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 ($r=-0\cdot469$, $p<0\cdot001$) and death ($r=-0\cdot477$, $p<0\cdot001$). Infection prevention and control ($r=-0\cdot532$, Bonferroni-adjusted $p<0\cdot001$), surveillance ($r=-0\cdot482$, Bonferroni-adjusted $p<0\cdot001$), and stewardship ($r=-0\cdot459$, Bonferroni-adjusted $p<0\cdot001$) 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 santiation. 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.[1,2] 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.[3] 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.[4] Many countries have so far failed to transition from preparing detailed action plans to implementing them.[5] Many NAPs might require redesigning, moving from documents that are all-encompassing (but unlikely to be implemented) towards

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.[6] 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.[7] 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.[8] 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[9] (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,[10] European Centre for Disease Prevention and Control,[11] FDI World Dental Federation,[12] Food and Agriculture Organization of the UN,[13] Global Health Security Index,[14] Google, government websites, ReAct Action on Antibiotic Resistance,[15] WHO Library of AMR national action plans,[16] and WHO Tripartite Antimicrobial Resistance Country Self-Assessment Survey[17] (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,[8] 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,[17] Global Antimicrobial Resistance Research and Development Hub 2022,[18] Global Antimicrobial Resistance and Use Surveillance System 2022,[19] WHO 2018 South-East Asia Region Situational Analysis,[20] and WHO 2022 Immunization Dashboard[21]). 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.

See Online for appendix

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[7] 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,[7] 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.[22] 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.

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.[1] 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.[23] 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.[24] 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 22 057 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	87	100	85	70	92	54	56	98	100	93	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)

	Governance score	Policy design	Implementation tools	Monitoring and evaluation	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	58	41	57	63	0	75	79	42	24	10	71	0	23	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	21	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**

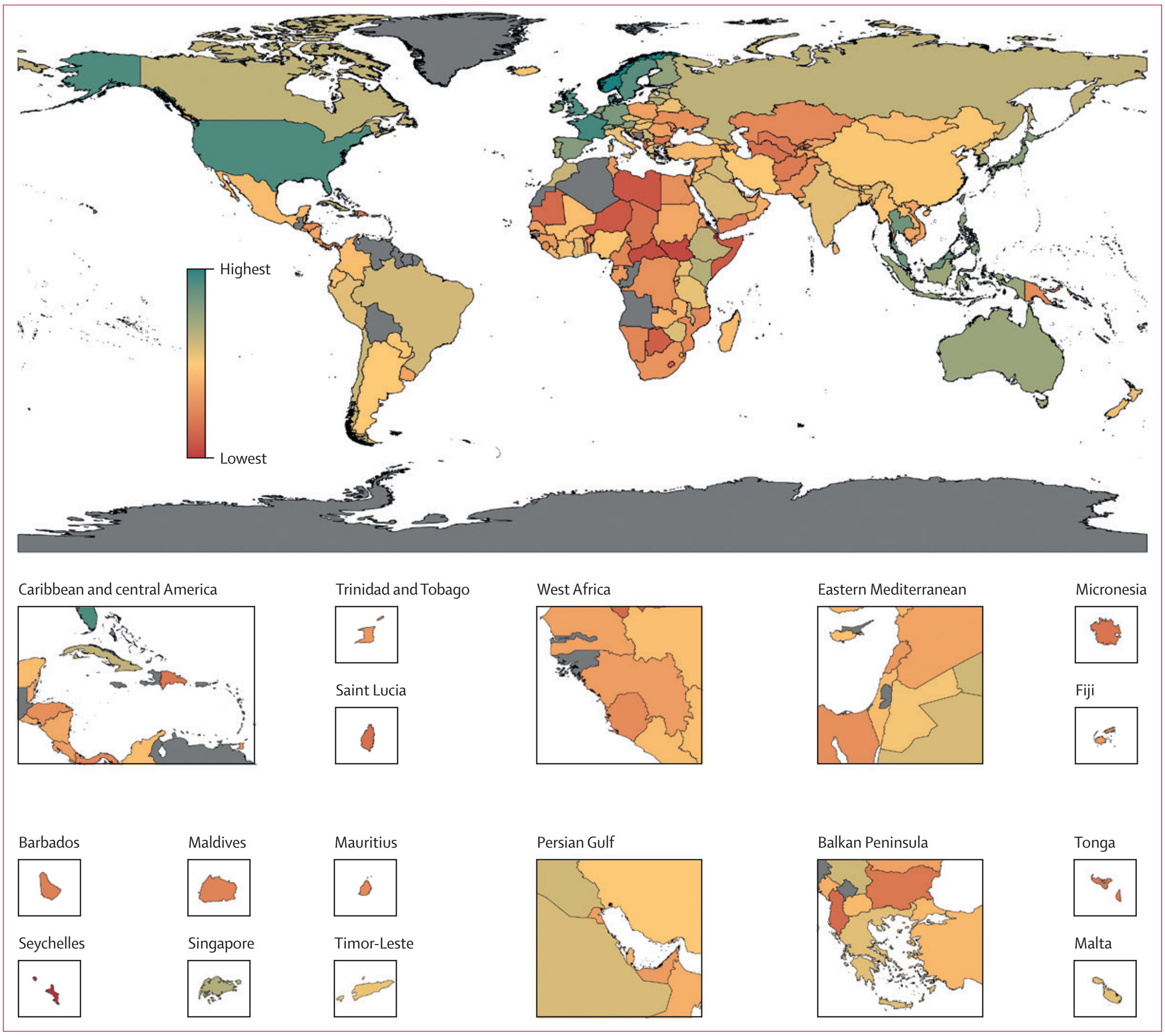

Figure 2: **Global distribution of overall scores, 2021–22**
Locations excluded from this analysis are in grey.

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

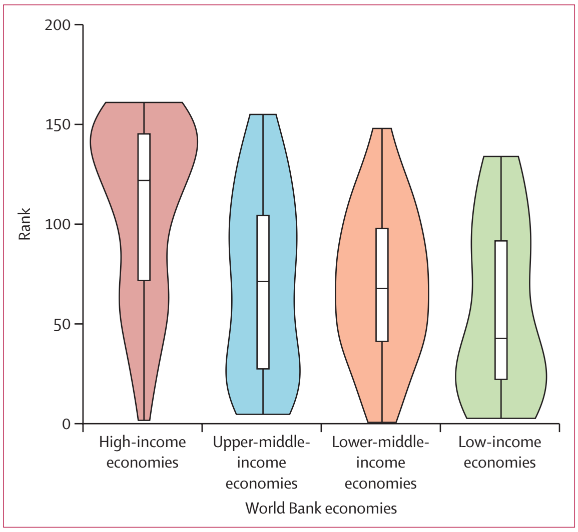

Figure 3: **Violin plot illustrating the distribution of ranks for 161 countries and territories, grouped by World Bank economic region**
World Bank 2022 economic classifications[25] as a function of gross national income per capita: high-income economies (≥US$13 846), upper-middle-income economies ($4466–13 845), lower-middle-income economies ($1136–4465), and low-income economies (≤$1135).

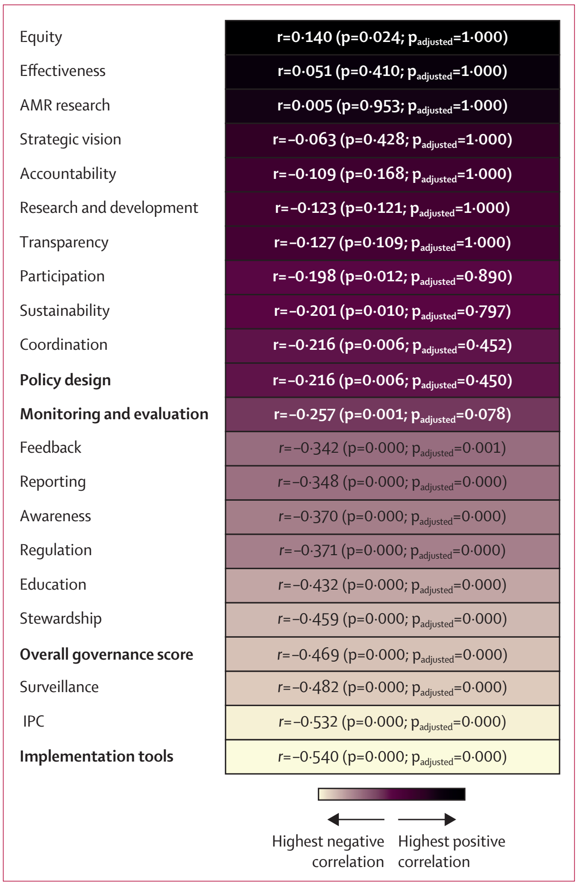

Figure 4: **Correlation between country scores and the DALYs rate of drug-resistant infections associated with antimicrobial resistance**
The values in parenthesis represent raw and Bonferroni-adjusted p values. AMR=antimicrobial resistance. DALY=disability-adjusted life year. IPC=infection prevention and control.

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 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[7] 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
Eastern Mediterranean region			
Implementation tools	−0·610	0·003	0·252
Infection prevention and control	−0·625	0·002	0·184
European region			
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
Region of the Americas			
Implementation tools	−0·621	0·002	0·153
Infection prevention and control	−0·617	0·002	0·167
Western Pacific region			
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.[6,26] 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.[27]

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.[28]

Infrastructure, including sanitation, and good governance were factors that were more strongly correlated with a lower burden of resistance in many low-income countries.[28] 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.[29] 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.[30] 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.[30]

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.[30]

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. The corresponding author can be contacted for assistance in acquiring data.

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