

# Surveillance of antimicrobial resistance in Europe, 2023 data

## Executive summary

### WHO European Region

This executive summary sets out results derived from 2023 antimicrobial resistance (AMR) data, sourced from invasive isolates reported to both the Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR) network and the European Antimicrobial Resistance Surveillance Network (EARS-Net). CAESAR received reports from 15 countries, while EARS-Net amassed data from 30 countries, encompassing the whole of the European Union/European Economic Area (EU/EEA). Although both EARS-Net and CAESAR use compatible methodologies for data gathering and analysis, the information originates from distinct surveillance systems in the various countries. Given that each national surveillance system is shaped by country-specific protocols and practices, it is important to exercise caution when comparing AMR patterns between them.

### Epidemiology

Of the 15 countries that submitted data to CAESAR, eight (53%) reported that their participating laboratories had an estimated population coverage of over two-thirds of the population, including three countries that reported having an estimated population coverage of 100%. However, six countries reported an estimated population coverage of less than half of their population and one did not report data on population coverage.

Of the 15 countries that reported data to CAESAR, one (7%) indicated that the reported data had a 'high' representativeness, in terms of three metrics: geographical representativeness, hospital representativeness and isolate representativeness. Nine countries stated that the representativeness was 'high' for two of the three metrics, one country reported the representativeness as 'high' for one of the three metrics, and four countries reported the representativeness as 'low' for all three metrics.

In hospitals served by laboratories reporting data to CAESAR in 2023, the blood culture rate was reported by 12 countries. Blood culture rates were found to be three times higher in countries with 'high' representativeness for the metrics listed above when compared to those with 'low' or 'medium' representativeness (13.0 versus 4.0 blood culture sets per 1 000 patient-days). One country reported 'high' representativeness across all three metrics, but no data on blood culture rate was available.

For 2023, all but three countries reported isolate data for all eight bacterial species. One country (Kazakhstan) reported isolate data for only *Escherichia coli*, *Klebsiella pneumoniae*, *Acinetobacter* spp. and *Staphylococcus aureus*, one country (Kyrgyzstan) reported isolate data for only *E. coli*, *K. pneumoniae*, *Pseudomonas aeruginosa*, *Acinetobacter* spp. and *S. aureus*, and one country (Turkmenistan) reported isolate data for only

*E. coli*, *K. pneumoniae*, *P. aeruginosa*, *S. aureus* and *Enterococcus faecalis*. According to the data submitted to CAESAR in 2023 by 15 countries, the majority of isolates (72%) were *E. coli* 50 313 (40%), *S. aureus* 21940 (17%) and *K. pneumoniae* 18731 (15%). This ranking was also observed in 2022.

All 15 countries that reported data in 2023 also did so in 2022. Among these 15 countries, the total number of laboratories reporting data increased from 353 in 2022 to 397 in 2023.

Among the 15 countries that provided data to CAESAR in both 2022 and 2023, the total number of reported invasive isolates increased by 10%, from 113 914 in 2022 to 125 841 in 2023. This overall tendency was not always observed at country level.

Looking at the 15 countries that provided data to CAESAR in 2022 and 2023, the largest increase in the total number of reported isolates were for *Streptococcus pneumoniae* (+21%), followed by *K. pneumoniae* (+17%), *E. faecalis* (+15%), and *S. aureus* (+10%). When comparing 2019 to 2023, according to the data provided to CAESAR in both years by 12 countries, the largest increase in the total number of reported isolates was for *Enterococcus faecium* (+59%), followed by *K. pneumoniae* (+57%), *E. faecalis* (+48%), and *S. aureus* (+34%).

The AMR situation in bacterial species reported to the AMR surveillance networks in 2023 varied widely depending on species, antimicrobial group and geographical region. Within the WHO European Region, pronounced disparities are evident, echoing trends highlighted in past reports. A notable resistance gradient emerges, with a clear pattern from north-to-south and west-to-east. The northern and western regions predominantly show lower resistance rates, while the eastern and southern regions tend to report higher ones. Across the Region, resistance to third-generation cephalosporins and carbapenems was generally higher in *K. pneumoniae* than *E. coli*. Though 36% of countries reported carbapenem resistance percentages of 25% or higher in *K. pneumoniae*, resistance in *P. aeruginosa* and *Acinetobacter* spp. were generally at a higher percentage.

In terms of bacterial species-specific results from 2023, a resistance percentage to fluoroquinolones in *E. coli* below 25% was observed in 18 (41%) of 44 countries that reported data on this microorganism-antimicrobial group combination. This percentage was generally lowest in the northern parts of the WHO European Region and highest in the south. A resistance percentage of 25% or above was reported in 23 (52%) countries. A resistance percentage of 50% or above was observed in six (14%) countries. For third-generation cephalosporin resistance in *E. coli*, eight (18%) of 44 countries reported percentages below 10%, whereas resistance percentages equal to or above 50% were observed in six countries (14%). For carbapenem resistance in *E. coli*, 10 (23%) of 44 countries reported percentages of 1% or above.

In 2023, percentages for third-generation cephalosporin resistance in *K. pneumoniae* below 10% were observed in seven (16%) of 44 countries in the Region reporting data on this microorganism-antimicrobial group combination, while 19 (43%), particularly in the southern and eastern parts of the Region, reported resistance percentages of 50% or above. This geographic trend has been consistent since 2019. For carbapenem resistance in *K. pneumoniae*, eight (18%) of 44 countries reported resistance percentages below 1%, whereas nine (20%) countries reported resistance percentages equal to or above 50%.

Large differences were observed in the percentages of carbapenem-resistant *P. aeruginosa* in the WHO European Region. In 2023, resistance percentages of below 5% were observed in two (5%) of the 43 countries reporting data on this microorganism-antimicrobial group combination, whereas seven (16%) countries reported percentages equal to or above 50%.

The percentages of carbapenem-resistant *Acinetobacter* spp. varied widely within the Region in 2023, from below 5% in 10 (24%) of the 42 countries that reported data on this microorganism-antimicrobial group combination, to equal to or above 50% in 18 (43%) countries, mostly in southern and eastern Europe.

In 2023, nine (20%) of 44 countries reporting data on *S. aureus* reported meticillin-resistant *S. aureus* (MRSA) percentages below 5%. MRSA percentages equal to or above 50% were reported in two (5%) of 44 countries.

The percentages of penicillin non-wild-type *S. pneumoniae* varied markedly across the Region. Of the 42 countries reporting data on this microorganism-antimicrobial group combination, three (7%) registered percentages below 5%, while eight (19%) recorded rates of 25% or higher.

Resistance to vancomycin in *E. faecium* varied substantially among countries in the Region. In 2023, resistance percentages of below 1% were reported by five (13%) of 40 countries providing data on this microorganism-antimicrobial group combination, while percentages equal to or above 50% were seen in five (13%) countries.

Country-specific information for each bacterial species, including information on patient age group and sex, are available on the WHO European Region website (1).

## Discussion

Although assessing the exact magnitude of AMR is challenging and the results should be interpreted with caution, the results from CAESAR and EARS-Net clearly show the presence of specific AMR patterns across clinical settings covered by these surveillance networks. High percentages of resistance to third-generation cephalosporins and carbapenems in *K. pneumoniae* and of carbapenem-resistant *Acinetobacter* spp. in several countries are of serious concern. They suggest the dissemination of resistant clones in healthcare settings

and indicate that many countries have serious limitations in treatment options for patients with infections caused by these pathogens.

While the west-to-east gradient in AMR percentages is evident for gram-negative bacteria (*E. coli*, *K. pneumoniae*, *P. aeruginosa* and *Acinetobacter* spp.), it is less obvious for gram-positive bacteria (*S. aureus*, *S. pneumoniae* and *E. faecium*). These findings underscore the imperative need to address AMR, not just within the WHO European Region, but globally, and fostering international cooperation is crucial in order to tackle this shared health challenge.

In 2023, there was an increase in the number of reported *S. pneumoniae* isolates compared to 2022. Similarly, an increase in the reported number of *S. pneumoniae* isolates was also observed from 2021 to 2022. This trend could be attributed to the increasing circulation of respiratory pathogens in communities following the lifting of lockdowns during the late stages of the COVID-19 pandemic.

Overall, more and more laboratories have been reporting data to the European surveillance networks since both networks were initiated, which is an encouraging step. Nevertheless, when looking at surveillance capacity in the WHO European Region, 38% (20/52) of countries still only collected AMR data at local level or without a standardised approach. This highlights the ongoing need to strive for enhanced standardisation of surveillance systems and networks as they continue to grow and mature (2).

Antimicrobial consumption patterns across the EU/EEA countries have shown considerable variations in adherence to WHO targets. During 2022, 17 of 28 (61%) EU/EEA countries reported data through the European Surveillance of Antimicrobial Consumption Network (ESAC-Net) for both the community and the hospital sector that met or exceeded the WHO country-level target of 60% of total antibacterial consumption coming from WHO's Access category, as defined in the Access, Watch, Reserve (AWaRe) classification list (3,4). In contrast, only four of 15 countries that reported 2022 consumption data to the WHO Regional Office for Europe Antimicrobial Medicines Consumption (AMC) Network achieved this target in 2022 (5).

While 85% (44/52) of countries in the WHO European Region reported having developed a National Action Plan (NAP) on AMR in 2024, only 29% (15/52) reported incorporating operational strategies and securing financial resources for implementation (2).

To address these challenges, the WHO Regional Office for Europe launched the Roadmap on Antimicrobial Resistance for the WHO European Region 2023–2030 (6), which replaces the European Strategic Action Plan on Antibiotic Resistance that concluded in 2020. The Roadmap aims to provide comprehensive guidance to countries, recognising that the primary obstacle is not planning, but the effective implementation of

AMR priorities. It is designed to support countries in translating their strategic ambitions into tangible actions—assessing national capacity, agreeing on priorities, setting clear targets, implementing priority interventions, and measuring progress. With a focus on reducing the burden of infectious diseases, controlling AMR levels, and ensuring the continued availability of effective treatments, the Roadmap serves as a high-level framework to guide targeted efforts. It emphasises the importance of evidence-based, adaptable interventions tailored to local contexts. For example, the Roadmap highlights leveraging digital innovations and addressing environmental and social determinants of AMR, reinforcing its holistic approach to combating this critical public health issue. By offering practical tools to identify impactful interventions, the Roadmap aims to enable countries to move beyond planning, make targeted investments and achieve meaningful progress in their efforts to address AMR.

### Public health implications

The 2024 update of the WHO Bacterial Priority Pathogens List emphasises the critical priority status of several gram-negative bacteria resistant to last-resort antibiotics, specifically carbapenem-resistant *Acinetobacter baumannii*, carbapenem-resistant Enterobacterales (CRE), and third-generation cephalosporin-resistant Enterobacterales. These resistant bacteria are associated with high mortality and morbidity, making them a significant concern for healthcare (7). In the WHO European Region, estimates from 2019 showed that these microorganism-antimicrobial group combinations were among those with the highest number of deaths associated with, and attributable to AMR (8). Similarly, surveillance data from the Region highlights a persistent challenge, showing high levels of resistance in these bacteria.

Carbapenem resistance is of particular concern, as carbapenems are a potent class of broad-spectrum beta-lactam antibiotics often used as a last-resort treatment against multidrug-resistant bacteria. When resistance develops against these drugs, effective treatment becomes exceedingly difficult, leading to negative health outcomes. For example, a recent rapid risk assessment by ECDC highlighted the emergence of hypervirulent *Klebsiella pneumoniae* strains resistant to carbapenems, which poses an even greater threat (9). Many countries in the Region with high levels of *K. pneumoniae* lack the capacity to detect hypervirulence, pointing to a significant need for laboratory capacity-building and genomic surveillance. This gap in detection capabilities could have serious public health implications, as the combination of hypervirulence and AMR could lead to infections that are increasingly difficult, if not impossible, to treat.

Addressing AMR requires a multifaceted approach, including infection prevention and control (IPC) measures to prevent the spread of resistant bacteria, antimicrobial stewardship, and robust surveillance. Key interventions involve improving diagnostic capabilities

and ensuring prudent antibiotic use. WHO recently introduced guidelines to reduce catheter-related infections, emphasising better practices for insertion, maintenance, and removal of peripherally inserted catheters (PIVCs). Since up to 70% of inpatients require PIVCs during their stay, these guidelines are crucial to lowering the risk of bloodstream infections, particularly from resistant pathogens, and reducing mortality rates (10).

Recent global targets for AMR, established during the 2024 High-level Meeting on AMR at the United Nations General Assembly, are a significant milestone in guiding international efforts. These targets, which aim to reduce bacterial AMR-related deaths by 10% by 2030 compared to the 2019 baseline, serve as a concrete roadmap for action (11). Commitments include improving governance, expanding surveillance, increasing investments, and ensuring access to essential antimicrobials. These measures are aligned with the measures included in the Roadmap on AMR for the WHO European Region which provides a practical framework to translate declarations into real-world solutions, advancing progress in tackling AMR (6).

## EU/EEA countries

### Epidemiology

In 2024, all EU Member States and EEA countries reported data for 2023 to EARS-Net. Twenty (66.7%) of these 30 countries reported that their participating laboratories had a population coverage of over two-thirds of the national population, including 14 countries that reported having a national population coverage of 90.0% or more. However, eight countries reported data with a coverage of less than half of their population. EARS-Net data are collected from the countries through the web-based platform EpiPulse. The data provided to EpiPulse by France was more limited in 2023 than in previous years and the data analysis was adjusted accordingly.

Twenty-one (70.0%) of the 30 participating countries indicated that their reported data had a 'high' national representativeness in terms of three metrics: covered geographical areas, included acute care hospitals, and microorganisms that caused invasive infections in those hospitals. A further four countries reported that the representativeness was 'high' for two of the three metrics and one country reported that one of the metrics was 'high'. Two countries reported representativeness as 'medium' for all three metrics and two countries reported representativeness as 'low' for all three metrics.

In hospitals served by the laboratories that reported data to EARS-Net in 2023, the blood culture rate was reported by 25 countries. The reported blood culture rates (blood culture sets per 1 000 patient-days) varied widely among the countries. However, these varying estimates should be interpreted with caution since the definitions of a 'blood culture set' and a 'patient-day' may differ between and within countries.

In 2023, all but two countries reported isolate data for all eight bacterial species under surveillance by EARS-Net (*E. coli*, *K. pneumoniae*, *P. aeruginosa*, *Acinetobacter* spp., *S. pneumoniae*, *S. aureus*, *E. faecalis* and *E. faecium*), while one country (France) reported isolate data for only *S. pneumoniae*, and one country (Liechtenstein) reported isolate data for only *E. coli*, *K. pneumoniae*, *P. aeruginosa*, *S. pneumoniae*, *S. aureus* and *E. faecalis*.

Based on the laboratory identifiers provided by the countries, the number of laboratories participating in EARS-Net has increased since 2019, indicating that national AMR surveillance systems are being strengthened in the EU/EEA. For 2023, data were reported from 1123 laboratories (935 when excluding France). Moreover, 763 laboratories were identified as having reported data for each year during the period 2019–2023.

As part of pilot reporting of antimicrobial susceptibility testing (AST) data for new antimicrobials, nine (30.0%) of the 30 reporting countries reported data on susceptibility to new antimicrobials for carbapenem-resistant gram-negative bacteria. These data were not included in the analyses since the data were not considered as representative of the EU/EEA.

Compared to 2022, the total number of reported invasive isolates decreased from 396 900 to 373 770. However, when excluding isolates for France (except *S. pneumoniae* isolates), the number increased from 353 237 to 373 700.

Both 2020 and 2021 coincided with major COVID-19 pandemic-associated pressures on healthcare. Therefore, it is useful to also compare 2023 data with 2019 data (the last year before the COVID-19 pandemic). To analyse changes in AMR percentage and estimated incidence at EU and EU/EEA level, we excluded countries which did not continuously report data to EARS-Net, as well as France for results other than *S. pneumoniae* due to recent changes in the reporting from the French surveillance system.

For bacteria (not taking AST results into account), the highest estimated EU/EEA incidence of invasive isolates from all reporting laboratories in 2023 was for *E. coli* (71.4 per 100 000 population), followed by *S. aureus* (36.9 per 100 000 population), *K. pneumoniae* (24.2 per 100 000 population), *E. faecalis* (14.1 per 100 000 population), *E. faecium* (10.7 per 100 000 population), *P. aeruginosa* (10.5 per 100 000 population), *S. pneumoniae* (7.2 per 100 000 population) and *Acinetobacter* spp. (4.6 per 100 000 population). This ranking did not differ from the ranking in 2022. It is interesting to note that, compared to 2022, the largest increase in estimated incidence occurred for *S. pneumoniae* (+26.3%) which has now surpassed its estimated incidence for 2019 (6.9 per 100 000 population).

When comparing 2019 to 2023, the largest increases (5%) in the estimated EU/EEA incidence of invasive isolates (per 100 000 population) were for *E. faecium*

(+25.9%; 8.5 and 10.7, respectively), followed by *Acinetobacter* spp. (+21.1%; 3.8 and 4.6, respectively), *K. pneumoniae* (+18.0%; 20.5 and 24.2, respectively), *P. aeruginosa* (+11.7%; 9.4 and 10.5, respectively), and *E. faecalis* (+11.0%; 12.7 and 14.1, respectively). There was no decrease in the estimated EU/EEA incidence of invasive isolates for the bacteria covered by EARS-Net compared to 2019. However, this comparison obscured two more recent changes to the estimated incidence. For *Acinetobacter* spp., the estimated incidence of invasive isolates has decreased from 2021 to 2023 (-24.6%; 6.1 and 4.6, respectively). Meanwhile for *S. pneumoniae*, after a steep decrease in 2020 from 2019 (-46.4%; from 6.9 to 3.7), there was an increase from 2021 until 2023 (+100.0%; from 3.6 to 7.2) so that it exceeded the estimated incidence recorded for 2019 (6.9). These more recent patterns indicate that some of the most pronounced changes which occurred after 2019 continue to be reversed. Another development worth noting is that the estimated incidence of invasive isolates for *K. pneumoniae* ranged between 19.8 and 21.8 per 100 000 population between 2019 and 2022, but increased to 24.2 per 100 000 population in 2023.

For AMR, the situation reported by EU/EEA countries to EARS-Net for 2023 varied widely, depending on the bacterial species, antimicrobial group and geographical region, as demonstrated by varying AMR percentages and often also estimated incidence of bloodstream infections with AMR.

Overall, in 2023 more than 80% of the estimated EU (excluding the UK and excluding France for results other than *S. pneumoniae*) incidences of bloodstream infections with AMR under EARS-Net surveillance exceeded one per 100 000 population. Moreover, the results showed increases from 2019 to 2023 for almost two-thirds (63.0%) of the combinations, ranging from +4.3 to +57.5%. In particular, for all AMR combinations for *K. pneumoniae*, for vancomycin resistance in *E. faecium* and for piperacillin-tazobactam resistance, ceftazidime resistance and carbapenem resistance in *P. aeruginosa*, there was a significantly increasing trend. As of 2023, there are recommended EU targets on AMR to reduce the total EU incidence of MRSA, third-generation cephalosporin-resistant *E. coli* and carbapenem-resistant *K. pneumoniae* bloodstream infections by 15%, 10% and 5%, respectively, by 2030 against the baseline year 2019 (12). In the data for 2023, the estimated total EU incidence of MRSA bloodstream infections was 4.64 per 100 000 population (country range 0–15.5). This was 17.6% lower than in 2019 (baseline year) and 0.15 per 100 000 population lower than the 2030 target of 4.79 per 100 000 population. For the EU overall, a statistically significant decreasing trend was detected between 2019 (baseline year) and 2023. The estimated total EU incidence of third-generation cephalosporin-resistant *E. coli* bloodstream infections was 10.35 per 100 000 population (country range 0–19.56) in 2023. This was 3.6% lower than in 2019 (baseline year) and 0.68 per 100 000 population higher than the 2030 target of 9.67 per 100 000 population. For the EU overall, no statistically significant trend

was detected between 2019 (baseline year) and 2023. The estimated total EU incidence of carbapenem-resistant *K. pneumoniae* bloodstream infections was 3.97 per 100 000 population (country range 0.00–21.44) in 2023. This was 57.5% higher than in 2019 (baseline year) and 1.58 per 100 000 population higher than the 2030 target of 2.39 per 100 000 population. For the EU overall, a statistically significant increasing trend was detected between 2019 (baseline year) and 2023.

Overall, in 2023, the population-weighted EU/EEA (excluding the UK and excluding France for results other than *S. pneumoniae*) mean AMR percentages exceeded 10% in 85.2% of the combinations under regular surveillance. However, the pattern of change in the AMR percentages differed from the estimated EU incidence of bloodstream infections with AMR. Most of the bacterial species–antimicrobial combinations either had a significantly decreasing trend or no significant trend in the AMR percentage. The exceptions were carbapenem resistance in *K. pneumoniae*, as well as penicillin non-wild-type and macrolide resistance, including the combination of these two types of resistance, in *S. pneumoniae*.

In 2023, the two bacterial species with the highest estimated EU incidences of bloodstream infections with AMR were *E. coli* and *K. pneumoniae*. More than half of the *E. coli* isolates reported to EARS-Net, and more than a third of the *K. pneumoniae* isolates, were resistant to at least one antimicrobial group under surveillance, and combined resistance to several antimicrobial groups was a frequent occurrence. Despite lower estimated EU incidences of *E. coli* bloodstream infections with AMR in 2023 than in 2019, these incidences have been increasing since 2021 and may be on their way towards reaching the 2019 levels. The estimated EU incidences of *K. pneumoniae* bloodstream infections with AMR also decreased in 2020, but have since increased and have now reached higher levels than in 2019, and showed a significantly increasing trend during the period 2019–2023. With one notable exception – carbapenem resistance in *K. pneumoniae* – both *E. coli* and *K. pneumoniae* saw either significantly decreasing trends in the EU/EEA population-weighted mean AMR percentages, or no significant trend. Among antimicrobial groups monitored for both species, the estimated EU incidences of bloodstream infections with AMR were, with one exception (carbapenem resistance) higher in *E. coli* than in *K. pneumoniae*. However, the EU/EEA population-weighted mean AMR percentages for the same groups were higher in *K. pneumoniae* than in *E. coli*.

In general, *P. aeruginosa* and *Acinetobacter* spp. exhibited lower estimated EU incidences of bloodstream infections with AMR than *E. coli* and *K. pneumoniae*. However, the estimated EU incidences of *P. aeruginosa* and *Acinetobacter* spp. bloodstream infections with carbapenem resistance were 2.01 and 2.98 per 100 000 population, respectively. In addition, there was a significantly increasing trend for carbapenem resistance, piperacillin-tazobactam resistance and ceftazidime resistance for *P. aeruginosa* bloodstream

infections. Although no such trend was observed for *Acinetobacter* spp., the reported data showed that, compared to the high incidence reported for 2021, there has been a decrease over the last two years. This pattern for *Acinetobacter* spp. with AMR has also been observed for the EU/EEA population-weighted mean AMR percentages.

For most gram-negative bacteria under surveillance, the patterns of the estimated EU incidences of AMR bloodstream infections during 2019–2023 indicate that, with the exception of *Acinetobacter* spp., further increases may be expected. Conversely, the EU/EEA population-weighted mean AMR percentages for most gram-negative bacteria under surveillance showed significantly decreasing trends between 2019 and 2023. However, the AMR percentages remained at high levels. It is also interesting to note that for 2023 the EU/EEA population-weighted mean AMR percentages for some of the *P. aeruginosa* combinations decreased against 2022, whereas some *E. coli* combinations have increased since 2021.

For *S. aureus*, the estimated EU incidence of MRSA bloodstream infections decreased by 17.6% from 2019 (5.63 per 100 000 population) to 2023 (4.64 per 100 000 population) and showed a significantly decreasing trend during the period 2019–2023. The reported data also showed a decrease and a significantly decreasing trend in the EU/EEA population-weighted mean MRSA percentage from 2019 (18.2%) to 2023 (15.8%).

For *S. pneumoniae*, in addition to the considerable increase in the estimated EU/EEA incidence of invasive isolates in 2023 compared to 2021, the last five years have seen a significantly increasing trend in AMR. The EU/EEA population-weighted mean percentage of macrolide resistance and penicillin non-wild-type, including combined resistance in *S. pneumoniae*, has increased since 2019. Moreover, the lower estimated EU incidences of *S. pneumoniae* bloodstream infections with AMR in 2020 and 2021, at the start of the COVID-19 pandemic, have not remained at the same level, and in 2023 they surpassed those of 2019.

*E. faecium* continued to be of concern in 2023. The results showed a significantly increasing trend in the estimated EU incidence of vancomycin-resistant *E. faecium* bloodstream infections over the last five years, although the last two years have shown slightly lower numbers, possibly indicating some improvement in the situation. However, the 2023 EU/EEA population-weighted mean percentage of vancomycin resistance in *E. faecium* (19.8%) remained within the range reported for the previous four years (19.7%–20.7%).

The reported AMR percentages, and often also the estimated incidences of bloodstream infections with AMR, varied widely among EU/EEA countries. Often the AMR percentages showed a north-to-south and west-to-east gradient. In general, the lowest AMR percentages were reported by countries in the north of Europe and the highest by countries in the south and east of Europe. For

the estimated incidences of bloodstream infections with AMR, the same pattern was evident for *K. pneumoniae*, and fairly evident for *P. aeruginosa*, *Acinetobacter* spp., *S. aureus*, but less evident for *E. coli*, *S. pneumoniae*, *E. faecalis* and *E. faecium*. Nevertheless, the highest incidences were generally reported from countries in the south or south-east of Europe.

In addition to this executive summary, published jointly by ECDC and the WHO Regional Office for Europe, an Annual Epidemiological Report on Antimicrobial Resistance in the EU/EEA (EARS-Net) using 2023 data has been published by ECDC (13). For each bacterial species, country-specific information on the estimated incidence of antimicrobial-resistant bloodstream infections (including the recommended EU targets on AMR), the percentage of invasive isolates with AMR, data availability and the percentage of intensive care unit patients is available in country summaries that are published as an annex to the Report. Results by age group and sex are available in ECDC's Surveillance Atlas of Infectious Diseases (14).

## Discussion

In 2024, all EU/EEA countries reported data for 2023 to EARS-Net. Representativeness, as reported by the countries, was high for 70% of countries. This indicates that, although all EU/EEA countries are included in EARS-Net, progress is needed in some countries to improve surveillance representativeness.

The summary showed that EU progress towards its targets on AMR varied, depending on the pathogen. For MRSA, a favourable decreasing trend in the estimated incidence of bloodstream infections was noted and the EU reduction target of 15% was already reached by 2023. For third-generation cephalosporin-resistant *E. coli*, despite a slightly lower incidence than in 2019 (baseline year) and a decrease in 2020 and 2021, the incidence of bloodstream infections has since been increasing and may be on its way to reaching pre-pandemic values. This indicates that further work needs to be done to reach the EU reduction target of 10%. For carbapenem-resistant *K. pneumoniae*, the incidence of bloodstream infections showed an increase of over 50% during the period 2019–2023, which means that, instead of progressing towards the EU reduction target of 5%, the situation in the EU has worsened since 2019 (baseline year). This increase indicates the need to rapidly strengthen prevention and control actions in the EU, as highlighted in the 'Council Recommendation on stepping up EU actions to combat antimicrobial resistance in a One Health approach' (2023/C 220/01) (12).

Increases in the estimated EU incidences of bloodstream infections with resistant bacteria were observed not only for two of the above-mentioned AMR-pathogen combinations with an EU target, but also for many other bacteria and antimicrobial groups under surveillance, such as antimicrobial-resistant *K. pneumoniae* (other than carbapenem-resistant), vancomycin-resistant

*E. faecium* and piperacillin-tazobactam-, ceftazidime-, and carbapenem-resistant *P. aeruginosa*. Moreover, for most gram-negative bacteria under surveillance, except for *Acinetobacter* spp., the recent changes in the estimated EU incidences of bloodstream infections with AMR indicate that, in the absence of stronger, swifter public health action, further increases may be expected in the coming years. On the other hand, for most gram-positive bacteria under surveillance, except for *S. pneumoniae*, the patterns indicated that decreases in AMR can be expected in the future.

Overall, as in previous years, AMR levels remained high in the EU/EEA in 2023, with many of the estimated EU incidences of antimicrobial-resistant bloodstream infections and most of the EU/EEA population-weighted mean AMR percentages for the bacterial species-antimicrobial group combinations under surveillance continuing to be elevated. Nevertheless, the AMR situation reported by EU/EEA countries varied widely, depending on the bacterial species, antimicrobial group and geographical region. The highest estimated incidences of antimicrobial-resistant bloodstream infections were generally reported from countries in the south or south-east of Europe and the highest AMR percentages were generally reported by countries in the south and east of Europe.

The wide variability in the estimated incidences of bloodstream infections with AMR and AMR percentages across EU/EEA countries in 2023 suggests that there are further opportunities for significant AMR reduction through interventions to improve IPC and antimicrobial stewardship practices. For carbapenem-resistant *K. pneumoniae* and other CRE, the options for action are highlighted in the 2019 update of ECDC's rapid risk assessment on CRE, including timely and appropriate diagnosis, high standards of IPC and antimicrobial stewardship (15).

Data for the years 2020 and 2021 coincided with the first years of the COVID-19 pandemic. Changes to human behaviour in 2020–2021 to control the pandemic, and then again in 2022 as the number of non-pharmaceutical interventions were reduced, may have modified the risk of infection with antimicrobial-resistant pathogens. However, unlike antimicrobial consumption in the EU/EEA (16–18), for AMR under EARS-Net surveillance there was no uniform pattern across the bacterial species. Some of the bacterial species, such as *Acinetobacter* spp. (19–21) and *S. pneumoniae* (20, 21), showed indications of having been affected by the COVID-19 pandemic and the actions taken during this time. However, these two bacterial species followed different patterns (i.e. increases for *Acinetobacter* spp. and decreases for *S. pneumoniae*, during 2020–2021) compared to 2019, followed by a reversal of the changes in 2022 and 2023. These changes point towards the importance of IPC in healthcare settings, as well as non-pharmaceutical interventions in the community.

When interpreting the EARS-Net data, it is important to be mindful of the structure of the surveillance system, including variations in national blood culture rates as well as changes in the national surveillance systems

and in EARS-Net over time. An example of a limitation of EARS-Net surveillance is that the magnitude of the impact of Russia's war of aggression against Ukraine on AMR in the EU/EEA cannot be assessed using data regularly reported to EARS-Net. On 8 March 2022, ECDC published a report entitled 'Operational public health considerations for the prevention and control of infectious diseases in the context of Russia's aggression towards Ukraine' (22). The report presents considerations for hospitalised patients in the EU/EEA, including recommendations that patients transferred from hospitals in Ukraine, or with a history of hospitalisation in Ukraine during the last 12 months, should be pre-emptively isolated and screened for carriage of multidrug-resistant organisms. Although it is not possible to follow through the data annually reported to ECDC, since 2022 there have been reports from EU/EEA countries of multidrug-resistant organisms being detected in patients having recently been hospitalised in Ukraine (23–25). Despite these limitations, data from EARS-Net are considered to reflect the overall AMR situation in the EU/EEA.

The European Health Union was created in 2020 to better protect the health of EU citizens (26). This included strengthened mandates for ECDC and the European Medicines Agency (EMA), the creation of the European Health Emergency preparedness and Response Authority (HERA) and a new Regulation on serious cross-border threats to health that was adopted by the Council on 24 October 2022 (27). Moreover, a large budget is available under the EU4Health programme (EUR 5.3 billion for the period 2021–2027), which is one of the main instruments for the European Health Union, dedicated to wider policy areas and including action on AMR.

At the global level, the Political Declaration of the High-Level Meeting on AMR at the United Nations (UN) General Assembly (September 2024) has also highlighted the importance of AMR as a health threat (11). Moreover, the Declaration called for the establishment of an independent panel to collect evidence for action against AMR. The European Commission declared that it will be providing funds for the establishment of such a panel (28).

## Public health implications

Estimates based on EARS-Net data from 2020 indicate that each year more than 35 000 people die in the EU/EEA as a direct consequence of antimicrobial-resistant infections (29). Together with the poor progress towards the EU targets on AMR overall and, more particularly, the continued increase in the incidence of carbapenem-resistant *K. pneumoniae* bloodstream infections, the increases in many of the other estimated EU incidences of bloodstream infections with antimicrobial-resistant bacteria described in this summary highlight the urgent need for intensified public health action against AMR.

The 'Council Recommendation on stepping up EU actions to combat antimicrobial resistance in a One Health approach' (2023/C 220/01), adopted in June 2023, encourages Member States to develop and implement

national action plans against AMR and highlights the need for them to allocate appropriate human and financial resources for the effective implementation of these plans (12). The plans should include key elements, such as enhanced surveillance and strengthened IPC programmes in hospitals and other healthcare settings, integrated with antimicrobial stewardship programmes and good diagnostic practices.

Public health interventions to tackle AMR can have a significant positive impact on population health and future healthcare expenditure in the EU/EEA. Such interventions include IPC measures, starting with the promotion of better hand hygiene in healthcare to prevent transmission; antibiotic stewardship programmes (e.g. rapid testing of patients to discriminate viral from bacterial infections) and the promotion of prudent use of antibiotics, to prevent the development and selection of AMR. In addition, mass media campaigns can be useful to raise public awareness of AMR and the importance of the prudent use of antibiotics. In 2023, the Organisation for Economic Co-operation and Development (OECD) estimated that a mixed intervention package including enhanced hygiene, antibiotic stewardship programmes, mass media campaigns, and food handling practices would have the potential to prevent nearly 613 000 resistant infections and avoid more than 10 000 deaths per year in the EU/EEA. Moreover, the combined health expenditure reduction and productivity gains from such a package would be about three times higher than the average cost of implementation (30).

In the absence of stronger and swifter public health action, it is unlikely that the EU will reach all its AMR targets by 2030. The consequence will be an increased number of infections with antimicrobial-resistant bacteria that will be more difficult to treat, leading to increasing challenges for patients and AMR-related deaths.

## References

- World Health Organization Regional Office for Europe (WHO/Europe). AMR Dashboard. Copenhagen: WHO/Europe; 2023. Available at: <https://worldhealthorg.shinyapps.io/WHO-AMR-Dashboard/>
- World Health Organization (WHO). Global database for the tripartite antimicrobial resistance country self-assessment survey (TrACSS). Geneva: WHO; 2024. Available at: <https://amrcountryprogress.org/#/map-view>
- World Health Organization (WHO). 2019 WHO AWaRe Classification Database of Antibiotics for evaluation and monitoring of use. Geneva: WHO; 2019. Available at: <https://www.who.int/publications/i/item/WHOEMPIAU2019.11>
- European Centre for Disease Prevention and Control (ECDC). EU/EEA consumption characteristics. In: Latest surveillance data on antimicrobial consumption. Stockholm: ECDC; 2023. Available at: [https://gap.ecdc.europa.eu/public/extensions/AMC2\\_Dashboard/AMC2\\_Dashboard.html#eu-consumption-tab](https://gap.ecdc.europa.eu/public/extensions/AMC2_Dashboard/AMC2_Dashboard.html#eu-consumption-tab)
- World Health Organization Regional Office for Europe (WHO/Europe). WHO Regional Office for Europe Antimicrobial Medicines Consumption (AMC) Network AMC data 2022. Copenhagen: WHO/Europe; 2024. Available at: <https://www.who.int/europe/publications/i/item/9789289061346>
- World Health Organization Regional Office for Europe (WHO/Europe). Seventy-third Regional Committee for Europe: Astana, 24–26 October 2023: roadmap on antimicrobial resistance for the WHO European Region 2023–2030. Copenhagen: WHO/Europe; 2023. Available at: <https://iris.who.int/handle/10665/372503>
- World Health Organization (WHO). WHO Bacterial Priority Pathogens List, 2024: bacterial pathogens of public health importance to guide research, development and strategies to prevent and control antimicrobial resistance. Geneva: WHO; 2024. Available at: <https://iris.who.int/bitstream/handle/10665/376776/9789240093461-eng.pdf?sequence=1>
- Mestrovic T, Robles Aguilar G, Swetschinski LR, Ikuta KS, Gray AP, Davis Weaver N, et al. The burden of bacterial antimicrobial resistance in the WHO European region in 2019: a cross-country systematic analysis. *Lancet Public Health*, 2022;7:e897–e913. Available at: [https://www.thelancet.com/journals/lanpub/article/PIIS2468-2667\(22\)00225-0/fulltext](https://www.thelancet.com/journals/lanpub/article/PIIS2468-2667(22)00225-0/fulltext)
- European Centre for Disease Prevention and Control (ECDC). Rapid risk assessment: Emergence of hypervirulent *Klebsiella pneumoniae* ST23 carrying carbapenemase genes in EU/EEA countries - first update. Stockholm: ECDC; 2024. Available at: [www.ecdc.europa.eu/sites/default/files/documents/RRA-20240129-48%20FINAL.pdf](https://www.ecdc.europa.eu/sites/default/files/documents/RRA-20240129-48%20FINAL.pdf)
- World Health Organization (WHO). Guidelines for the prevention of bloodstream infections and other infections associated with the use of intravascular catheters: Part I: peripheral catheters. Geneva: WHO; 2024. Available at: <https://iris.who.int/handle/10665/376722>
- United Nations General Assembly, High-level Meeting on Antimicrobial Resistance 2024. New York: UN; 2024. Available at: <https://www.un.org/pga/wp-content/uploads/sites/108/2024/09/FINAL-Text-AMR-to-PGA.pdf>
- Council of the European Union. Council Recommendation on stepping up EU actions to combat antimicrobial resistance in a One Health approach (2023/C 220/01). Brussels: Council of the European Union; 2023. Available at: [https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:JOC\\_2023\\_220\\_R\\_0001](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:JOC_2023_220_R_0001)
- European Centre for Disease Prevention and Control (ECDC). Antimicrobial resistance in the EU/EEA (EARS-Net) - Annual Epidemiological Report for 2023. Stockholm: ECDC; 2024. Available at: <https://www.ecdc.europa.eu/en/publications-data/antimicrobial-resistance-eueea-ears-net-annual-epidemiological-report-2023>
- European Centre for Disease Prevention and Control (ECDC). Surveillance Atlas of Infectious Diseases. Stockholm: ECDC; 2024. Available at: <https://www.ecdc.europa.eu/en/surveillance-atlas-infectious-diseases>
- European Centre for Disease Prevention and Control (ECDC). Rapid risk assessment: carbapenem-resistant Enterobacteriaceae, second update – 26 September 2019. Stockholm: ECDC; 2019. Available at: <https://www.ecdc.europa.eu/sites/default/files/documents/carbapenem-resistant-enterobacteriaceae-risk-assessment-rev-2.pdf>
- European Centre for Disease Prevention and Control (ECDC). Antimicrobial consumption in the EU/EEA (ESAC-Net) - Annual Epidemiological Report for 2022. Stockholm: ECDC; 2023. Available at: <https://www.ecdc.europa.eu/en/publications-data/antimicrobial-consumption-eueea-esac-net-annual-epidemiological-report-2022>
- Ventura-Gabarró C, Leung VH, Vlahović-Palčevski V, Machowska A, Monnet DL, Högberg LD, et al. Rebound in community antibiotic consumption after the observed decrease during the COVID-19 pandemic, EU/EEA, 2022. *Eurosurveillance*. 2023;28(46):2300604. Available at: <https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2023.28.46.2300604>
- European Centre for Disease Prevention and Control (ECDC). Antimicrobial consumption in the EU/EEA (ESAC-Net) - Annual Epidemiological Report for 2023. Stockholm: ECDC; 2024. Available at: <https://www.ecdc.europa.eu/en/publications-data/antimicrobial-consumption-eueea-esac-net-annual-epidemiological-report-2023>
- Kinross P, Gagliotti C, Merk H, Plachouras D, Monnet DL, Högberg LD, et al. Large increase in bloodstream infections with carbapenem-resistant *Acinetobacter* species during the first 2 years of the COVID-19 pandemic, EU/EEA, 2020 and 2021. *Eurosurveillance*. 2022;27(46):2200845. Available at: <https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2022.27.46.2200845>
- European Centre for Disease Prevention and Control (ECDC). Antimicrobial resistance in the EU/EEA (EARS-Net) - Annual Epidemiological Report for 2021. Stockholm: ECDC; 2022. Available at: <https://www.ecdc.europa.eu/en/publications-data/surveillance-antimicrobial-resistance-europe-2021>
- European Centre for Disease Prevention and Control (ECDC). Antimicrobial resistance in the EU/EEA (EARS-Net) - Annual Epidemiological Report for 2022. Stockholm: ECDC; 2023. Available at: <https://www.ecdc.europa.eu/en/publications-data/surveillance-antimicrobial-resistance-europe-2022>
- European Centre for Disease Prevention and Control (ECDC). Operational public health considerations for the prevention and control of infectious diseases in the context of Russia's aggression towards Ukraine. 8 March 2022. Stockholm: ECDC; 2022. Available at: <https://www.ecdc.europa.eu/en/publications-data/>

- [operational-public-health-considerations-prevention-and-control-infectious](#)
23. Zwitter RD, Wielders CC, Notermans DW, Verkaik NJ, Schoffelen AF, Witteveen S, et al. Multidrug-resistant organisms in patients from Ukraine in the Netherlands, March to August 2022. *EuroSurveillance*. 2022;27(50):2200896. Available at: <https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2022.27.50.2200896>
  24. Schultze T, Hogardt M, Velázquez ES, Hack D, Besier S, Wichelhaus TA, et al. Molecular surveillance of multidrug-resistant Gram-negative bacteria in Ukrainian patients, Germany, March to June 2022. *EuroSurveillance*. 2023;28(1):2200850. Available at: <https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2023.28.1.2200850>
  25. Hernández-García M, Cabello M, Ponce-Alonso M, Herrador-Gómez PM, Gioia F, Cobo J, et al. First detection in Spain of NDM-1-producing *Pseudomonas aeruginosa* in two patients transferred from Ukraine to a university hospital. *J Glob Antimicrob Resist*. 2024;36:105-111. Available at: <https://www.sciencedirect.com/science/article/pii/S2213716523002345>
  26. European Commission (EC). European Health Union - Protecting our health together. Brussels: EC; 2020. Available at: [https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/promoting-our-european-way-life/european-health-union\\_en](https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/promoting-our-european-way-life/european-health-union_en)
  27. European Commission (EC). European Health Union: building a stronger EU health response. Brussels: EC; 2022. Available at: [https://ec.europa.eu/commission/presscorner/detail/en/jp\\_22\\_6363](https://ec.europa.eu/commission/presscorner/detail/en/jp_22_6363)
  28. European Commission (EC). Remarks by Commissioner Kyriakides at UNGA High-Level meeting on Antimicrobial Resistance. Brussels: EC; 2024. Available at: [https://ec.europa.eu/commission/presscorner/detail/en/speech\\_24\\_4846](https://ec.europa.eu/commission/presscorner/detail/en/speech_24_4846)
  29. European Centre for Disease Prevention and Control (ECDC). Health burden of infections with antibiotic-resistant bacteria in the European Union and the European Economic Area, 2016-2020. Stockholm: ECDC, 2022. Available at: <https://www.ecdc.europa.eu/en/publications-data/health-burden-infections-antibiotic-resistant-bacteria-2016-2020>
  30. Organisation for Economic Co-operation and Development (OECD). Fighting Antimicrobial Resistance in EU and EEA countries. Paris: OECD, 2023. Available at: [https://www.oecd.org/content/dam/oecd/en/publications/reports/2023/11/fighting-antimicrobial-resistance-in-eu-and-eea-countries\\_aa49a732/fdb1629f-en.pdf](https://www.oecd.org/content/dam/oecd/en/publications/reports/2023/11/fighting-antimicrobial-resistance-in-eu-and-eea-countries_aa49a732/fdb1629f-en.pdf)

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