
Africa	9.70%	20.00%
LATAM	2.88%	4.85%
Asia	3.76%	6.27%
MENA	2.64%	4.17%
North America	1.86%	3.17%
World	3.44%	6.08%

Source: KPMG analysis

The economic impact of AMR will vary significantly between regions. Chart 13 below maps the economic impact by geographical region in Scenario D.

Chart 13: % reduction in 2050 GDP in Scenario D compared to baseline scenario



Source: KPMG analysis

7 Conclusions

AMR represents a genuine cost to society. Rising AMR levels are projected to cause increasing numbers of mortalities and morbidity across the world.

The impact of higher AMR is unlikely to be spread equally, however, with those more vulnerable likely to pay the highest price, as low income countries suffer the biggest loss of population and economic output.

The potential loss from not addressing the AMR challenge cannot therefore be seen as a potential economic loss in isolation, and any future decisions need to incorporate the social loss associated with rising AMR in tandem.

The rise in AMR and its potential real damage to society and to the world economy should encourage the development of new antibiotics, and increase efforts to ensure future social and economic impacts are minimised.

8 Annex: Key statistics for 156 countries

Table 12: Estimates of cumulative premature deaths between 2015 and 2050 under different AMR scenarios (millions)

Scenario	A			B			C			D		
Disease	TB	HIV	Malaria	TB	HIV	Malaria	TB	HIV	Malaria	TB	HIV	Malaria
Albania	0.0021	0.0000	0.0000	0.0044	0.0000	0.0000	0.0048	0.0000	0.0000	0.0094	0.0000	0.0000
Angola	0.4770	0.1353	0.8266	1.1262	0.3037	1.9953	0.9638	0.2894	0.8129	2.2047	0.6101	1.9315
Antigua and Barbuda	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0001	0.0001	0.0000	0.0002	0.0002	0.0000
Argentina	0.0258	0.0117	0.0062	0.0628	0.0272	0.0155	0.0526	0.0254	0.0062	0.1257	0.0559	0.0153
Armenia	0.0050	0.0000	0.0113	0.0107	0.0001	0.0280	0.0118	0.0001	0.0112	0.0230	0.0002	0.0277
Australia	0.0040	0.0011	0.1115	0.0096	0.0025	0.2767	0.0085	0.0024	0.1109	0.0194	0.0052	0.2742
Austria	0.0026	0.0013	0.0000	0.0055	0.0029	0.0000	0.0061	0.0027	0.0000	0.0118	0.0060	0.0000
Azerbaijan	0.0300	0.0010	0.0116	0.0638	0.0022	0.0288	0.0704	0.0021	0.0115	0.1367	0.0045	0.0285
Bahamas	0.0001	0.0004	0.0001	0.0002	0.0010	0.0001	0.0002	0.0010	0.0001	0.0005	0.0021	0.0001
Bahrain	0.0009	0.0001	0.0018	0.0020	0.0002	0.0046	0.0018	0.0002	0.0018	0.0041	0.0005	0.0046
Bangladesh	1.4987	0.0029	0.7109	3.6262	0.0067	1.7593	3.0449	0.0063	0.7026	7.1979	0.0137	1.7263
Barbados	0.0000	0.0002	0.0000	0.0000	0.0004	0.0001	0.0000	0.0004	0.0000	0.0000	0.0008	0.0001
Belarus	0.0197	0.0013	0.0000	0.0420	0.0031	0.0000	0.0463	0.0028	0.0000	0.0901	0.0063	0.0000
Belgium	0.0036	0.0005	0.0000	0.0077	0.0012	0.0000	0.0085	0.0011	0.0000	0.0166	0.0024	0.0000
Belize	0.0004	0.0004	0.0001	0.0009	0.0008	0.0002	0.0008	0.0008	0.0001	0.0019	0.0017	0.0002
Benin	0.0456	0.0171	0.3742	0.1088	0.0388	0.9131	0.0928	0.0368	0.3708	0.2169	0.0793	0.8999
Bhutan	0.0056	0.0002	0.0034	0.0135	0.0005	0.0085	0.0114	0.0004	0.0034	0.0269	0.0010	0.0084
Bolivia	0.0546	0.0016	0.0018	0.1328	0.0037	0.0046	0.1112	0.0034	0.0018	0.2647	0.0075	0.0045
Bosnia and Herzegovina	0.0055	0.0000	0.0000	0.0117	0.0000	0.0000	0.0130	0.0000	0.0000	0.0252	0.0000	0.0000
Botswana	0.0395	0.0237	0.0529	0.0929	0.0531	0.1273	0.0795	0.0506	0.0518	0.1801	0.1056	0.1220

Table 12: Estimates of cumulative premature deaths between 2015 and 2050 under different AMR scenarios (millions)

Scenario	A			B			C			D		
Disease	TB	HIV	Malaria	TB	HIV	Malaria	TB	HIV	Malaria	TB	HIV	Malaria
Brazil	0.2340	0.0602	0.0319	0.5695	0.1392	0.0792	0.4780	0.1302	0.0317	1.1399	0.2861	0.0784
Brunei	0.0007	0.0001	0.0019	0.0016	0.0003	0.0048	0.0014	0.0003	0.0019	0.0032	0.0006	0.0047
Bulgaria	0.0060	0.0004	0.0000	0.0129	0.0009	0.0000	0.0143	0.0009	0.0000	0.0279	0.0019	0.0000
Burkina Faso	0.0603	0.0220	1.3831	0.1408	0.0488	3.3029	0.1227	0.0474	1.3707	0.2809	0.0999	3.2589
Burundi	0.0909	0.0230	0.5638	0.2142	0.0515	1.3583	0.1851	0.0496	0.5590	0.4252	0.1049	1.3334
Cabo Verde	0.0033	0.0001	0.0129	0.0079	0.0001	0.0314	0.0067	0.0001	0.0128	0.0156	0.0003	0.0309
Cambodia	0.1811	0.0038	0.1015	0.4286	0.0087	0.1557	0.3772	0.0081	0.1002	0.8586	0.0177	0.1524
Cameroon	0.3254	0.1391	0.9179	0.7681	0.3123	2.2156	0.6589	0.2982	0.9047	1.5112	0.6305	2.1555
Canada	0.0048	0.0022	0.0000	0.0116	0.0050	0.0000	0.0097	0.0047	0.0000	0.0232	0.0103	0.0000
Central African Republic	0.0962	0.0210	0.1454	0.2272	0.0472	0.3513	0.1942	0.0449	0.1429	0.4446	0.0947	0.3399
Chad	0.1336	0.0422	0.6154	0.3161	0.0949	1.4892	0.2713	0.0907	0.6084	0.6264	0.1930	1.4590
Chile	0.0069	0.0033	0.0026	0.0168	0.0076	0.0065	0.0141	0.0071	0.0026	0.0337	0.0157	0.0065
China	2.3491	0.0806	5.4950	5.5872	0.1866	13.6713	4.9154	0.1739	5.4493	11.3138	0.3832	13.5305
Colombia	0.0432	0.0150	0.0169	0.1052	0.0346	0.0421	0.0882	0.0324	0.0168	0.2107	0.0712	0.0417
Comoros	0.0015	0.0002	0.0249	0.0036	0.0005	0.0609	0.0031	0.0004	0.0247	0.0073	0.0009	0.0602
Congo	0.0117	0.0172	0.1623	0.0279	0.0391	0.3958	0.0238	0.0371	0.1608	0.0556	0.0799	0.3899
Congo, Dem. Rep	1.4276	0.1168	2.4397	3.3779	0.2628	5.9023	2.8900	0.2503	2.4037	6.6372	0.5298	5.7344
Costa Rica	0.0015	0.0010	0.0008	0.0036	0.0022	0.0019	0.0031	0.0021	0.0008	0.0073	0.0046	0.0019
Cote d'Ivoire	0.2132	0.0692	0.6891	0.5067	0.1564	1.6745	0.4328	0.1487	0.6809	1.0027	0.3176	1.6385
Croatia	0.0018	0.0001	0.0000	0.0039	0.0001	0.0000	0.0043	0.0001	0.0000	0.0084	0.0003	0.0000
Cyprus	0.0003	0.0000	0.0015	0.0005	0.0000	0.0036	0.0006	0.0000	0.0015	0.0012	0.0001	0.0036
Czech Republic	0.0021	0.0001	0.0000	0.0044	0.0002	0.0000	0.0049	0.0002	0.0000	0.0096	0.0004	0.0000
Denmark	0.0015	0.0006	0.0000	0.0031	0.0013	0.0000	0.0035	0.0012	0.0000	0.0067	0.0027	0.0000
Djibouti	0.0189	0.0007	0.0240	0.0440	0.0016	0.0582	0.0390	0.0015	0.0236	0.0870	0.0033	0.0563

Table 12: Estimates of cumulative premature deaths between 2015 and 2050 under different AMR scenarios (millions)

Scenario	A			B			C			D		
Disease	TB	HIV	Malaria	TB	HIV	Malaria	TB	HIV	Malaria	TB	HIV	Malaria
Dominican Republic	0.0165	0.0046	0.0026	0.0403	0.0106	0.0064	0.0337	0.0099	0.0026	0.0806	0.0217	0.0064
Ecuador	0.0253	0.0064	0.0042	0.0617	0.0148	0.0105	0.0517	0.0138	0.0042	0.1234	0.0304	0.0104
Egypt	0.0475	0.0010	0.1169	0.1139	0.0024	0.2916	0.0988	0.0022	0.1160	0.2301	0.0050	0.2888
El Salvador	0.0061	0.0018	0.0009	0.0149	0.0042	0.0022	0.0124	0.0039	0.0009	0.0297	0.0087	0.0022
Equatorial Guinea	0.0069	0.0060	0.0283	0.0164	0.0135	0.0685	0.0141	0.0129	0.0279	0.0325	0.0273	0.0669
Estonia	0.0009	0.0002	0.0000	0.0020	0.0004	0.0000	0.0022	0.0004	0.0000	0.0043	0.0009	0.0000
Ethiopia	1.2747	0.1221	3.1810	3.0338	0.2763	7.7404	2.5835	0.2619	3.1376	5.9996	0.5606	7.5688
Fiji	0.0012	0.0001	0.0036	0.0029	0.0002	0.0089	0.0026	0.0002	0.0036	0.0059	0.0005	0.0088
Finland	0.0011	0.0001	0.0000	0.0023	0.0001	0.0000	0.0026	0.0001	0.0000	0.0050	0.0003	0.0000
France	0.0207	0.0055	0.0000	0.0440	0.0126	0.0000	0.0487	0.0118	0.0000	0.0946	0.0260	0.0000
Gabon	0.0422	0.0058	0.0553	0.0994	0.0129	0.1333	0.0852	0.0123	0.0544	0.1941	0.0258	0.1287
Gambia	0.0227	0.0027	0.1148	0.0533	0.0059	0.2760	0.0460	0.0057	0.1135	0.1056	0.0121	0.2704
Georgia	0.0154	0.0001	0.0044	0.0327	0.0003	0.0109	0.0361	0.0003	0.0043	0.0700	0.0006	0.0107
Germany	0.0155	0.0036	0.0000	0.0330	0.0083	0.0000	0.0366	0.0077	0.0000	0.0711	0.0170	0.0000
Ghana	0.0958	0.0334	0.8129	0.2289	0.0759	1.9857	0.1952	0.0721	0.8060	0.4566	0.1555	1.9587
Greece	0.0018	0.0001	0.0000	0.0039	0.0002	0.0000	0.0043	0.0002	0.0000	0.0085	0.0005	0.0000
Grenada	0.0000	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0003	0.0000
Guatemala	0.0320	0.0062	0.0068	0.0780	0.0144	0.0169	0.0652	0.0134	0.0067	0.1560	0.0295	0.0167
Guinea	0.1291	0.0402	0.6771	0.3036	0.0899	1.6277	0.2617	0.0863	0.6679	0.6008	0.1825	1.5924
Guinea-Bissau	0.0394	0.0129	0.1336	0.0908	0.0282	0.3143	0.0795	0.0274	0.1310	0.1770	0.0563	0.3030
Honduras	0.0136	0.0027	0.0018	0.0333	0.0062	0.0046	0.0278	0.0057	0.0018	0.0665	0.0127	0.0045
Hong Kong	0.0129	0.0004	0.0301	0.0306	0.0010	0.0749	0.0269	0.0010	0.0299	0.0620	0.0021	0.0742
Hungary	0.0058	0.0001	0.0000	0.0125	0.0002	0.0000	0.0138	0.0002	0.0000	0.0270	0.0004	0.0000
Iceland	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0002	0.0000	0.0000

Table 12: Estimates of cumulative premature deaths between 2015 and 2050 under different AMR scenarios (millions)

Scenario	A			B			C			D		
Disease	TB	HIV	Malaria	TB	HIV	Malaria	TB	HIV	Malaria	TB	HIV	Malaria
India	8.9388	0.0797	15.5720	21.5542	0.1827	38.4050	18.1761	0.1714	15.4028	42.8922	0.3731	37.7817
Indonesia	1.9644	0.1164	1.1312	4.7472	0.2676	2.7961	4.0014	0.2509	1.1209	9.4355	0.5457	2.7474
Iran	0.0542	0.0036	0.3521	0.1298	0.0083	0.8761	0.1129	0.0078	0.3494	0.2622	0.0171	0.8678
Ireland	0.0016	0.0001	0.0000	0.0033	0.0003	0.0000	0.0037	0.0003	0.0000	0.0071	0.0007	0.0000
Israel	0.0020	0.0003	0.0111	0.0042	0.0007	0.0275	0.0046	0.0007	0.0110	0.0090	0.0014	0.0273
Italy	0.0120	0.0066	0.0000	0.0256	0.0153	0.0000	0.0282	0.0142	0.0000	0.0552	0.0315	0.0000
Jamaica	0.0004	0.0013	0.0004	0.0010	0.0029	0.0010	0.0009	0.0027	0.0004	0.0021	0.0060	0.0009
Japan	0.0500	0.0004	0.4569	0.1187	0.0010	1.1356	0.1048	0.0009	0.4544	0.2408	0.0020	1.1259
Jordan	0.0016	0.0001	0.0107	0.0038	0.0001	0.0267	0.0033	0.0001	0.0107	0.0077	0.0003	0.0265
Kazakhstan	0.0891	0.0067	0.0000	0.1894	0.0154	0.0000	0.2088	0.0143	0.0000	0.4049	0.0314	0.0000
Kenya	0.7541	0.2927	1.5522	1.7865	0.6594	3.7596	1.5234	0.6260	1.5261	3.5067	1.3281	3.6490
Korea, South	0.1169	0.0012	0.1986	0.2777	0.0027	0.4933	0.2449	0.0025	0.1970	0.5619	0.0055	0.4878
Kuwait	0.0034	0.0002	0.0056	0.0082	0.0005	0.0139	0.0072	0.0005	0.0055	0.0166	0.0011	0.0137
Kyrgyzstan	0.0332	0.0023	0.0000	0.0706	0.0054	0.0000	0.0778	0.0050	0.0000	0.1509	0.0110	0.0000
Latvia	0.0031	0.0005	0.0000	0.0066	0.0011	0.0000	0.0072	0.0010	0.0000	0.0142	0.0023	0.0000
Lebanon	0.0023	0.0008	0.0058	0.0056	0.0019	0.0144	0.0049	0.0018	0.0057	0.0113	0.0040	0.0142
Lesotho	0.0881	0.0411	0.0535	0.2028	0.0899	0.1260	0.1749	0.0864	0.0518	0.3802	0.1730	0.1169
Lithuania	0.0063	0.0003	0.0000	0.0135	0.0006	0.0000	0.0149	0.0006	0.0000	0.0291	0.0013	0.0000
Luxembourg	0.0002	0.0000	0.0000	0.0004	0.0000	0.0000	0.0004	0.0000	0.0000	0.0009	0.0000	0.0000
Madagascar	0.3558	0.0096	0.8571	0.8441	0.0217	2.0788	0.7229	0.0207	0.8475	1.6688	0.0440	2.0322
Malawi	0.1778	0.2080	0.6230	0.4197	0.4671	1.5040	0.3606	0.4467	0.6150	0.8248	0.9418	1.4613
Malaysia	0.0842	0.0096	0.1427	0.1995	0.0221	0.3538	0.1764	0.0207	0.1418	0.4033	0.0453	0.3495
Maldives	0.0006	0.0000	0.0017	0.0016	0.0000	0.0042	0.0013	0.0000	0.0017	0.0032	0.0000	0.0042
Mali	0.0681	0.0159	1.5504	0.1579	0.0351	3.6770	0.1387	0.0343	1.5372	0.3150	0.0718	3.6264

Table 12: Estimates of cumulative premature deaths between 2015 and 2050 under different AMR scenarios (millions)

Scenario	A			B			C			D		
Disease	TB	HIV	Malaria	TB	HIV	Malaria	TB	HIV	Malaria	TB	HIV	Malaria
Malta	0.0002	0.0000	0.0000	0.0004	0.0000	0.0000	0.0004	0.0000	0.0000	0.0008	0.0000	0.0000
Mauritania	0.0274	0.0009	0.1319	0.0653	0.0021	0.3216	0.0558	0.0020	0.1308	0.1301	0.0043	0.3166
Mauritius	0.0011	0.0002	0.0283	0.0025	0.0004	0.0694	0.0022	0.0004	0.0280	0.0051	0.0009	0.0687
Mexico	0.0667	0.0234	0.0190	0.1629	0.0542	0.0475	0.1361	0.0505	0.0189	0.3263	0.1115	0.0470
Moldova	0.0160	0.0010	0.0000	0.0341	0.0023	0.0000	0.0376	0.0021	0.0000	0.0729	0.0047	0.0000
Mongolia	0.0142	0.0000	0.0131	0.0337	0.0000	0.0325	0.0297	0.0000	0.0130	0.0680	0.0001	0.0320
Montenegro	0.0004	0.0000	0.0000	0.0009	0.0000	0.0000	0.0010	0.0000	0.0000	0.0020	0.0000	0.0000
Morocco	0.1159	0.0016	0.0439	0.2770	0.0038	0.1091	0.2413	0.0036	0.0436	0.5582	0.0078	0.1078
Mozambique	0.8776	0.4679	2.0465	1.9997	1.0138	4.7674	1.7558	0.9910	1.9925	3.8298	1.9924	4.5147
Namibia	0.0798	0.0209	0.0683	0.1863	0.0464	0.1629	0.1602	0.0444	0.0667	0.3579	0.0915	0.1547
Nepal	0.1851	0.0028	0.1269	0.4485	0.0064	0.3144	0.3769	0.0060	0.1256	0.8928	0.0131	0.3094
Netherlands	0.0035	0.0006	0.0000	0.0073	0.0014	0.0000	0.0081	0.0013	0.0000	0.0154	0.0029	0.0000
New Zealand	0.0009	0.0001	0.0201	0.0021	0.0002	0.0500	0.0019	0.0002	0.0201	0.0043	0.0005	0.0495
Niger	0.1591	0.0070	1.5343	0.3733	0.0155	3.6793	0.3239	0.0150	1.5196	0.7427	0.0317	3.6199
Nigeria	3.9861	0.6689	11.1911	9.2929	1.4827	26.6744	8.0561	1.4310	11.0077	18.2090	2.9813	25.8444
Norway	0.0016	0.0001	0.0000	0.0035	0.0003	0.0000	0.0038	0.0003	0.0000	0.0074	0.0006	0.0000
Oman	0.0015	0.0007	0.0054	0.0036	0.0017	0.0134	0.0031	0.0016	0.0053	0.0072	0.0036	0.0133
Pakistan	1.8428	0.0338	0.9001	4.3843	0.0778	2.2278	3.8174	0.0726	0.8892	8.7754	0.1584	2.1855
Panama	0.0052	0.0019	0.0007	0.0127	0.0045	0.0016	0.0107	0.0042	0.0007	0.0255	0.0092	0.0016
Paraguay	0.0088	0.0029	0.0012	0.0215	0.0067	0.0029	0.0181	0.0062	0.0012	0.0431	0.0137	0.0029
Peru	0.1044	0.0043	0.0049	0.2544	0.0099	0.0121	0.2124	0.0092	0.0048	0.5081	0.0202	0.0120
Philippines	0.8927	0.0270	0.5011	2.1112	0.0621	1.2397	1.8634	0.0581	0.4957	4.2420	0.1265	1.2174
Poland	0.0272	0.0010	0.0000	0.0580	0.0022	0.0000	0.0640	0.0021	0.0000	0.1247	0.0046	0.0000
Portugal	0.0090	0.0050	0.0000	0.0192	0.0115	0.0000	0.0212	0.0108	0.0000	0.0414	0.0238	0.0000

Table 12: Estimates of cumulative premature deaths between 2015 and 2050 under different AMR scenarios (millions)

Scenario	A			B			C			D		
Disease	TB	HIV	Malaria	TB	HIV	Malaria	TB	HIV	Malaria	TB	HIV	Malaria
Qatar	0.0032	0.0000	0.0031	0.0076	0.0001	0.0077	0.0066	0.0001	0.0031	0.0154	0.0002	0.0076
Romania	0.0594	0.0006	0.0000	0.1264	0.0014	0.0000	0.1393	0.0013	0.0000	0.2713	0.0028	0.0000
Russia	0.4095	0.0742	0.0000	0.8706	0.1716	0.0000	0.9605	0.1601	0.0000	1.8662	0.3518	0.0000
Rwanda	0.0515	0.0389	0.4173	0.1229	0.0881	1.0171	0.1049	0.0838	0.4135	0.2446	0.1800	1.0010
Saint Lucia	0.0000	0.0001	0.0000	0.0001	0.0002	0.0001	0.0001	0.0002	0.0000	0.0001	0.0004	0.0001
Saint Vincent and the Grenadines	0.0000	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0000	0.0001	0.0003	0.0000
Sao Tome and Principe	0.0011	0.0002	0.0065	0.0026	0.0004	0.0159	0.0022	0.0004	0.0065	0.0052	0.0008	0.0157
Saudi Arabia	0.0143	0.0015	0.0402	0.0343	0.0034	0.1002	0.0298	0.0032	0.0400	0.0692	0.0070	0.0992
Senegal	0.1256	0.0058	0.5204	0.2993	0.0131	1.2674	0.2556	0.0124	0.5153	0.5949	0.0267	1.2458
Serbia	0.0051	0.0002	0.0000	0.0109	0.0006	0.0000	0.0120	0.0005	0.0000	0.0234	0.0012	0.0000
Sierra Leone	0.1020	0.0125	0.3469	0.2379	0.0276	0.8273	0.2066	0.0267	0.3420	0.4681	0.0558	0.8051
Singapore	0.0073	0.0002	0.0252	0.0174	0.0005	0.0626	0.0153	0.0004	0.0250	0.0352	0.0010	0.0620
Slovakia	0.0014	0.0000	0.0000	0.0030	0.0001	0.0000	0.0033	0.0001	0.0000	0.0064	0.0002	0.0000
Slovenia	0.0005	0.0000	0.0000	0.0012	0.0001	0.0000	0.0013	0.0001	0.0000	0.0025	0.0001	0.0000
South Africa	1.9551	0.9217	1.2769	4.5251	2.0284	3.0217	3.8863	1.9394	1.2353	8.5337	3.9253	2.8177
Spain	0.0214	0.0049	0.0000	0.0455	0.0114	0.0000	0.0504	0.0106	0.0000	0.0982	0.0234	0.0000
Sri Lanka	0.0554	0.0003	0.0892	0.1345	0.0007	0.2217	0.1128	0.0007	0.0884	0.2690	0.0015	0.2192
Sudan	0.1776	0.0475	0.7228	0.4206	0.1087	1.7806	0.3687	0.1022	0.7154	0.8457	0.2223	1.7548
Swaziland	0.0806	0.0306	0.0558	0.1807	0.0654	0.1281	0.1579	0.0636	0.0533	0.3301	0.1225	0.1157
Sweden	0.0027	0.0001	0.0000	0.0057	0.0003	0.0000	0.0063	0.0003	0.0000	0.0122	0.0007	0.0000
Switzerland	0.0022	0.0009	0.0000	0.0046	0.0022	0.0000	0.0051	0.0020	0.0000	0.0099	0.0045	0.0000
Tajikistan	0.0403	0.0027	0.0000	0.0857	0.0062	0.0000	0.0944	0.0058	0.0000	0.1833	0.0127	0.0000
Tanzania	0.5655	0.2825	1.9151	1.3395	0.6361	4.6374	1.1496	0.6078	1.8946	2.6461	1.2895	4.5299
Thailand	0.2848	0.0260	0.5807	0.6925	0.0602	0.5776	0.5806	0.0561	0.5758	1.3815	0.1232	0.5696

Table 12: Estimates of cumulative premature deaths between 2015 and 2050 under different AMR scenarios (millions)

Scenario	A			B			C			D		
Disease	TB	HIV	Malaria	TB	HIV	Malaria	TB	HIV	Malaria	TB	HIV	Malaria
Togo	0.0310	0.0159	0.2824	0.0737	0.0359	0.6862	0.0631	0.0342	0.2798	0.1468	0.0734	0.6758
Trinidad and Tobago	0.0006	0.0010	0.0002	0.0015	0.0024	0.0004	0.0012	0.0022	0.0002	0.0030	0.0049	0.0004
Tunisia	0.0114	0.0008	0.0140	0.0273	0.0019	0.0348	0.0238	0.0018	0.0139	0.0552	0.0039	0.0345
Turkey	0.0594	0.0015	0.0974	0.1266	0.0035	0.2428	0.1395	0.0032	0.0967	0.2722	0.0071	0.2405
Uganda	0.4505	0.4489	1.6968	1.0618	1.0058	4.0881	0.9139	0.9638	1.6751	2.0874	2.0291	3.9742
Ukraine	0.1295	0.0240	0.0000	0.2755	0.0555	0.0000	0.3036	0.0517	0.0000	0.5905	0.1138	0.0000
United Arab Emirates	0.0006	0.0012	0.0142	0.0015	0.0027	0.0354	0.0013	0.0026	0.0141	0.0030	0.0056	0.0351
United Kingdom	0.0040	0.0011	0.0000	0.0085	0.0025	0.0000	0.0094	0.0024	0.0000	0.0183	0.0052	0.0000
United States	0.0286	0.0640	0.0000	0.0698	0.1484	0.0000	0.0584	0.1385	0.0000	0.1398	0.3053	0.0000
Uruguay	0.0024	0.0009	0.0005	0.0058	0.0022	0.0012	0.0049	0.0020	0.0005	0.0116	0.0045	0.0012
Uzbekistan	0.0921	0.0019	0.0000	0.1959	0.0044	0.0000	0.2160	0.0041	0.0000	0.4202	0.0090	0.0000
Venezuela	0.0279	0.0083	0.0049	0.0681	0.0191	0.0123	0.0570	0.0178	0.0049	0.1362	0.0393	0.0122
Vietnam	0.3321	0.0373	0.5426	0.7879	0.0861	0.9522	0.6954	0.0806	0.5385	1.5913	0.1765	0.9399
Yemen	0.0488	0.0066	0.3023	0.1161	0.0152	0.7479	0.1016	0.0142	0.2999	0.2343	0.0312	0.7396
Zambia	0.4499	0.2033	0.8301	1.0487	0.4504	1.9780	0.9038	0.4322	0.8115	2.0298	0.8947	1.8931
Zimbabwe	0.4539	0.2140	0.4586	1.0611	0.4757	1.0960	0.9095	0.4540	0.4472	2.0378	0.9375	1.0407

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