

# Global policy responses to antimicrobial resistance, 2021–22: a systematic governance analysis of 161 countries and territories



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## Summary

**Background** Most countries have endorsed a national action plan (NAP) on antimicrobial resistance. We previously used a governance framework to assess NAPs on antimicrobial resistance available for the period of 2020–21 from 114 countries, finding substantial variation worldwide in the commitment of resources to address an escalating global health challenge. We sought to expand and advance this analysis to include the NAPs of more low-income and middle-income countries, to cover the period of 2021–22, and to examine the strength of NAPs to address antimicrobial resistance.

**Methods** In this systematic governance analysis, we searched ten repositories from their inception to April 1, 2023, to identify all publicly retrievable NAPs on antimicrobial resistance, with no language restrictions. Machine learning tools and artificial intelligence were used to translate all native-language NAPs into English. Three researchers independently conducted a detailed content analysis of new and updated NAPs on antimicrobial resistance. 22 057 datapoints were mapped against a governance framework and a numerical system was developed to quantify country scores for 54 indicators, 18 domains, and three governance areas. We applied principal component analysis to construct country scores between 0 and 100. Through Pearson's correlation coefficient, we evaluated the correlation between the country scores and various metrics pertaining to the burden of antibiotic-resistant infections from the IHME GRAM project.

**Findings** 161 countries and territories were included in this analysis, 47 more than the previous report. Governance scores varied across countries, with Norway achieving the highest score (score of 100) and Djibouti the lowest (score of 0). Generally, higher scores were seen in high-income countries (eg, France, USA, UK, Sweden, and Denmark), whereas lower scores were more common in low-income countries. High-income regions performed well across governance domains, whereas lower scores were seen in other regions (eg, Libya, Central African Republic, South Sudan, and Seychelles). Higher governance scores were significantly associated with a lower burden of antimicrobial resistance-associated disability-adjusted life-years ( $r=-0.469$ ,  $p<0.001$ ) and death ( $r=-0.477$ ,  $p<0.001$ ). Infection prevention and control ( $r=-0.532$ , Bonferroni-adjusted  $p<0.001$ ), surveillance ( $r=-0.482$ , Bonferroni-adjusted  $p<0.001$ ), and stewardship ( $r=-0.459$ , Bonferroni-adjusted  $p<0.001$ ) were the domains most strongly correlated with a lower burden of drug-resistant infections.

**Interpretation** The global response to antimicrobial resistance was greatly affected by the income level of the nation, highlighting global disparities in antimicrobial resistance governance capacity. Lower scores in lower-income regions likely reflect systemic challenges, such as less public health spending and less access clean water and sanitation. Implementation tools should be prioritised in the design and execution of NAPs, especially measures that improve infection prevention and control, surveillance systems for antimicrobial use, and stewardship programmes.

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## Introduction

Antimicrobial resistance is forecasted to remain a major global health challenge over the coming decades. Its health and economic impact is expected to substantially impede the UN's sustainable development agenda.<sup>1,2</sup> 178 countries, most of which are WHO members, have now adopted a national action plan (NAP) on antimicrobial resistance, often modelled on the WHO Global Action Plan on antimicrobial resistance.<sup>3</sup> A report

to the 154th session of WHO's Executive Board 2015 highlighted that only 27% of those countries had begun to implement the planned activities, and only 11% had allocated the necessary national budgets to enable full implementation.<sup>4</sup> Many countries have so far failed to transition from preparing detailed action plans to implementing them.<sup>5</sup> Many NAPs might require redesigning, moving from documents that are all-encompassing (but unlikely to be implemented) towards

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### Research in context

#### Evidence before this study

For our previous analysis of national action plans (NAPs) on antimicrobial resistance, we searched Google Scholar, PubMed, MEDLINE, and Web of Science for articles related to antimicrobial resistance, governance, policy responses, and NAPs published between Jan 1, 2000, and June 1, 2022, without language restrictions, finding no comprehensive global study of antimicrobial resistance governance. For this study, we screened Google Scholar and PubMed for publications up to April 1, 2025, that evaluated progress towards addressing antimicrobial resistance internationally. The search terms ("antimicrobial resistance" OR "antibiotic resistance" OR "drug resistance" OR "AMR"), AND ("govern\*" OR "policy" OR "respon\*" OR "measur\*" OR "monitor\*" OR "progress"), AND ("national action" OR "national action plan" OR "NAP") were used. The results indicated a general trajectory of progress to reduce antimicrobial resistance; however, these claims were largely unsupported by robust data. Little effort was made to convey specific cases of progress from individual nations. Our previous study found variance in the strength of NAPs on antimicrobial resistance across 114 countries, with monitoring and evaluation mechanisms and core governance elements, including equity, education, and accountability, underperforming constituents.

#### Added value of this study

This analysis advances on the original study in several ways. First, we report on the NAPs of 161 countries and territories, including several updated NAPs and 47 new locations. Previous difficulties in analysing some native-language NAPs had led to their exclusion from the previous study; however, in this study we used enhanced machine learning and artificial intelligence capabilities to translate native-language NAPs into English, thereby ensuring that no location was excluded based on language. Second, country scores were generated from a vast input of 22 057 individual datapoints, synthesising data of various types and levels of granularity, that better

contextualised antimicrobial resistance control efforts. Third, compared with the previous study that relied on calculation of arithmetic means, this study used descriptive statistics at the most granular level and summarised scores at the domain-level and above through principal component analysis. This methodological enhancement allowed the team to account for greater heterogeneity in the data. Fourth, to understand the relevance of the findings for population-level health outcomes and policy, the scores were correlated with proxies (deaths and disability-adjusted life-years) for the burden of bacterial drug-resistant infections. Finally, the standardisation of data using novel statistical methods and the retention and reapplication of key components in the statistical analysis allowed the new results of this study to be compared with the 2020–21 findings. Although we do not advocate that this comparison be used to monitor progress (the time period is not sufficient to allow substantive policy changes), it is the start of an accountability mechanism, which is how the evolution of this study is anticipated.

#### Implications of all the available evidence

During the acute phases of the COVID-19 pandemic, many countries were not able to take new action and sustain existing programmes on antimicrobial resistance. Implementation shortcomings, coupled with an increasing burden of drug-resistant infections, call for a re-evaluation of the governance of NAPs on antimicrobial resistance. We found that improved governance of NAPs and strategic prioritisation of activities that pertain to implementation tools were correlated with a reduction in the burden of antimicrobial resistance. Prioritising efforts that strengthen infection prevention and control, advance professional education agendas for health-care professionals on antimicrobial stewardship, and strengthen or establish surveillance systems for antibiotic use are likely to deliver the greatest return on investments into the mitigation of antimicrobial resistance.

highly prioritised commitments, with clear actions, milestones, and accountability. Findings from *The Lancet* Series on antimicrobial resistance provided insights and evidence to inform the prioritisation of NAPs.<sup>6</sup> A global cross-country assessment of factors impeding the implementation of NAPs could serve as a guide for public health policy and resource allocation.

In our original analysis for the 2020–21 period, we provided a snapshot of international response efforts to address antimicrobial resistance across 114 countries.<sup>7</sup> We did a systematic search to locate all publicly available NAPs internationally. We did a content analysis of 114 plans using a governance framework developed by Anderson and colleagues.<sup>8</sup> We then represented the policy responses, strengths, and weaknesses of the plans numerically and generated indicator scores for each country. We found that

planned and implemented initiatives to control antimicrobial resistance varied considerably across countries, and the existence of a NAP did not correlate with the observed level of antimicrobial resistance. However, this correlation was not quantified robustly.

In this study, we aimed to expand and advance our previous analysis to assess available NAPs on antimicrobial resistance from more countries and territories, to cover the period of 2021–22, and to quantify the association between the governance scores and various metrics of the burden of drug-resistant infections.

## Methods

### Overview

Advancing on methods established in the 2020–21 study, our analysis involved four steps: identifying and

conducting a detailed content analysis of new and updated NAPs against a governance framework; developing a system of generating scores through combining qualitative insights from NAPs with data from additional sources; calculating composite country scores through principal component analysis (PCA), providing a measure of the strength of planned and implemented response efforts to antimicrobial resistance on a scale of 0–100; and examining associations between the country scores and the burden of antimicrobial resistance in 161 locations. This analysis complies with the Guidelines for Accurate and Transparent Health Estimates Reporting<sup>9</sup> (appendix pp 3–4).

### Search strategy and selection criteria

To identify NAPs on antimicrobial resistance, ten repositories were searched from their inception to Jan 1, 2023: Antimicrobial Resistance National Action Plan Translation Project,<sup>10</sup> European Centre for Disease Prevention and Control,<sup>11</sup> FDI World Dental Federation,<sup>12</sup> Food and Agriculture Organization of the UN,<sup>13</sup> Global Health Security Index,<sup>14</sup> Google, government websites, ReAct Action on Antibiotic Resistance,<sup>15</sup> WHO Library of AMR national action plans,<sup>16</sup> and WHO Tripartite Antimicrobial Resistance Country Self-Assessment Survey<sup>17</sup> (TrACSS; appendix pp 9–45). When repositories were not dedicated NAP libraries, we used the search terms “antimicrobial resistance”, “antibiotic resistance”, “AMR”, “national”, “action”, “plan”, and “NAP”, with relevant country names to identify the relevant documents. Native-language NAPs were translated to English using machine learning, and the Antimicrobial Resistance National Action Plan Translation Project was used to identify additional native-language NAPs that had been carefully translated to English outside of this study by NV. The inclusion criteria for a country or territory in this analysis were the existence of a valid and publicly available NAP on antimicrobial resistance, publication in English or the ability to translate the NAP to English, and participation in the TrACSS 7.0 2021–22. The complete tabulation of country names and their NAPs are detailed in the appendix (pp 46–67). If a country had more than one NAP at the time, only the most recent was included.

### Assessment framework and indicator quantification

The country assessment was conducted against a cyclical governance framework developed by Anderson and colleagues,<sup>8</sup> retaining the 54 indicators, 18 domains, and three governance areas (policy design, implementation tools, and monitoring and evaluation) that underpin the constituent parameters of the study. The additional indicator (compared with Anderson and colleagues' study) represents the separation of an indicator within the accountability domain of the policy design governance area into two parts (PD 4.2 and PD 4.3; appendix p 14). The methods for quantifying indicator scores have been

adapted from the original analysis, to appropriately manage the increased volume of datapoints and sources of data, relevant to the indicator questions. Descriptive statistics were used to generate indicator scores, and the quantification system developed and applied for each indicator is detailed in the appendix (pp 9–45).

Detailed content analysis of 161 NAPs was performed by three researchers (JP, SR, and AH), who independently reviewed each new and updated NAP against the matrix of indicators. Findings from this analysis were combined with various data (appendix pp 9–45) extracted from five additional sources (TrACSS 7.0,<sup>17</sup> Global Antimicrobial Resistance Research and Development Hub 2022,<sup>18</sup> Global Antimicrobial Resistance and Use Surveillance System 2022,<sup>19</sup> WHO 2018 South-East Asia Region Situational Analysis,<sup>20</sup> and WHO 2022 Immunization Dashboard<sup>21</sup>). Finally, all values were transformed by PCA to a scale from 0 (lowest score) to 100 (highest score), to standardise the data. To support the understanding of geographical and economic variation, we disaggregated results by WHO region and World Bank income groups to observe trends between and within these groups.

### Data extraction and analysis

These scores were tabulated using Microsoft Excel (version 16.88). When data could not be reliably ascertained or when there was substantial disagreement between reviewers in assigning scores, the research team collaborated to locate the information through an expanded search and to reach a consensus when there was disagreement. In the case of missing data, if the corresponding data from the original analysis<sup>7</sup> were available, these data were inputted into this study. There were very few instances of missing data or disagreement.

To allow for a comparison of the dataset in this study against our previous analysis,<sup>7</sup> we also report the scores as arithmetic means. Although the arithmetic mean was used in the former analysis, the use of PCA was more appropriate for this study, given the increased dimensionality of the dataset. We recognise that summarising features of a high-dimensional dataset into reduced dimensions might not capture all of the variance and that the loss of information is inevitable.<sup>22</sup> However, PCA allowed for the most appropriate transformation of a broad array of variables into a smaller subset that retained and maximally explained the variance across the indicators. Before conducting PCA, key assumptions were evaluated to ensure the suitability of the data. The Kaiser–Meyer–Olkin measure of sampling adequacy was used to assess the proportion of variance among variables that might be common variance. Additionally, Bartlett's test of sphericity was conducted to determine whether the correlation matrix significantly differed from an identity matrix, indicating sufficient intercorrelations among variables. These preliminary tests were used to confirm that PCA was appropriate for the dataset.

See Online for appendix

### Examining correlates

The governance framework reflects many factors that affect the capacity of a country or territory to effectively control antimicrobial resistance. Data pertaining to the burden associated with and attributable to antimicrobial resistance were obtained from the Institute for Health Metrics and Evaluation, through the Global Research on Antimicrobial Resistance (GRAM) project.<sup>1</sup> Measuring Infectious Causes and Resistance Outcomes for Burden Estimation—an initiative by the GRAM team—provided estimates for both fatal and non-fatal (disability-adjusted life years [DALYs]) burden measures of bacterial drug resistance.<sup>23</sup> The data are estimated for 23 pathogens and 88 pathogen–drug combinations from 1990 to 2021, categorised by age group (all ages, age-standardised, neonates [ $<28$  days], post-neonates [28–364 days], individuals aged 1–94 years in 5-year increments, and adults aged 95 years and older) and sex, across 204 countries and territories.<sup>24</sup> For this paper, two cross-sections were selected (2020 and 2021) to examine the correlation between country scores in 2020–21 against the burden in 2020 across 114 countries, and scores in 2021–22 against the burden in 2021 across 161 countries. To account for multiple comparisons, *p* values were adjusted using the Bonferroni correction method.

### Role of the funding source

There was no funding source for this study.

### Results

We included NAPs on antimicrobial resistance from 161 countries and territories in the analysis, including 47 more than in our previous report (appendix pp 47–70). NAPs were excluded if the country did not also report TrACSS. New NAPs came from various WHO regions: 21 additional locations in the African region, 13 in the European region, seven in the region of the Americas, four in the Eastern Mediterranean region, and two in the Western Pacific region; 37 new NAPs were from low-income and middle-income countries and ten were from high-income countries. We generated 8533 scores from 22057 input datapoints. To assess the dimensionality of the dataset, we performed PCA on 54 indicators after verifying that the assumptions were met. Using PCA, we summarised these scores by domain, governance area, and as an overall country governance score (figure 1).

For 2021–22, Norway had the highest overall governance score (score of 100) and Djibouti had the lowest (score of 0; figure 1). There was a marked divide, whereby high-income countries (eg, Norway, France, USA, UK, Sweden, and Denmark) generally had higher governance scores, indicating more effective and robust antimicrobial resistance control measures. In contrast, low-income countries, particularly those in Africa, the Middle East, and south Asia, had less effective governance areas and domains (figure 2).

Parts of the Americas, Europe, and southeast Asia generally performed strongly across the three governance areas (appendix p 153). Africa, the Middle East, and south Asia had lower scores across all governance areas and domains, suggesting systemic challenges in governance and policy effectiveness in these regions. Stratifying the country ranking by World Bank economic group showed that high-income nations scored highest (median rank 122.0 [IQR 71.0–145.5]) and low-income economies scored lowest (median rank 43.0 [IQR 22.0–92.5]; figure 3).

The comparison of scores between 2020–21 and 2021–22 across 114 countries revealed significant disparities in performance during the assessed period (appendix p 90). Notably, Indonesia exhibited the highest increase in mean overall governance score, improving by 14.7 points. Other countries with substantial improvements included Ethiopia (10.8 points), Brazil (9.3 points), and Mongolia (8.7 points). Several countries had substantial declines in their mean scores, such as Mozambique (18.5 points), China (16.7 points), and Greece (14.9 points).

The Pearson correlation coefficient between the governance scores and antimicrobial resistance-associated DALYs in 2021 suggested a moderate inverse relationship ( $r=-0.469$ ,  $p<0.001$ ; figure 4), as well as between governance scores and antimicrobial resistance-associated deaths in 2021 ( $r=-0.477$ ,  $p<0.001$ ; appendix pp 118–141). Many countries in the African region and the Eastern Mediterranean region had low country scores and high DALY rates. Countries in the European region showed generally higher scores and lower DALY rates. Greater variance was noted in the region of the Americas, the South-East Asia region, and the Western Pacific region (appendix pp 91–138).

The domains most strongly correlated with a lower burden of DALYs associated with antimicrobial resistance in 2021 were infection prevention and control ( $r=-0.532$ , unadjusted  $p<0.001$ , Bonferroni-adjusted  $p<0.001$ ), surveillance ( $r=-0.482$ , unadjusted  $p<0.001$ , Bonferroni-adjusted  $p<0.001$ ), and antimicrobial stewardship ( $r=-0.459$ , unadjusted  $p<0.001$ , Bonferroni-adjusted  $p<0.001$ ). Regarding mortality, the domains most strongly correlated with a lower burden of deaths associated with antimicrobial resistance in 2021 were the same as for DALYs; the correlations and *p* values are provided in the appendix (pp 118–141). All three domains belong to the implementation tools governance area, which of the three governance areas was most strongly correlated with antimicrobial resistance burden ( $r=-0.540$ , unadjusted  $p<0.001$ , Bonferroni-adjusted  $p<0.001$ ). The monitoring and evaluation ( $r=-0.257$ , unadjusted  $p=0.001$ , Bonferroni-adjusted  $p=0.078$ ) and policy design ( $r=-0.216$ , unadjusted  $p=0.006$ , Bonferroni-adjusted  $p=0.450$ ) governance areas showed weaker but significant correlations based on the unadjusted *p* values, and insignificant correlations after Bonferroni adjustment.

|                | Policy design    |               |                      |                           |                  |              |               |                |              |                | Implementation tools |              |                           |                                  |           |                  |                      | Monitoring and evaluation                   |           |                    |               |                                   |
|----------------|------------------|---------------|----------------------|---------------------------|------------------|--------------|---------------|----------------|--------------|----------------|----------------------|--------------|---------------------------|----------------------------------|-----------|------------------|----------------------|---|-----------|--------------------|---------------|-----------------------------------|
|                | Governance score | Policy design | Implementation tools | Monitoring and evaluation | Strategic vision | Coordination | Participation | Accountability | Transparency | Sustainability | Equity               | Surveillance | Antimicrobial stewardship | Infection prevention and control | Education | Public awareness | Medicines regulation | Research and development for novel products | Reporting | Feedback mechanism | Effectiveness | Antimicrobial resistance research |
| Norway         | 100              | 89            | 100                  | 94                        | 82               | 82           | 89            | 78             | 87           | 67             | 100                  | 86           | 99                        | 86                               | 100       | 100              | 100                  | 100   | 94        | 77                 | 100           | 100                               |
| France         | 95               | 88            | 97                   | 73                        | 98               | 93           | 75            | 67             | 87           | 83             | 100                  | 100          | 98                        | 91                               | 100       | 80               | 98                   | 86  | 96        | 77                 | 43            | 44                                |
| USA            | 92               | 96            | 86                   | 94                        | 76               | 100          | 100           | 78             | 87           | 100            | 100                  | 86           | 93                        | 67                               | 85        | 89               | 80                   | 100   | 91        | 79                 | 100           | 100                               |
| UK             | 91               | 96            | 80                   | 100                       | 100              | 91           | 94            | 78             | 87           | 100            | 85                   | 70           | 92                        | 54                               | 56        | 98               | 100                  | 93  | 100       | 100                | 100           | 100                               |
| Sweden         | 90               | 90            | 82                   | 95                        | 77               | 91           | 94            | 78             | 87           | 80             | 0                    | 94           | 87                        | 85                               | 45        | 50               | 100                  | 100   | 98        | 76                 | 100           | 100                               |
| Denmark        | 90               | 85            | 95                   | 59                        | 86               | 71           | 89            | 76             | 100          | 70             | 0                    | 100          | 98                        | 90                               | 95        | 89               | 98                   | 14  | 93        | 70                 | 0             | 41                                |
| Thailand       | 84               | 94            | 74                   | 86                        | 95               | 100          | 100           | 78             | 69           | 93             | 50                   | 80           | 91                        | 70                               | 47        | 97               | 85                   | 0   | 86        | 94                 | 43            | 100                               |
| Malaysia       | 84               | 85            | 85                   | 55                        | 71               | 96           | 87            | 72             | 57           | 88             | 50                   | 97           | 95                        | 67                               | 73        | 91               | 88                   | 62  | 61        | 86                 | 43            | 15                                |
| Germany        | 82               | 77            | 81                   | 71                        | 48               | 60           | 76            | 61             | 87           | 68             | 100                  | 87           | 79                        | 96                               | 58        | 45               | 98                   | 100   | 93        | 43                 | 43            | 85                                |
| Ireland        | 80               | 88            | 74                   | 78                        | 73               | 80           | 94            | 76             | 87           | 83             | 100                  | 75           | 57                        | 95                               | 80        | 27               | 98                   | 86  | 89        | 56                 | 100           | 59                                |
| Spain          | 79               | 84            | 75                   | 60                        | 71               | 82           | 75            | 88             | 82           | 80             | 50                   | 86           | 74                        | 84                               | 52        | 89               | 22                   | 86  | 94        | 65                 | 43            | 15                                |
| Netherlands    | 78               | 69            | 82                   | 56                        | 37               | 60           | 76            | 61             | 87           | 62             | 0                    | 85           | 83                        | 67                               | 67        | 91               | 88                   | 100   | 76        | 67                 | 0             | 56                                |
| Belgium        | 77               | 78            | 77                   | 55                        | 33               | 73           | 94            | 67             | 82           | 80             | 0                    | 89           | 97                        | 88                               | 47        | 27               | 98                   | 14  | 91        | 76                 | 0             | 15                                |
| Philippines    | 77               | 88            | 68                   | 82                        | 83               | 78           | 87            | 61             | 87           | 95             | 100                  | 68           | 79                        | 55                               | 45        | 50               | 93                   | 76  | 73        | 73                 | 100           | 85                                |
| Japan          | 77               | 77            | 75                   | 62                        | 100              | 75           | 63            | 67             | 69           | 56             | 100                  | 86           | 64                        | 73                               | 56        | 89               | 60                   | 86  | 100       | 47                 | 43            | 29                                |
| Austria        | 76               | 85            | 74                   | 42                        | 68               | 91           | 94            | 78             | 69           | 80             | 0                    | 77           | 75                        | 66                               | 52        | 91               | 85                   | 76  | 85        | 35                 | 0             | 15                                |
| Finland        | 75               | 82            | 74                   | 49                        | 39               | 90           | 100           | 76             | 57           | 90             | 0                    | 83           | 92                        | 100                              | 52        | 19               | 98                   | 0   | 54        | 85                 | 0             | 29                                |
| Switzerland    | 75               | 91            | 64                   | 71                        | 73               | 82           | 94            | 95             | 87           | 87             | 0                    | 63           | 56                        | 84                               | 36        | 48               | 90                   | 76  | 93        | 39                 | 100           | 44                                |
| Australia      | 73               | 87            | 64                   | 73                        | 55               | 82           | 100           | 67             | 87           | 93             | 50                   | 70           | 64                        | 64                               | 54        | 39               | 78                   | 100   | 73        | 29                 | 100           | 100                               |
| South Korea    | 73               | 89            | 64                   | 54                        | 93               | 91           | 94            | 100            | 57           | 80             | 50                   | 95           | 86                        | 73                               | 23        | 50               | 7                    | 43  | 61        | 94                 | 0             | 29                                |
| Indonesia      | 72               | 82            | 70                   | 64                        | 83               | 86           | 87            | 71             | 57           | 85             | 50                   | 78           | 69                        | 60                               | 69        | 45               | 88                   | 76  | 52        | 50                 | 100           | 59                                |
| Estonia        | 71               | 63            | 75                   | 68                        | 81               | 41           | 82            | 63             | 57           | 54             | 0                    | 69           | 95                        | 63                               | 80        | 27               | 98                   | 47  | 40        | 88                 | 100           | 60                                |
| Portugal       | 70               | 59            | 77                   | 44                        | 22               | 50           | 76            | 60             | 57           | 58             | 0                    | 92           | 100                       | 85                               | 20        | 53               | 100                  | 14  | 75        | 69                 | 0             | 0                                 |
| Lithuania      | 68               | 72            | 70                   | 40                        | 39               | 69           | 88            | 73             | 69           | 61             | 50                   | 69           | 89                        | 57                               | 91        | 24               | 90                   | 0   | 80        | 33                 | 0             | 15                                |
| Singapore      | 67               | 73            | 58                   | 80                        | 45               | 78           | 76            | 72             | 69           | 62             | 0                    | 82           | 72                        | 55                               | 23        | 56               | 37                   | 76  | 91        | 30                 | 100           | 100                               |
| Kenya          | 67               | 92            | 57                   | 44                        | 70               | 100          | 100           | 78             | 69           | 93             | 50                   | 68           | 87                        | 54                               | 32        | 48               | 71                   | 0   | 64        | 44                 | 43            | 15                                |
| Russia         | 64               | 64            | 66                   | 42                        | 75               | 80           | 44            | 61             | 44           | 65             | 0                    | 90           | 84                        | 60                               | 43        | 39               | 78                   | 38  | 59        | 68                 | 0             | 15                                |
| Ethiopia       | 64               | 88            | 48                   | 67                        | 83               | 80           | 100           | 71             | 66           | 93             | 100                  | 72           | 60                        | 46                               | 18        | 45               | 0                    | 81  | 73        | 68                 | 43            | 71                                |
| Canada         | 64               | 69            | 61                   | 43                        | 34               | 50           | 100           | 63             | 57           | 61             | 100                  | 88           | 75                        | 55                               | 34        | 39               | 48                   | 39  | 58        | 88                 | 0             | 0                                 |
| Cuba           | 64               | 73            | 61                   | 36                        | 32               | 100          | 88            | 54             | 32           | 93             | 0                    | 83           | 66                        | 68                               | 60        | 27               | 78                   | 0   | 43        | 80                 | 0             | 0                                 |
| Morocco        | 63               | 80            | 57                   | 38                        | 32               | 71           | 100           | 65             | 75           | 97             | 0                    | 72           | 62                        | 54                               | 40        | 53               | 85                   | 0   | 41        | 76                 | 0             | 15                                |
| Malawi         | 63               | 77            | 56                   | 56                        | 83               | 85           | 49            | 56             | 87           | 79             | 100                  | 75           | 81                        | 34                               | 32        | 42               | 47                   | 86  | 64        | 41                 | 43            | 71                                |
| Slovenia       | 62               | 63            | 66                   | 45                        | 58               | 45           | 69            | 53             | 63           | 70             | 0                    | 74           | 82                        | 56                               | 73        | 16               | 78                   | 86  | 40        | 29                 | 43            | 71                                |
| Latvia         | 62               | 60            | 62                   | 66                        | 64               | 49           | 56            | 57             | 75           | 39             | 0                    | 75           | 82                        | 50                               | 38        | 22               | 85                   | 76  | 56        | 36                 | 100           | 85                                |
| Chile          | 61               | 74            | 58                   | 35                        | 34               | 86           | 87            | 48             | 57           | 85             | 0                    | 80           | 81                        | 60                               | 21        | 50               | 78                   | 0   | 49        | 53                 | 0             | 15                                |
| Serbia         | 61               | 80            | 57                   | 31                        | 80               | 79           | 100           | 75             | 50           | 87             | 0                    | 54           | 61                        | 66                               | 43        | 45               | 80                   | 62  | 34        | 33                 | 43            | 15                                |
| Iraq           | 60               | 90            | 50                   | 33                        | 72               | 82           | 100           | 67             | 75           | 100            | 50                   | 69           | 66                        | 46                               | 18        | 83               | 37                   | 0   | 50        | 30                 | 0             | 29                                |
| Brazil         | 60               | 74            | 55                   | 49                        | 27               | 69           | 100           | 73             | 87           | 61             | 0                    | 69           | 78                        | 60                               | 21        | 22               | 71                   | 76  | 69        | 6                  | 0             | 100                               |
| Saudi Arabia   | 59               | 90            | 45                   | 49                        | 64               | 96           | 87            | 72             | 75           | 95             | 100                  | 62           | 56                        | 44                               | 25        | 50               | 71                   | 0   | 40        | 44                 | 43            | 71                                |
| North Korea    | 58               | 70            | 53                   | 44                        | 56               | 82           | 75            | 65             | 44           | 80             | 0                    | 69           | 75                        | 45                               | 27        | 45               | 71                   | 62  | 41        | 74                 | 43            | 15                                |
| Czech Republic | 57               | 61            | 61                   | 27                        | 39               | 56           | 82            | 68             | 44           | 42             | 0                    | 78           | 79                        | 60                               | 29        | 27               | 90                   | 14  | 58        | 30                 | 0             | 0                                 |
| Zimbabwe       | 57               | 87            | 43                   | 52                        | 51               | 79           | 100           | 75             | 87           | 93             | 50                   | 50           | 63                        | 46                               | 9         | 3                | 85                   | 76  | 55        | 52                 | 43            | 56                                |
| Greece         | 56               | 65            | 57                   | 31                        | 41               | 56           | 63            | 56             | 75           | 63             | 0                    | 47           | 41                        | 69                               | 60        | 42               | 95                   | 14  | 52        | 3                  | 0             | 56                                |
| India          | 56               | 80            | 41                   | 66                        | 65               | 75           | 87            | 69             | 69           | 82             | 50                   | 60           | 49                        | 28                               | 21        | 24               | 71                   | 76  | 65        | 41                 | 100           | 71                                |
| Peru           | 56               | 100           | 29                   | 68                        | 87               | 100          | 100           | 100            | 100          | 100            | 0                    | 46           | 35                        | 21                               | 11        | 16               | 71                   | 86  | 58        | 58                 | 100           | 71                                |
| Malta          | 56               | 71            | 51                   | 33                        | 37               | 89           | 62            | 61             | 69           | 78             | 0                    | 79           | 73                        | 43                               | 31        | 30               | 47                   | 0   | 65        | 44                 | 0             | 0                                 |
| Ghana          | 55               | 76            | 40                   | 72                        | 85               | 64           | 69            | 60             | 87           | 73             | 50                   | 67           | 46                        | 36                               | 16        | 39               | 37                   | 86  | 65        | 32                 | 100           | 100                               |
| Uganda         | 55               | 61            | 52                   | 51                        | 95               | 40           | 50            | 57             | 75           | 25             | 100                  | 76           | 70                        | 53                               | 21        | 22               | 71                   | 76  | 54        | 35                 | 43            | 71                                |
| Tanzania       | 54               | 80            | 40                   | 60                        | 99               | 70           | 62            | 54             | 88           | 81             | 50                   | 61           | 49                        | 42                               | 14        | 50               | 0                    | 43  | 61        | 29                 | 43            | 100                               |
| Italy          | 54               | 61            | 49                   | 53                        | 87               | 43           | 63            | 63             | 87           | 24             | 0                    | 75           | 47                        | 34                               | 45        | 36               | 78                   | 14  | 91        | 41                 | 43            | 15                                |
| Hungary        | 54               | 35            | 69                   | 24                        | 31               | 42           | 38            | 26             | 0            | 48             | 0                    | 84           | 89                        | 73                               | 40        | 39               | 90                   | 14  | 38        | 43                 | 0             | 0                                 |
| Belarus        | 54               | 41            | 67                   | 21                        | 27               | 51           | 44            | 49             | 0            | 61             | 0                    | 82           | 74                        | 64                               | 58        | 80               | 80                   | 0   | 34        | 36                 | 0             | 0                                 |
| New Zealand    | 54               | 64            | 49                   | 48                        | 48               | 48           | 82            | 35             | 57           | 68             | 100                  | 59           | 74                        | 42                               | 27        | 22               | 15                   | 67  | 51        | 58                 | 43            | 29                                |
| Timor-Leste    | 53               | 93            | 29                   | 56                        | 65               | 100          | 100           | 78             | 82           | 93             | 50                   | 44           | 16                        | 14                               | 14        | 74               | 78                   | 62  | 56        | 62                 | 100           | 15                                |
| Jordan         | 52               | 74            | 43                   | 45                        | 92               | 71           | 36            | 72             | 100          | 71             | 50                   | 49           | 50                        | 63                               | 16        | 36               | 78                   | 0   | 64        | 41                 | 0             | 56                                |

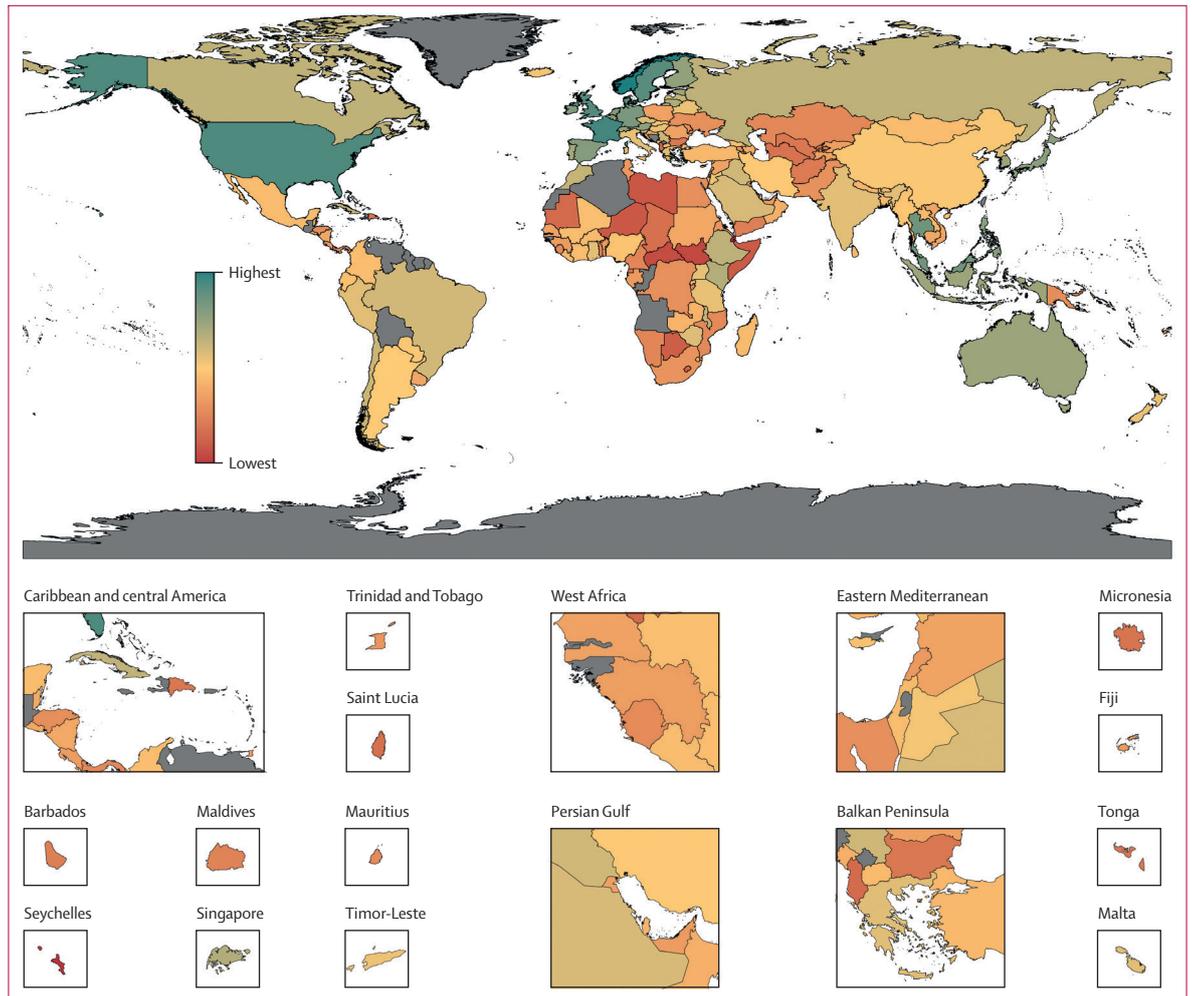
(Figure 1 continues on next page)

|                      | Policy design    |               |                      |                           |                  |              |               |                |              |                | Implementation tools |              |                           |                                  |           |                  | Monitoring and evaluation |   |           |                    |               |                                   |
|----------------------|------------------|---------------|----------------------|---------------------------|------------------|--------------|---------------|----------------|--------------|----------------|----------------------|--------------|---------------------------|----------------------------------|-----------|------------------|---------------------------|---|-----------|--------------------|---------------|-----------------------------------|
|                      | Governance score | Policy design | Implementation tools | Monitoring and evaluation | Strategic vision | Coordination | Participation | Accountability | Transparency | Sustainability | Equity               | Surveillance | Antimicrobial stewardship | Infection prevention and control | Education | Public awareness | Medicines regulation      | Research and development for novel products | Reporting | Feedback mechanism | Effectiveness | Antimicrobial resistance research |
| Iceland              | 52               | 48            | 54                   | 39                        | 31               | 42           | 50            | 26             | 57           | 48             | 0                    | 87           | 83                        | 36                               | 11        | 48               | 71                        | 14  | 77        | 32                 | 0             | 15                                |
| China                | 51               | 62            | 44                   | 51                        | 50               | 85           | 49            | 33             | 57           | 73             | 50                   | 45           | 43                        | 40                               | 38        | 86               | 10                        | 19  | 71        | 44                 | 43            | 29                                |
| Slovakia             | 51               | 49            | 60                   | 29                        | 75               | 54           | 49            | 29             | 44           | 40             | 0                    | 69           | 85                        | 55                               | 36        | 42               | 78                        | 14  | 23        | 53                 | 43            | 0                                 |
| Paraguay             | 51               | 50            | 59                   | 25                        | 11               | 43           | 75            | 52             | 44           | 50             | 50                   | 72           | 71                        | 60                               | 56        | 16               | 52                        | 62  | 23        | 51                 | 0             | 15                                |
| Iran                 | 50               | 66            | 44                   | 40                        | 87               | 61           | 75            | 63             | 57           | 50             | 0                    | 64           | 50                        | 34                               | 23        | 45               | 71                        | 62  | 58        | 27                 | 57            | 15                                |
| Argentina            | 50               | 61            | 48                   | 30                        | 32               | 79           | 50            | 60             | 57           | 75             | 0                    | 63           | 66                        | 54                               | 14        | 42               | 71                        | 14  | 41        | 62                 | 0             | 0                                 |
| Rwanda               | 49               | 70            | 43                   | 39                        | 60               | 69           | 100           | 50             | 50           | 67             | 50                   | 57           | 58                        | 69                               | 7         | 19               | 71                        | 14  | 22        | 55                 | 0             | 71                                |
| Myanmar              | 48               | 82            | 33                   | 41                        | 60               | 71           | 100           | 65             | 69           | 90             | 50                   | 42           | 41                        | 38                               | 16        | 22               | 37                        | 62  | 60        | 6                  | 43            | 44                                |
| Georgia              | 48               | 80            | 36                   | 26                        | 40               | 80           | 94            | 76             | 63           | 83             | 0                    | 38           | 36                        | 39                               | 23        | 71               | 37                        | 14  | 43        | 3                  | 43            | 15                                |
| Nigeria              | 48               | 70            | 39                   | 35                        | 81               | 80           | 56            | 61             | 69           | 65             | 50                   | 44           | 55                        | 46                               | 16        | 27               | 37                        | 62  | 55        | 24                 | 43            | 15                                |
| Cyprus               | 48               | 60            | 48                   | 18                        | 36               | 41           | 94            | 63             | 44           | 47             | 0                    | 74           | 73                        | 49                               | 7         | 39               | 71                        | 14  | 54        | 3                  | 0             | 0                                 |
| Ecuador              | 47               | 53            | 53                   | 22                        | 78               | 44           | 100           | 0              | 32           | 53             | 0                    | 69           | 55                        | 82                               | 27        | 29               | 78                        | 24  | 6         | 52                 | 43            | 0                                 |
| Mali                 | 46               | 83            | 31                   | 33                        | 37               | 87           | 87            | 90             | 69           | 88             | 50                   | 41           | 46                        | 39                               | 7         | 17               | 45                        | 19  | 51        | 21                 | 43            | 15                                |
| Côte d'Ivoire        | 46               | 82            | 33                   | 17                        | 42               | 91           | 94            | 78             | 69           | 80             | 0                    | 38           | 53                        | 36                               | 18        | 7                | 78                        | 0   | 43        | 12                 | 0             | 0                                 |
| Colombia             | 46               | 57            | 44                   | 28                        | 32               | 31           | 94            | 38             | 57           | 44             | 50                   | 56           | 73                        | 43                               | 5         | 22               | 85                        | 0   | 40        | 41                 | 0             | 15                                |
| Liberia              | 46               | 79            | 35                   | 32                        | 76               | 82           | 75            | 65             | 75           | 86             | 50                   | 34           | 47                        | 27                               | 16        | 45               | 71                        | 62  | 27        | 15                 | 43            | 56                                |
| Israel               | 46               | 47            | 50                   | 23                        | 24               | 43           | 62            | 29             | 53           | 50             | 0                    | 46           | 64                        | 70                               | 27        | 24               | 78                        | 14  | 40        | 35                 | 0             | 0                                 |
| Mexico               | 46               | 62            | 36                   | 52                        | 65               | 65           | 87            | 45             | 44           | 56             | 0                    | 43           | 49                        | 27                               | 11        | 19               | 80                        | 86  | 29        | 65                 | 100           | 29                                |
| Mongolia             | 46               | 64            | 39                   | 33                        | 85               | 75           | 37            | 54             | 69           | 69             | 50                   | 66           | 53                        | 39                               | 45        | 7                | 0                         | 0   | 47        | 38                 | 43            | 0                                 |
| Bhutan               | 46               | 56            | 41                   | 47                        | 73               | 46           | 49            | 19             | 82           | 66             | 0                    | 70           | 70                        | 31                               | 16        | 10               | 71                        | 0   | 62        | 43                 | 43            | 29                                |
| Madagascar           | 46               | 69            | 33                   | 53                        | 48               | 56           | 87            | 63             | 75           | 62             | 0                    | 60           | 50                        | 15                               | 11        | 16               | 71                        | 62  | 45        | 52                 | 43            | 71                                |
| North Macedonia      | 45               | 55            | 42                   | 34                        | 46               | 35           | 63            | 53             | 69           | 50             | 0                    | 58           | 44                        | 21                               | 18        | 94               | 78                        | 0   | 73        | 36                 | 0             | 0                                 |
| Burkina Faso         | 45               | 60            | 38                   | 58                        | 75               | 38           | 69            | 57             | 75           | 49             | 0                    | 45           | 54                        | 50                               | 18        | 17               | 71                        | 19  | 46        | 37                 | 43            | 100                               |
| Bangladesh           | 45               | 76            | 33                   | 28                        | 43               | 73           | 75            | 83             | 69           | 80             | 50                   | 44           | 49                        | 36                               | 16        | 19               | 71                        | 0   | 49        | 30                 | 0             | 15                                |
| Laos                 | 45               | 61            | 39                   | 49                        | 73               | 43           | 75            | 52             | 57           | 50             | 100                  | 52           | 69                        | 21                               | 16        | 19               | 71                        | 62  | 41        | 26                 | 100           | 44                                |
| Türkiye              | 45               | 53            | 44                   | 33                        | 45               | 33           | 75            | 50             | 53           | 47             | 0                    | 54           | 50                        | 45                               | 21        | 53               | 71                        | 14  | 40        | 32                 | 43            | 15                                |
| Sri Lanka            | 45               | 66            | 36                   | 45                        | 46               | 47           | 87            | 57             | 69           | 56             | 100                  | 42           | 50                        | 47                               | 14        | 17               | 71                        | 62  | 58        | 6                  | 100           | 29                                |
| Nepal                | 44               | 64            | 35                   | 31                        | 22               | 54           | 75            | 53             | 82           | 76             | 0                    | 52           | 51                        | 20                               | 18        | 19               | 71                        | 62  | 60        | 26                 | 0             | 15                                |
| Qatar                | 44               | 56            | 44                   | 17                        | 42               | 79           | 50            | 60             | 13           | 75             | 0                    | 45           | 61                        | 56                               | 11        | 36               | 78                        | 14  | 34        | 24                 | 0             | 0                                 |
| Eswatini             | 43               | 65            | 37                   | 32                        | 69               | 66           | 87            | 41             | 32           | 82             | 0                    | 53           | 47                        | 28                               | 21        | 24               | 71                        | 47  | 23        | 35                 | 43            | 29                                |
| Zambia               | 43               | 46            | 43                   | 45                        | 56               | 18           | 38            | 41             | 75           | 20             | 100                  | 69           | 58                        | 35                               | 21        | 17               | 71                        | 62  | 41        | 44                 | 43            | 56                                |
| Oman                 | 42               | 51            | 41                   | 27                        | 39               | 30           | 56            | 46             | 69           | 32             | 50                   | 51           | 68                        | 46                               | 18        | 16               | 71                        | 0   | 56        | 16                 | 0             | 15                                |
| Montenegro           | 42               | 77            | 28                   | 25                        | 33               | 79           | 100           | 52             | 75           | 93             | 0                    | 28           | 36                        | 35                               | 7         | 19               | 85                        | 0   | 69        | 6                  | 0             | 0                                 |
| Brunei               | 41               | 52            | 47                   | 11                        | 17               | 58           | 41            | 57             | 63           | 0              | 75                   | 79           | 42                        | 24                               | 10        | 71               | 0                         | 23  | 0         | 0                  | 0             | 15                                |
| Azerbaijan           | 41               | 42            | 46                   | 20                        | 20               | 36           | 75            | 56             | 0            | 52             | 0                    | 53           | 57                        | 72                               | 38        | 24               | 37                        | 0   | 31        | 38                 | 0             | 0                                 |
| Belize               | 40               | 71            | 29                   | 27                        | 19               | 69           | 100           | 73             | 56           | 67             | 50                   | 55           | 40                        | 30                               | 0         | 20               | 71                        | 14  | 53        | 23                 | 0             | 15                                |
| El Salvador          | 40               | 52            | 36                   | 35                        | 23               | 75           | 49            | 31             | 32           | 69             | 0                    | 55           | 42                        | 49                               | 16        | 30               | 15                        | 0   | 27        | 56                 | 43            | 15                                |
| Croatia              | 40               | 62            | 31                   | 33                        | 88               | 43           | 69            | 57             | 63           | 44             | 0                    | 30           | 37                        | 30                               | 9         | 33               | 71                        | 76  | 40        | 27                 | 0             | 56                                |
| Nicaragua            | 39               | 63            | 34                   | 21                        | 36               | 82           | 75            | 42             | 32           | 80             | 50                   | 39           | 43                        | 34                               | 27        | 16               | 78                        | 0   | 29        | 27                 | 0             | 15                                |
| Sudan                | 39               | 67            | 33                   | 29                        | 79               | 58           | 62            | 57             | 75           | 52             | 100                  | 41           | 59                        | 34                               | 18        | 27               | 33                        | 0   | 25        | 6                  | 43            | 56                                |
| Cambodia             | 39               | 66            | 30                   | 27                        | 82               | 47           | 82            | 63             | 57           | 42             | 100                  | 47           | 43                        | 26                               | 18        | 16               | 0                         | 62  | 43        | 9                  | 43            | 15                                |
| Uruguay              | 39               | 63            | 31                   | 19                        | 25               | 60           | 100           | 68             | 32           | 61             | 0                    | 44           | 39                        | 45                               | 16        | 13               | 71                        | 0   | 29        | 36                 | 0             | 0                                 |
| Viet Nam             | 38               | 34            | 47                   | 22                        | 33               | 30           | 37            | 0              | 53           | 24             | 100                  | 99           | 52                        | 79                               | 6         | 10               | 71                        | 0   | 19        | 19                 | 43            | 15                                |
| Syria                | 38               | 73            | 26                   | 29                        | 70               | 69           | 100           | 73             | 54           | 61             | 50                   | 32           | 38                        | 32                               | 16        | 13               | 71                        | 0   | 22        | 27                 | 43            | 29                                |
| Senegal              | 37               | 72            | 27                   | 22                        | 64               | 68           | 87            | 37             | 57           | 92             | 50                   | 44           | 52                        | 11                               | 9         | 19               | 71                        | 0   | 36        | 6                  | 0             | 29                                |
| Romania              | 37               | 37            | 43                   | 18                        | 20               | 38           | 69            | 34             | 0            | 42             | 0                    | 47           | 63                        | 11                               | 69        | 16               | 71                        | 14  | 17        | 49                 | 0             | 0                                 |
| Tajikistan           | 37               | 73            | 23                   | 24                        | 50               | 69           | 100           | 73             | 57           | 61             | 50                   | 37           | 27                        | 22                               | 18        | 22               | 71                        | 0   | 27        | 40                 | 0             | 15                                |
| Kuwait               | 37               | 56            | 34                   | 38                        | 64               | 46           | 49            | 42             | 54           | 73             | 50                   | 21           | 25                        | 45                               | 71        | 42               | 0                         | 0   | 11        | 13                 | 43            | 100                               |
| Poland               | 37               | 45            | 33                   | 39                        | 69               | 21           | 38            | 46             | 87           | 25             | 0                    | 46           | 45                        | 36                               | 14        | 14               | 71                        | 14  | 78        | 6                  | 43            | 15                                |
| Kyrgyzstan           | 36               | 51            | 30                   | 30                        | 14               | 51           | 50            | 54             | 69           | 48             | 0                    | 62           | 49                        | 24                               | 9         | 16               | 37                        | 0   | 62        | 35                 | 0             | 0                                 |
| Fiji                 | 36               | 69            | 23                   | 31                        | 73               | 57           | 87            | 35             | 57           | 82             | 50                   | 46           | 41                        | 16                               | 14        | 13               | 0                         | 0   | 34        | 35                 | 43            | 15                                |
| Costa Rica           | 35               | 58            | 31                   | 11                        | 15               | 65           | 87            | 45             | 44           | 56             | 0                    | 41           | 29                        | 41                               | 16        | 42               | 71                        | 0   | 31        | 6                  | 0             | 0                                 |
| Guinea               | 35               | 52            | 32                   | 19                        | 14               | 65           | 75            | 45             | 41           | 56             | 0                    | 36           | 40                        | 39                               | 18        | 20               | 78                        | 0   | 20        | 47                 | 0             | 0                                 |
| United Arab Emirates | 35               | 68            | 20                   | 34                        | 41               | 72           | 75            | 64             | 69           | 76             | 0                    | 22           | 21                        | 36                               | 7         | 16               | 71                        | 0   | 60        | 12                 | 43            | 15                                |
| Bahrain              | 35               | 59            | 27                   | 33                        | 61               | 58           | 62            | 57             | 63           | 52             | 50                   | 15           | 28                        | 18                               | 14        | 68               | 78                        | 62  | 31        | 15                 | 43            | 56                                |

(Figure 1 continues on next page)

|                          | Policy design    |               |                      |                           |                  |              |               |                |              |                | Implementation tools |              |                           |                                  |           |                  |                      | Monitoring and evaluation                   |           |                    |               |                                   |
|--------------------------|------------------|---------------|----------------------|---------------------------|------------------|--------------|---------------|----------------|--------------|----------------|----------------------|--------------|---------------------------|----------------------------------|-----------|------------------|----------------------|---|-----------|--------------------|---------------|-----------------------------------|
|                          | Governance score | Policy design | Implementation tools | Monitoring and evaluation | Strategic vision | Coordination | Participation | Accountability | Transparency | Sustainability | Equity               | Surveillance | Antimicrobial stewardship | Infection prevention and control | Education | Public awareness | Medicines regulation | Research and development for novel products | Reporting | Feedback mechanism | Effectiveness | Antimicrobial resistance research |
| Benin                    | 35               | 56            | 25                   | 49                        | 68               | 40           | 56            | 52             | 75           | 39             | 50                   | 26           | 25                        | 12                               | 21        | 16               | 71                   | 81  | 39        | 15                 | 43            | 100                               |
| Gabon                    | 34               | 57            | 23                   | 46                        | 78               | 58           | 50            | 57             | 54           | 49             | 50                   | 28           | 49                        | 14                               | 11        | 29               | 0                    | 0   | 23        | 83                 | 0             | 71                                |
| Lebanon                  | 34               | 46            | 30                   | 36                        | 75               | 21           | 50            | 46             | 63           | 25             | 0                    | 45           | 53                        | 24                               | 14        | 16               | 71                   | 0   | 27        | 60                 | 43            | 15                                |
| Tunisia                  | 34               | 50            | 28                   | 35                        | 55               | 36           | 49            | 41             | 69           | 40             | 0                    | 36           | 34                        | 46                               | 7         | 6                | 71                   | 14  | 41        | 39                 | 43            | 15                                |
| Trinidad and Tobago      | 33               | 59            | 26                   | 13                        | 10               | 86           | 75            | 71             | 13           | 85             | 0                    | 27           | 35                        | 38                               | 18        | 14               | 71                   | 0   | 27        | 18                 | 0             | 0                                 |
| Eritrea                  | 33               | 60            | 23                   | 36                        | 71               | 52           | 75            | 34             | 50           | 57             | 50                   | 28           | 25                        | 27                               | 7         | 48               | 37                   | 24  | 22        | 18                 | 43            | 71                                |
| Moldova                  | 32               | 46            | 31                   | 12                        | 15               | 47           | 75            | 34             | 32           | 56             | 0                    | 33           | 44                        | 30                               | 21        | 33               | 71                   | 0   | 20        | 22                 | 0             | 0                                 |
| South Africa             | 32               | 37            | 31                   | 31                        | 22               | 32           | 25            | 46             | 69           | 8              | 50                   | 55           | 37                        | 43                               | 16        | 6                | 71                   | 0   | 62        | 23                 | 0             | 15                                |
| Armenia                  | 32               | 61            | 22                   | 34                        | 62               | 55           | 69            | 54             | 44           | 66             | 100                  | 20           | 35                        | 17                               | 7         | 19               | 37                   | 86  | 4         | 3                  | 100           | 59                                |
| Pakistan                 | 31               | 56            | 19                   | 40                        | 79               | 54           | 49            | 52             | 69           | 40             | 0                    | 38           | 31                        | 20                               | 7         | 4                | 37                   | 0   | 62        | 29                 | 43            | 15                                |
| Ukraine                  | 31               | 48            | 28                   | 14                        | 27               | 54           | 49            | 52             | 44           | 40             | 0                    | 42           | 49                        | 25                               | 14        | 7                | 71                   | 0   | 11        | 41                 | 0             | 0                                 |
| DR Congo                 | 31               | 76            | 17                   | 5                         | 42               | 77           | 87            | 65             | 53           | 88             | 100                  | 19           | 23                        | 17                               | 21        | 10               | 0                    | 43  | 11        | 6                  | 0             | 0                                 |
| Luxembourg               | 30               | 51            | 22                   | 29                        | 18               | 67           | 38            | 56             | 57           | 46             | 50                   | 40           | 22                        | 18                               | 12        | 30               | 71                   | 0   | 38        | 23                 | 43            | 15                                |
| Egypt                    | 30               | 56            | 19                   | 37                        | 68               | 40           | 56            | 52             | 87           | 39             | 0                    | 22           | 25                        | 29                               | 14        | 16               | 0                    | 14  | 47        | 9                  | 43            | 56                                |
| Cabo Verde               | 30               | 63            | 19                   | 33                        | 66               | 85           | 49            | 55             | 41           | 73             | 50                   | 26           | 22                        | 18                               | 14        | 42               | 0                    | 0   | 19        | 12                 | 43            | 71                                |
| Honduras                 | 30               | 29            | 37                   | 10                        | 27               | 25           | 51            | 29             | 0            | 24             | 0                    | 58           | 71                        | 32                               | 9         | 26               | 0                    | 0   | 27        | 6                  | 0             | 0                                 |
| Papua New Guinea         | 30               | 65            | 15                   | 42                        | 76               | 50           | 62            | 47             | 63           | 78             | 50                   | 29           | 22                        | 9                                | 7         | 10               | 71                   | 0   | 11        | 36                 | 100           | 56                                |
| Sierra Leone             | 28               | 74            | 12                   | 13                        | 56               | 70           | 94            | 75             | 44           | 73             | 50                   | 14           | 14                        | 15                               | 14        | 17               | 37                   | 0   | 5         | 3                  | 43            | 15                                |
| Mauritius                | 28               | 34            | 31                   | 21                        | 78               | 14           | 25            | 35             | 57           | 8              | 0                    | 45           | 38                        | 32                               | 14        | 10               | 85                   | 0   | 40        | 6                  | 43            | 0                                 |
| Mozambique               | 28               | 71            | 10                   | 32                        | 48               | 50           | 100           | 86             | 57           | 61             | 100                  | 21           | 10                        | 6                                | 0         | 20               | 71                   | 0   | 31        | 6                  | 100           | 15                                |
| Burundi                  | 28               | 50            | 20                   | 14                        | 33               | 47           | 64            | 68             | 44           | 29             | 0                    | 35           | 31                        | 15                               | 11        | 16               | 71                   | 0   | 43        | 0                  | 0             | 0                                 |
| Kazakhstan               | 28               | 34            | 30                   | 15                        | 23               | 55           | 31            | 30             | 0            | 53             | 0                    | 46           | 53                        | 31                               | 5         | 13               | 71                   | 0   | 13        | 41                 | 0             | 0                                 |
| Panama                   | 28               | 34            | 32                   | 8                         | 5                | 38           | 69            | 34             | 0            | 42             | 0                    | 41           | 49                        | 46                               | 9         | 6                | 52                   | 0   | 23        | 3                  | 0             | 0                                 |
| Cameroon                 | 27               | 57            | 14                   | 41                        | 66               | 38           | 56            | 56             | 75           | 35             | 100                  | 17           | 21                        | 7                                | 7         | 11               | 71                   | 14  | 34        | 20                 | 43            | 71                                |
| Namibia                  | 27               | 45            | 20                   | 35                        | 42               | 40           | 50            | 34             | 57           | 19             | 100                  | 23           | 26                        | 25                               | 18        | 11               | 71                   | 0   | 32        | 17                 | 100           | 15                                |
| Togo                     | 26               | 30            | 29                   | 30                        | 76               | 4            | 25            | 34             | 44           | 5              | 50                   | 36           | 68                        | 26                               | 5         | 13               | 0                    | 19  | 13        | 6                  | 100           | 29                                |
| Maldives                 | 25               | 54            | 15                   | 19                        | 55               | 34           | 69            | 52             | 57           | 37             | 50                   | 19           | 17                        | 14                               | 7         | 22               | 37                   | 62  | 32        | 3                  | 0             | 29                                |
| Barbados                 | 24               | 39            | 25                   | 6                         | 47               | 39           | 58            | 0              | 32           | 34             | 50                   | 36           | 13                        | 33                               | 24        | 18               | 37                   | 86  | 0         | 10                 | 0             | 15                                |
| Yemen                    | 24               | 46            | 15                   | 48                        | 61               | 16           | 43            | 85             | 54           | 30             | 50                   | 22           | 18                        | 11                               | 9         | 9                | 0                    | 81  | 18        | 39                 | 43            | 100                               |
| San Marino               | 23               | 22            | 31                   | 8                         | 7                | 15           | 51            | 27             | 0            | 21             | 0                    | 34           | 43                        | 40                               | 12        | 17               | 78                   | 0   | 14        | 13                 | 0             | 0                                 |
| Afghanistan              | 22               | 58            | 9                    | 26                        | 25               | 33           | 75            | 50             | 75           | 54             | 50                   | 16           | 9                         | 2                                | 9         | 7                | 37                   | 62  | 18        | 6                  | 43            | 56                                |
| Tonga                    | 22               | 57            | 8                    | 29                        | 59               | 57           | 76            | 46             | 32           | 55             | 50                   | 18           | 3                         | 6                                | 0         | 22               | 71                   | 0   | 5         | 12                 | 100           | 29                                |
| Uzbekistan               | 21               | 26            | 25                   | 12                        | 17               | 25           | 37            | 39             | 0            | 37             | 0                    | 26           | 26                        | 42                               | 23        | 24               | 37                   | 0   | 8         | 36                 | 0             | 0                                 |
| Dominican Republic       | 21               | 41            | 19                   | 13                        | 49               | 38           | 82            | 34             | 0            | 42             | 0                    | 21           | 31                        | 18                               | 14        | 6                | 71                   | 24  | 16        | 3                  | 43            | 0                                 |
| Bulgaria                 | 21               | 26            | 27                   | 4                         | 5                | 21           | 38            | 23             | 44           | 19             | 0                    | 38           | 38                        | 19                               | 9         | 20               | 71                   | 14  | 14        | 0                  | 0             | 0                                 |
| Equatorial Guinea        | 21               | 36            | 16                   | 15                        | 12               | 32           | 76            | 39             | 0            | 34             | 0                    | 41           | 27                        | 6                                | 2         | 17               | 37                   | 0   | 22        | 29                 | 0             | 0                                 |
| Micronesia               | 20               | 47            | 13                   | 25                        | 60               | 25           | 100           | 0              | 32           | 53             | 50                   | 22           | 8                         | 18                               | 35        | 7                | 0                    | 0   | 0         | 19                 | 100           | 15                                |
| Turkmenistan             | 19               | 37            | 17                   | 17                        | 44               | 32           | 36            | 35             | 32           | 35             | 50                   | 23           | 26                        | 6                                | 21        | 27               | 37                   | 0   | 14        | 6                  | 43            | 15                                |
| Saint Lucia              | 19               | 25            | 21                   | 10                        | 12               | 25           | 51            | 29             | 0            | 24             | 0                    | 23           | 11                        | 5                                | 62        | 23               | 37                   | 0   | 20        | 13                 | 0             | 0                                 |
| Chad                     | 18               | 39            | 15                   | 8                         | 5                | 34           | 57            | 52             | 44           | 37             | 0                    | 27           | 27                        | 11                               | 0         | 11               | 71                   | 0   | 25        | 3                  | 0             | 0                                 |
| Albania                  | 17               | 27            | 21                   | 16                        | 25               | 7            | 38            | 16             | 44           | 10             | 100                  | 34           | 43                        | 32                               | 9         | 6                | 0                    | 0   | 20        | 6                  | 0             | 29                                |
| Mauritania               | 16               | 26            | 17                   | 10                        | 20               | 41           | 18            | 46             | 13           | 22             | 0                    | 24           | 27                        | 21                               | 0         | 4                | 80                   | 0   | 31        | 3                  | 0             | 0                                 |
| Lesotho                  | 15               | 33            | 12                   | 10                        | 8                | 40           | 44            | 52             | 25           | 32             | 0                    | 28           | 25                        | 1                                | 9         | 16               | 0                    | 0   | 31        | 3                  | 0             | 0                                 |
| Botswana                 | 12               | 13            | 19                   | 5                         | 15               | 13           | 18            | 11             | 0            | 18             | 0                    | 21           | 27                        | 25                               | 7         | 19               | 71                   | 0   | 14        | 3                  | 0             | 0                                 |
| Somalia                  | 11               | 35            | 5                    | 22                        | 72               | 14           | 25            | 35             | 57           | 8              | 50                   | 13           | 5                         | 6                                | 7         | 14               | 0                    | 0   | 22        | 0                  | 43            | 29                                |
| Niger                    | 10               | 35            | 6                    | 0                         | 10               | 36           | 69            | 38             | 0            | 39             | 0                    | 0            | 8                         | 2                                | 18        | 19               | 0                    | 0   | 0         | 3                  | 0             | 0                                 |
| Libya                    | 10               | 40            | 0                    | 17                        | 76               | 22           | 25            | 45             | 63           | 12             | 50                   | 2            | 0                         | 1                                | 2         | 7                | 33                   | 0   | 20        | 0                  | 43            | 15                                |
| Central African Republic | 7                | 3             | 13                   | 4                         | 14               | 0            | 0             | 5              | 0            | 0              | 0                    | 10           | 24                        | 28                               | 2         | 13               | 37                   | 0   | 14        | 0                  | 0             | 0                                 |
| South Sudan              | 5                | 17            | 4                    | 8                         | 0                | 18           | 25            | 41             | 13           | 14             | 0                    | 11           | 11                        | 5                                | 11        | 0                | 0                    | 0   | 27        | 0                  | 0             | 0                                 |
| Seychelles               | 1                | 0             | 8                    | 4                         | 1                | 0            | 0             | 5              | 0            | 0              | 0                    | 14           | 5                         | 13                               | 11        | 17               | 0                    | 0   | 13        | 0                  | 0             | 0                                 |
| Djibouti                 | 0                | 7             | 1                    | 6                         | 10               | 0            | 0             | 29             | 13           | 0              | 0                    | 8            | 0                         | 0                                | 9         | 0                | 37                   | 0   | 22        | 0                  | 0             | 0                                 |

Figure 1: Ranked heatmap of antimicrobial resistance governance scores 2021–22, by governance area and domain for 161 countries and territories



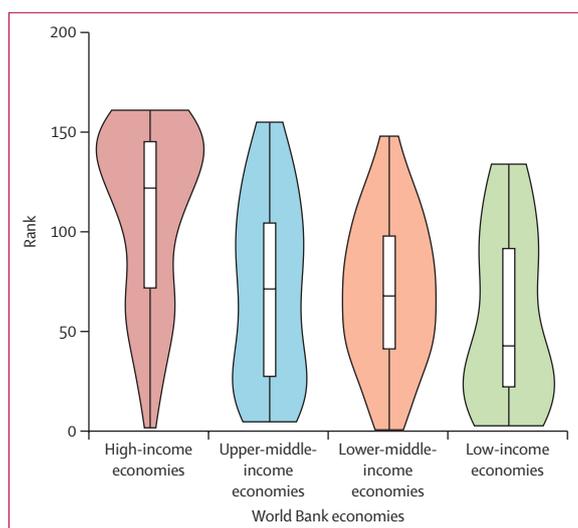
**Figure 2: Global distribution of overall scores, 2021-22**  
Locations excluded from this analysis are in grey.

Checking mortality showed a similar pattern: all three domains belonged to the implementation tools governance area, which was most strongly correlated with antimicrobial resistance burden ( $r=-0.551$ , unadjusted  $p<0.001$ , Bonferroni-adjusted  $p<0.001$ ). The monitoring and evaluation ( $r=-0.257$ , unadjusted  $p=0.001$ , Bonferroni-adjusted  $p=0.075$ ) and policy design ( $r=-0.214$ , unadjusted  $p=0.007$ , Bonferroni-adjusted  $p=0.495$ ) areas again showed weaker correlations that were significant by unadjusted  $p$  values but not after Bonferroni correction.

Among the monitoring and evaluation domains, the heatmap showed mixed correlations, with two domains (reporting and feedback mechanisms) having significant negative correlations (based on both unadjusted and Bonferroni-adjusted  $p$  values), and two (antimicrobial resistance research and effectiveness) having insignificant positive correlations with the burden of infection. Six of seven implementation tool domains showed significant

negative correlations, suggesting that better governance is associated with lower antimicrobial resistance. The seventh domain of the implementation tool governance area (fostering research and development and facilitating market access to novel products) had a negative correlation with the burden of infection that was insignificant in terms of both unadjusted and Bonferroni-adjusted  $p$  values. Analysis of the policy design domains revealed that six of seven domains had weakly negative correlations, with three being significant in terms of unadjusted  $p$  values, but none being significant in terms of Bonferroni-adjusted  $p$  values. The seventh domain (equity) had the strongest positive correlation among all domains, which was significant in terms of unadjusted  $p$  value but insignificant in terms of Bonferroni-adjusted  $p$  value.

The indicator (see appendix pp 6-9 for indicator descriptions) with the strongest significant correlation with antimicrobial resistance-associated DALYs in 2021



**Figure 3:** Violin plot illustrating the distribution of ranks for 161 countries and territories, grouped by World Bank economic region

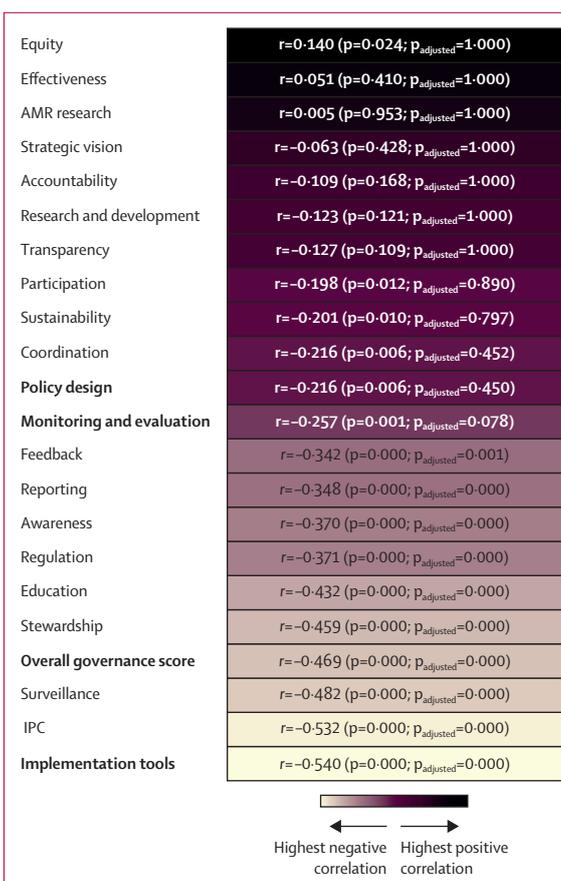
World Bank 2022 economic classifications<sup>25</sup> as a function of gross national income per capita: high-income economies ( $\geq$ US\$13 846), upper-middle-income economies (\$4466–13 845), lower-middle-income economies (\$1136–4465), and low-income economies ( $\leq$ \$1135).

was IT 3.2 (cross-sectoral national infection prevention and control guidelines;  $r=-0.547$ , unadjusted  $p<0.001$ , Bonferroni-adjusted  $p<0.001$ ), followed by indicator IT 3.1 (cross-sectoral infection prevention and control policies;  $r=-0.517$ , unadjusted  $p<0.001$ , Bonferroni-adjusted  $p<0.001$ ) and indicator IT 1.2 (surveillance systems for antibiotic use in humans and animals;  $r=-0.482$ , unadjusted  $p<0.001$ , Bonferroni-adjusted  $p<0.001$ ; appendix pp 91–141). Indicator IT 3.3 (immunisation programmes used to prevent infections) showed a positive but weak correlation with antimicrobial resistance-associated DALYs in 2021 ( $r=0.222$ , unadjusted  $p=0.005$ , Bonferroni-adjusted  $p=0.348$ ), which was significant based on the unadjusted  $p$  value and insignificant after Bonferroni adjustment. A similar pattern was observed for mortality correlations (appendix pp 118–141).

On assessment of correlations stratified by WHO region, we found that the overall governance score was only significantly correlated with a lower burden of antimicrobial resistance in the European region, in terms of both unadjusted and Bonferroni-adjusted  $p$  values (table). Europe was the only region with significant correlations across several domains and with significance maintained after Bonferroni correction, showing the strongest correlations for reporting, surveillance, infection prevention and control, and stewardship. Infection prevention and control is the only domain that showed significant correlations in other regions.

## Discussion

This analysis found that global policy responses to antimicrobial resistance varied substantially in 2021–22



**Figure 4:** Correlation between country scores and the DALYs rate of drug-resistant infections associated with antimicrobial resistance

The values in parenthesis represent raw and Bonferroni-adjusted  $p$  values. AMR=antimicrobial resistance. DALY=disability-adjusted life year. IPC=infection prevention and control.

and were associated with the economic classification of the nation. The study showed that the governance area of implementation tools was most significantly correlated with the burden of drug-resistant infections. Countries with higher scores in the domains pertaining to infection prevention and control measures, surveillance, antimicrobial stewardship, and education were associated with a lower burden of antimicrobial resistance. This study advances on the former 2020–21 analysis<sup>7</sup> in several key areas. First, the scope of the study has been expanded, including 47 additional countries, and with content analysis of 20 new and nine updated NAPs on antimicrobial resistance (Cameroon, China, Ethiopia, Fiji, Indonesia, Mongolia, South Korea, Spain, and Tanzania). The capacity for the research team to translate native-language NAPs into English had greatly improved, with a broader array of tools and methods used, which meant that countries were excluded from the analysis only when a NAP (of any language) was not retrievable from any of the ten online public repositories, or if the nation did not submit data to the Global Database for

|                                     | Pearson's correlation coefficient | Unadjusted p value | Bonferroni-adjusted p value |
|-------------------------------------|-----------------------------------|--------------------|-----------------------------|
| <b>Eastern Mediterranean region</b> |                                   |                    |                             |
| Implementation tools                | -0.610                            | 0.003              | 0.252                       |
| Infection prevention and control    | -0.625                            | 0.002              | 0.184                       |
| <b>European region</b>              |                                   |                    |                             |
| Governance score                    | -0.604                            | 0.000              | <0.0001                     |
| Policy design                       | -0.417                            | 0.003              | 0.196                       |
| Transparency                        | -0.495                            | 0.000              | 0.019                       |
| Implementation tools                | -0.610                            | 0.000              | <0.0001                     |
| Surveillance                        | -0.571                            | 0.000              | 0.001                       |
| Antimicrobial stewardship           | -0.537                            | 0.000              | 0.004                       |
| Infection prevention and control    | -0.570                            | 0.000              | 0.001                       |
| Medicines regulation                | -0.512                            | 0.000              | 0.011                       |
| Reporting                           | -0.595                            | 0.000              | <0.0001                     |
| AMR research                        | -0.406                            | 0.003              | 0.262                       |
| <b>Region of the Americas</b>       |                                   |                    |                             |
| Implementation tools                | -0.621                            | 0.002              | 0.153                       |
| Infection prevention and control    | -0.617                            | 0.002              | 0.167                       |
| <b>Western Pacific region</b>       |                                   |                    |                             |
| Infection prevention and control    | -0.682                            | 0.003              | 0.191                       |

In the reporting, we only include the regions that have a strong negative correlation, irrespective of whether the correlation was statistically significant or not. All correlations, both significant and non-significant, are provided in the appendix (pp 94–141). AMR=antimicrobial resistance. DALY=disability-adjusted life-year.

**Table: Significant correlations of governance framework scores with the burden of antimicrobial resistance-associated DALYs in 2021, by WHO region**

TrACSS, administered by the Quadripartite. Second, the volume of input data sources informing the country scores has increased substantially, with a synthesis of 6325 new datapoints, representing a 40.2% increase on the former analysis. Third, the methods for statistical analysis have been adapted to better suit the dataset. We transitioned towards PCA as the preferred method for generating scores, which has allowed for increased interpretability of the results—for an increasingly large and multidimensional dataset—while minimising information loss. Fourth, the results from this analysis have been evaluated against the burden of drug-resistant infections to determine the relevance of the governance scores against a tangible proxy indicator for antimicrobial resistance. Finally, the sequential generation of a dataset for 2021–22, retaining the same framework for assessment, allowed for some comparison with the 2020–21 scores (with adjustments for novel statistical methods). Although, at present, the time periods do not represent suitably spaced intervals to allow for an assessment of progress, we anticipate that repeated analyses at appropriate intervals would facilitate the start

of a longitudinal process for assessing country progress. Repeated assessments could support the development of an accountability mechanism in global antimicrobial resistance control, which is otherwise severely lacking.

The results of our study show that higher governance scores on antimicrobial resistance were correlated with a lower burden of antimicrobial resistance. Governance scores were also lower in regions with conflict or political instability, such as parts of Africa and the Middle East. Regions with long-standing democratic traditions and more stable political environments, such as North America and Western Europe, scored more highly.

The distribution of scores highlighted a trend whereby economic strength appeared closely aligned with both income levels and regional affiliation, emphasising a global inequality in antimicrobial resistance scores based on economic development.

The findings should help to guide prioritisation when designing and implementing NAPs. Although most countries have comprehensive NAPs, very few countries have effectively implemented them. Stakeholders can be challenged by the task of choosing priority areas, which can result in inaction. Our results suggest that it might be worthwhile for countries to focus on the governance area of implementation tools (significantly correlated even after Bonferroni correction), particularly on establishing national guidelines and policies on infection prevention and control, surveillance systems for antimicrobial use, and antimicrobial stewardship programmes. Initially, we report the correlation by governance score. Stratification refers to reporting correlations grouped by 54 indicators, 18 domains, and within 3 governance areas. After stratification and Bonferroni correction, the only domain significantly correlated with a low antimicrobial resistance burden was infection prevention and control. This finding is corroborated by evidence from *The Lancet* Series on antimicrobial resistance, which found that infection prevention and control measures were among the most effective interventions, preventing 7.8% of all antimicrobial resistance-associated mortality in low-income and middle-income countries.<sup>6,26</sup> Infection prevention and control measures and antimicrobial stewardship programmes were among ten priority interventions of 52 antimicrobial resistance interventions identified through a cost-effectiveness exercise in an economic investment case for action against antimicrobial resistance.<sup>27</sup>

The stratified results showed that significant correlations were mostly identified for the European region. There was substantial variation in the quality and quantity of data used for burden estimates in each region, which could contribute to differences in the correlation analysis. The absence of significant correlations for the African region with any governance domain is consistent with the findings from a multivariate analysis that showed that antibiotic use and resistance do not correlate across all countries, but primarily in high-income countries.<sup>28</sup>

Infrastructure, including sanitation, and good governance were factors that were more strongly correlated with a lower burden of resistance in many low-income countries.<sup>28</sup> Future studies should identify other factors correlated with the burden of drug-resistant infections in low-resource settings to guide policy making. Improving the governance of antimicrobial resistance through NAPs requires countries to engage in situational analysis to evaluate current performance. We encourage national and sub-national policy makers, responsible for prioritising and leading antimicrobial resistance interventions, to develop an implementation plan around the WHO people-centred core package of interventions.<sup>29</sup> This framework assembles 13 interventions, designed with two foundational steps: governance, awareness, and education; and surveillance and research. These foundational elements facilitate sustainable implementation of interventions within four pillars, centred around prevention, access, diagnostics, and treatment. This framework has the strategic advantage of prioritising specific areas that would derive value in all locations.

The implementation of NAPs on antimicrobial resistance was central to the High-Level Meeting on Antimicrobial Resistance at the UN General Assembly in 2024.<sup>30</sup> Our findings are an important contribution to the discourse on how implementation can effectively and practically be supported following this milestone meeting. Our findings can further contribute to meeting the commitment on improving the monitoring and evaluation of the implementation of NAPs.<sup>30</sup>

There are limitations to this study. As we relied on secondary data sources, the limitations of the underlying datasets, including their quality and reliability, are carried forward into this study. Self-reported data, which formulate a large part of the input data, is prone to overestimation of strengths and under-reporting of weaknesses. Furthermore, countries and territories reporting data with the highest standards of accuracy and honesty might be misrepresented (presumably minimised) in the country ranking. Despite these challenges, the data sources used represent a comprehensive collection of information that enhances the quality of our results. Our efforts to use a broader array of data to inform country scores reflect our aim to avoid over-reliance on a single data source, which might reflect an inaccurate characterisation. We discourage overinterpretation of the correlations between the governance scores and the antimicrobial resistance burden metrics as we recognise that the factors underpinning the burden of drug-resistant infections are multifactorial and time lags must be accounted for in the implementation of activities within the NAP. Furthermore, any causative interpretation between the variables should be avoided. This analysis has been prepared for cross-country and cross-regional comparative purposes, to enable countries and territories of similar macro-economic contexts to identify collaborative opportunities for learning. The time period of this study (2020–22) coincided with the

COVID-19 pandemic. Although the shift of strategic focus towards COVID-19 might have thwarted progress on antimicrobial resistance agendas, some shared aspects of public health management strategies could have derived indirect benefits for antimicrobial resistance control. For example, improved public awareness around hand hygiene, physical distancing, and the uptake of mask wearing are likely to have incurred a broader effect on disease transmission beyond COVID-19 alone. These positive trends might have suggested effective policy implementations or favourable conditions that fostered growth during the period; however, the COVID-19 pandemic greatly limited progress, therefore this would not be a truly representative analysis of progress. It is unclear whether the net result of COVID-19 policies has been beneficial or disadvantageous to the progression of resistance. Given that COVID-19 policies could be leveraged for antimicrobial resistance control, we believe that this time period remains crucial to study.

We assumed that missing data were likely to represent the absence of a measure. This assumption might have led to an underestimation of scores. Future research efforts should aim to triangulate country data using multiple sources. It is anticipated that data of better quality for a larger subset of countries will be available for future study, following the political commitment by states at the High-Level Meeting on Antimicrobial Resistance to improve monitoring and evaluation for NAP implementation and to aim for 95% of country participation in TrACSS by 2030.<sup>30</sup>

Although the governance framework (developed through systematic methods and Delphi consensus) attempts to capture the most important features of antimicrobial resistance governance, it might not account for all potential factors relevant to national control. Future research should consider evaluating the completeness of the governance framework for monitoring the global response to antimicrobial resistance.

Our study indicates that strengthening the governance of NAPs on antimicrobial resistance will likely support the efforts to control antimicrobial resistance. The strengthening of implementation tools—namely, infection prevention and control, stewardship, and surveillance—were correlated with a reduced burden of drug-resistant infections. These results should support policy makers to select priority actions for their respective action plans and to close the implementation gaps between countries and regions.

#### Contributors

JP, AH, and SSM contributed to the study conceptualisation and design. JP, SR, and AH made substantial contributions towards the search strategy and data extraction. JP, SR, and AH accessed and verified all the data. JP and SSM drafted the manuscript that was subsequently reviewed and revised by all authors. JP, SSM, and AH drafted the appendix, which was reviewed by all authors. SSM created the figures for the manuscript and appendix, which were revised by JP and AH. All authors read and approved the final version of the manuscript. JP had the final responsibility for the decision to submit the manuscript for publication.

**Declaration of interests**

Outside the submitted work, JP provided unpaid advisory assistance to the UK Health Security Agency and the Public Health Agency of Canada on national action plans for antimicrobial resistance. All other authors declare no competing interests.

**Data sharing**

This study used findings from the Global Health Security Index, that are available from [ghsindex.org](https://ghsindex.org). The corresponding author can be contacted for assistance in acquiring data.

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