

# Antimicrobial consumption in the EU/EEA (ESAC-Net)

## Annual Epidemiological Report for 2021

### Key facts

- For 2021, 29 countries (27 European Union (EU) Member States and two European Economic Area (EEA) countries – Iceland and Norway) reported data on antimicrobial consumption. Twenty-seven countries reported consumption data for the community and hospital sectors separately, one country (Cyprus) reported total consumption for both sectors combined, and one country (Germany) reported only community consumption.
- Antimicrobial consumption is expressed as the number of defined daily doses (DDD) per 1 000 inhabitants per day. The Anatomical Therapeutic Chemical (ATC) classification index with Defined Daily Doses (DDDs) 2022 was used for the analysis of both 2021 data and historical data.
- In 2021, the EU/EEA population-weighted mean total (community and hospital sectors combined) consumption of antibacterials for systemic use (ATC group J01) was 16.4 DDD per 1 000 inhabitants per day (country range: 8.3–25.7). During the period 2012–2021, a statistically significant decrease was observed for the EU/EEA population-weighted mean overall, as well as for 13 individual countries. A statistically significant increasing trend was observed for one country (Bulgaria).
- The EU/EEA population-weighted mean total (community and hospital sectors combined) consumption of antivirals for systemic use (ATC group J05) was 2.72 DDD per 1 000 inhabitants per day (country range: 0.28–6.25), with no statistically significant trend in the five-year period 2017–2021.

### Community (primary care sector)

- In the community, the EU/EEA population-weighted mean consumption of antibacterials for systemic use (ATC group J01) was 15.0 DDD per 1 000 inhabitants per day (country range: 7.2–24.3). During the period 2012–2021, a statistically significant decrease was observed for the EU/EEA population-weighted mean overall, as well as for 15 individual countries. A statistically significant increasing trend was observed for one country (Bulgaria).
- Between 2012 and 2021, there were statistically significant decreases in the EU/EEA population-weighted mean for consumption of certain sub-groups of antibacterials in the community. This applied to tetracyclines (J01A), cephalosporins and other beta-lactams (J01D), macrolides, lincosamides and streptogramins (J01F), and quinolones (J01M). No statistically significant trends were detected in the EU/EEA population-weighted mean for penicillins (J01C), or sulfonamides and trimethoprim (J01E).
- The EU/EEA population-weighted mean ratio of consumption of broad-spectrum penicillins, cephalosporins, macrolides (except erythromycin) and fluoroquinolones to the consumption of narrow-spectrum penicillins, cephalosporins and erythromycin in the community was 3.7 (country range: 0.1–20.7). During the period 2012–2021, a statistically significant increasing trend was observed for the EU/EEA population-weighted mean overall, and for 10 individual countries. Statistically significant decreasing trends were observed for nine countries.

- The EU/EEA population-weighted mean consumption of antimycotics and antifungals for systemic use (ATC groups J02 and D01B) in the community among 28 reporting countries was 0.9 DDD per 1 000 inhabitants per day (country range: 0.3–3.8).

## Hospital sector

- In the hospital sector, the EU/EEA population-weighted mean consumption of antibacterials for systemic use (ATC group J01) was 1.4 DDD per 1 000 inhabitants per day (country range: 0.7–2.2). During the period 2012–2021, a statistically significant decrease was observed at the EU/EEA level. Statistically significant decreasing trends were observed for seven countries, and a statistically significant increasing trend was observed for one country (Bulgaria).
- The hospital sector EU/EEA population-weighted mean consumption decreased significantly between 2012 and 2021 for penicillins (J01C) and quinolones (J01M), however there was a statistically significant increase for tetracyclines (J01A), cephalosporins and other beta-lactams (J01D), and sulfonamides and trimethoprim (J01E). No significant EU/EEA trend was detected for consumption of macrolides, lincosamides and streptogramins (J01F).
- Of the total consumption of antibacterials for systemic use in the hospital sector, the EU/EEA population-weighted proportion of glycopeptides, third- and fourth-generation cephalosporins, monobactams, carbapenems, fluoroquinolones, polymyxins, piperacillin and enzyme inhibitors, linezolid, tedizolid and daptomycin combined was 41.0% (country range: 19.5–70.9%). During the period 2012–2021, statistically significant increasing trends for this indicator were observed for the EU/EEA overall and for nine countries, while no country showed a statistically significant decreasing trend.
- The EU/EEA mean consumption of antimycotics and antifungals for systemic use (ATC groups J02 and D01B) in the hospital sector among 25 reporting countries was 0.14 DDD per 1 000 inhabitants per day (country range: 0.03–0.23).

## Changes in consumption of antibacterials for systemic use (ATC group J01) between 2019 and 2021

- In 2021, the EU/EEA population-weighted means for total consumption and community consumption stabilised after unprecedented reductions between 2019 and 2020.
- Only one country reported an increase in total consumption between 2019 and 2020, while over half of the countries reported increases between 2020 and 2021. However, 2021 consumption rates remained below 2019 rates for almost all countries.
- The rise in ratio of 'broad' to 'narrow' spectrum antibacterials for systemic use in the community sector accelerated during 2019–2021. The rise in the proportion of 'broad' spectrum antibacterials out of all antibacterials for systemic use in the hospital sector also accelerated during 2019–2021.
- While the hospital sector had unprecedented decreases in EU/EEA mean consumption during 2020 and 2021, there were large increases in consumption of broad-spectrum and last-line antibiotics.

*\* Important note: data were updated using the ATC/DDD Index 2022, which included several DDD alterations implemented in 2019. Data in this report should therefore not be compared with data reported by ECDC prior to 2019. For the most recent data on antimicrobial consumption and trends in EU/EEA countries, readers should refer to the most recent report, or the ESAC-Net interactive database.*

## Methods

This report is based on data reported to the European Surveillance of Antimicrobial Consumption Network (ESAC-Net) for the period 2012 to 2021, retrieved from The European Surveillance System (TESSy) on 21 September 2022. TESSy is a system for the collection, storage, analysis and dissemination of data on communicable diseases, allowing for correction and re-uploading of historical data by the reporting countries. Therefore, the latest published reports supersede previous reports and reflect the most recent available data. For a detailed description of the methods used to produce this report, please refer to the methods chapter in the introduction to the ECDC Annual Epidemiological Report [1] and the ESAC-Net reporting protocol [2]. A subset of the data used for this report is available from ECDC's online antimicrobial consumption database [3].

Antimicrobial consumption (AMC) data were collected using the Anatomical Therapeutic Chemical (ATC) classification system and analysed using the defined daily dose (DDD) methodology developed by the World Health Organization (WHO) Collaborating Centre for Drug Statistics Methodology (Oslo, Norway). For the analysis, DDDs listed in the ATC Index for 2022 were used [4]. One DDD represents the assumed average maintenance dose per day for a drug used in its main indication by adults. It is a technical unit of measurement, not a standard for appropriate use. Application of the ATC/DDD methodology makes it possible to aggregate different brands of medicines with different package sizes and strengths into units of measurement of active substances. It represents a standard for performing valid and reliable cross-national or longitudinal studies of AMC. DDD values of some medicines may change over time because of alterations in the main indication, or regulatory amendments to the recommended or prescribed daily dose. In the event of such changes, all historical data require retrospective adjustments to the latest DDD/ATC index.

There are four major categories of antimicrobials under surveillance:

- antibacterials for systemic use (ATC group J01);
- antimycotics and antifungals for systemic use (ATC groups J02 & D01B);
- antimycobacterials for systemic use (ATC group J04);
- antivirals for systemic use (ATC group J05).

In addition, due to the structure of the ATC classification, some antimicrobials under surveillance are classified in other ATC groups. Vancomycin and fidaxomicin for oral administration used against *Clostridioides difficile* infections are classified as 'intestinal anti-infectives, antibiotics' in ATC group A07AA. Metronidazole, which may be administered orally or rectally for *C. difficile*, is classified as an 'agent against amoebiasis and other protozoal diseases, nitroimidazole derivatives' in ATC group P01AB.

Consumption data were collected for the community (primary care) sector and the hospital (secondary care and tertiary care) sector as a detailed list of all available antimicrobial products (register) and the annual number of packages consumed, or, if unavailable, as the number of DDD per ATC substance and route of administration. Consumption of antibacterials for systemic use and of antimycotics and antifungals for systemic use are presented separately for the community and the hospital sector, while consumption of antivirals for systemic data are combined for the community and the hospital sector. Reporting of data from long-term care facilities was optional and could be included either with data for the community sector, the hospital sector, or both.

## Selected antimicrobial consumption indicators

The indicator 'defined daily doses (DDD) per 1 000 inhabitants per day' is used as the main indicator to report antimicrobial consumption. It provides a rough estimate of the proportion of the population treated daily with antimicrobials. Total consumption (community and hospital sectors) of antibacterials for systemic use (ATC group J01) expressed as 'DDD per 1 000 inhabitants per day' has been selected as the primary harmonised outcome indicator by ECDC, the European Food Safety Authority (EFSA) and the European Medicines Agency (EMA) to describe total AMC in humans, combining both the community and hospital sectors. This quantity metric has been validated by international expert consensus as a standardised tool for comparing and benchmarking drug consumption in outpatient settings [5]. We also report hospital consumption as 'DDD per 1 000 inhabitants per day' because the recommended denominator of 'occupied bed-days' [6] is not currently available for all EU/EEA countries, and presenting data with the same denominator helps to facilitate comparison.

The World Health Organization (WHO) Access, Watch and Reserve (AWaRe) classification of antimicrobials was developed in 2017 and updated in 2021 to include 258 antibiotics [7]. The AWaRe classification is a tool to evaluate and monitor antibiotic use and support antibiotic stewardship efforts, emphasising the importance of appropriate use. 'Access' antibiotics are mostly first-line and second-line therapies that offer the best therapeutic value, while minimising the potential for antimicrobial resistance (AMR). 'Watch' antibiotics have higher AMR potential and should be prioritised in stewardship and monitoring efforts. 'Watch' antibiotics include most of the highest priority agents in the WHO Critically Important Antimicrobials for Human Medicine [8]. 'Reserve' antibiotics include antibiotics of last resort and should be saved for treatment of confirmed or suspected infections due to multidrug-resistant organisms. The percentage of 'Access' group antibiotics out of all consumed antibiotics is a secondary outcome indicator for total AMC in humans. WHO's 13th General Programme of Work 2019–2023 set a target of at least 60% of total antibiotic consumption being 'Access' group antibiotics [9].

Patterns of AMC in the community and hospital sectors were selected as secondary harmonised outcome indicators for AMC following the agreement of an expert group convened by ECDC, EFSA and EMA, and at the request of the European Commission. For the community, the agreed secondary indicator is the ratio of consumption of broad-spectrum penicillins, cephalosporins, macrolides (except erythromycin) and fluoroquinolones to the consumption of narrow-spectrum penicillins, cephalosporins and erythromycin. For the hospital sector, the agreed secondary indicator is the proportion of glycopeptides, third- and fourth-generation cephalosporins, monobactams, carbapenems, fluoroquinolones, polymyxins, piperacillin and enzyme inhibitors, linezolid, tedizolid and daptomycin out of total hospital consumption of antibacterials for systemic use [10].

## Data analysis

### National data

For each EU/EEA country, AMC expressed as DDD per 1 000 inhabitants per day is displayed as reported to The European Surveillance System (TESSy). Missing data for a specific year and sector are displayed as an empty cell in the tables. Consumption of antibacterials for systemic use (ATC group J01) by sector (community and hospital) are displayed separately for countries that report AMC for each sector. In addition, for each sector, consumption of antibacterials for systemic use (J01) is displayed at the ATC level 3 sub-group for each country reporting AMC for each sector.

### EU/EEA population-weighted means

#### EU/EEA

The EU/EEA population-weighted mean, labelled as 'EU/EEA', is calculated by multiplying the DDD per 1 000 inhabitants per day for each country with the corresponding Eurostat population, and dividing the product by the total population of all participating countries contributing data for the same year. Annual population data were retrieved from the Eurostat online database [11].

To allow for comparison of the EU/EEA population-weighted mean between years and to assess trends, imputations were performed to replace missing data to ensure that the number of countries (and hence population under surveillance) was consistent for all years. Missing values for country-specific univariate time series were imputed by one of the following interpolation methods: linear interpolation, Spline regression or weighted moving average algorithms (where the missing values are replaced by moving average values). Missing values were imputed using the R package 'imputeTS'.

When a country only reported combined community and hospital sector data ('total care') for a specific year, the value was corrected using mean distribution between the hospital and community sectors, obtained from the other years in the studied period. If the country had not reported separate community and hospital data for any of the years during the studied time period (e.g. Germany), the EU/EEA mean distribution was used.

For Spain, the community consumption data reported for the years 2012–2015 were adjusted proportionally due to the change in reported data sources from 2016 onwards, when Spain changed reporting from reimbursement data to sales data. This resulted in a substantial technical increase in AMC compared with previous years, as the reimbursement data did not include consumption without a prescription and other non-reimbursed courses. As the United Kingdom (UK) left the EU in 2020 and data are no longer reported to ESAC-Net, the EU/EEA mean does not include the UK.

For the hospital sector, where missing data were more frequent, countries were not included in the EU/EEA means with ATC level 3 data if they reported data for less than eight years.

#### Crude EU/EEA

The 'Crude EU/EEA' represents a population-weighted mean, calculated in the same way as the 'EU/EEA' mean, but without imputing for missing data and including UK data, when available. The 'Crude EU/EEA' mean better reflects available data and is presented for the sake of transparency, but is less suitable for trend assessments as the number of countries included differs between years. Therefore no trend or compound annual growth rate (CAGR) is presented for this indicator.

### Trend analysis

To assess whether the 10-year trend in consumption of antibacterials for systemic use (ATC group J01) or of sub-groups was statistically significant, a linear regression model was applied. To describe the trends, the terms 'increase' or 'decrease' were used if the p-value for the regression coefficient was statistically significant ( $P \leq 0.05$ ). In the case of antivirals for systemic use (ATC group J05), five-year trends were assessed.

Trend analyses were only performed if the country reported eight or more consecutive years of data.

As the UK left the EU in 2020 and data are no longer reported to ESAC-Net, EU/EEA trend analyses do not include the UK and results cannot be directly compared with those published in previous years. UK data for the period 2012 to 2019 are still presented for reference, but no trend analyses were performed.

## Compound annual growth rate

To illustrate changes in AMC rates over time, we calculated the compound annual growth rate (CAGR) of total antimicrobial consumption for each country. The CAGR corresponds to the mean annual change as a proportion (%) of the consumption in the year of commencement.

More details on the methods, collection, validation and reporting of AMC data from EU/EEA countries are available from the ESAC-Net pages on ECDC's website<sup>1</sup>. The most recent data on AMC are available from the public ESAC-Net interactive database (data starting 1997) on ECDC's website<sup>2</sup>.

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1. ESAC-Net on ECDC website: <https://www.ecdc.europa.eu/en/about-us/partnerships-and-networks/disease-and-laboratory-networks/esac-net>

2. ESAC-Net interactive database: [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)

# Results

## Data availability

All 27 EU Member States and two EEA countries (Iceland and Norway) reported data on antimicrobial consumption (AMC) for 2021. Twenty-seven countries reported both community and hospital consumption, one country (Germany) only reported community consumption, and one country (Cyprus) reported total consumption for both sectors combined.

For both the community and the hospital sector, consumption data were mainly based on sales of antimicrobials in the country, or a combination of sales and reimbursement data.

Inclusion of long-term care facility antimicrobial consumption data in the community versus hospital sector varied greatly. Five countries included long-term care facility data in both community and hospital sector reporting; nine countries only included long-term care facility data in community sector reporting; and four countries only included long-term facility data in hospital sector reporting.

## Total consumption (community and hospital sectors) of antibacterials for systemic use (ATC group J01)

### ECDC/EFSA/EMA primary indicator for total consumption of antibacterials for systemic use (ATC group J01) in humans

In 2021, the mean total consumption (community and hospital sectors combined) of antibacterials for systemic use (ATC group J01) in the EU/EEA was 16.4 DDD per 1 000 inhabitants per day, the same as in 2020. Country-level total consumption ranged from 8.3 in the Netherlands to 25.7 in Romania. During the period 2012–2021, a statistically significant decrease was observed for the EU/EEA overall. Statistically significant decreasing trends were observed for 13 countries and a statistically significant increasing trend was observed for one country (Bulgaria) (Table 1).



**Table 1. Total consumption (community and hospital sector) of antibacterials for systemic use (ATC group J01), EU/EEA and UK, 2012–2021 (expressed as DDD per 1 000 inhabitants per day)**

Country	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Time series, 2012–2021	Trend	Compound annual growth rate (CAGR)
Austria								11.6	8.8	8.8		N/A	N/A
Belgium	25.6	24.2	24.0	24.4	24.2	22.8	22.3	21.4	16.7	17.4		↓	-4.2%
Bulgaria	17.4	18.6	20.0	20.1	19.2	20.5	21.1	20.7	22.7	24.4		↑	3.8%
Croatia	20.0	19.2	19.4	19.7	18.7	18.6	18.8	18.8	15.7	18.2		↓	-1.1%
Cyprus	25.1	23.9	22.2	26.6	28.4	28.9	28.0	30.1	28.9	25.0		-	0.0%
Czechia								16.9	13.4	13.7		N/A	N/A
Denmark	17.4	17.5	17.1	17.5	17.0	16.2	15.6	15.3	14.3	14.4		↓	-2.1%
Estonia	12.2	12.0	11.9	12.1	12.0	11.6	11.8	11.8	10.5	10.1		↓	-2.1%
Finland	20.6	19.6	19.1	18.1	17.4	15.7	15.4	14.7	11.9	11.3		↓	-6.5%
France	25.7	25.9	24.9	25.6	25.6	24.7	25.3	25.1	20.3	21.5		↓	-2.0%
Germany												N/A	N/A
Greece	29.9	29.8	31.0	33.2	33.1	34.2	34.1	34.1	28.1	23.5		-	-2.6%
Hungary	14.1	14.5	15.2	15.8	14.4	14.6	14.8	14.4	11.2	11.9		-	-1.8%
Iceland	19.7	19.4				20.7	20.4	19.3	16.5	16.8		N/A	N/A
Ireland	21.0	21.6	21.0	23.0	22.0	20.9	22.4	22.8	18.6	17.8		-	-1.8%
Italy	24.6	25.2	24.5	24.5	24.0	20.9	21.4	21.7	18.4	17.5		↓	-3.7%
Latvia	12.9	13.3	12.6	13.1	12.9	13.9	13.4	13.9	11.9	11.6		-	-1.2%
Lithuania	15.3	17.1	15.1	15.8	16.6	16.6	16.3	16.1	14.1	13.7		-	-1.3%
Luxembourg	25.0	25.0	23.2	23.5	22.9	22.6	22.1	21.1	16.1	15.9		N/A	N/A
Malta	20.8	22.2	22.4	21.2	20.9	22.6	20.2	20.7	16.6	15.8		↓	-3.0%
Netherlands	10.9	10.5	10.3	10.4	10.1	9.8	9.7	9.5	8.5	8.3		↓	-3.0%
Norway	17.9	17.2	16.9	16.8	16.2	15.7	15.3	14.9	13.9	14.0		↓	-2.7%
Poland			21.2	24.1	22.0	25.4	24.4	23.6	18.5	20.2		-	-0.7%
Portugal	20.1	17.6	18.0	18.8	19.0	18.3	19.1	19.3	15.2	15.3		-	-3.0%
Romania	25.9	26.8	26.6	28.0	24.4	24.5	25.1	25.8	25.2	25.7		-	-0.1%
Slovakia	19.7	23.2	21.2	24.2	23.6	20.0	22.0	19.3	14.4	16.0		↓	-2.3%
Slovenia	13.2	13.3	13.1	13.3	13.0	13.1	13.2	13.0	10.2	10.2		↓	-2.8%
Spain	15.7†	16.2†	17.1†	17.5†	27.5	26.8	26.3	24.9	19.8	20.0		N/A	N/A
Sweden	15.3	14.2	14.0	13.5	13.2	12.8	12.4	11.8	10.4	10.1		↓	-4.5%
<b>EU/EEA*</b>	<b>21.2</b>	<b>21.6</b>	<b>21.2</b>	<b>21.7</b>	<b>20.9</b>	<b>20.4</b>	<b>20.3</b>	<b>19.8</b>	<b>16.4</b>	<b>16.4</b>		↓	<b>-2.8%</b>
United Kingdom		20.5	20.8	20.2	19.7	19.4	18.8	18.2				N/A	N/A
Crude EU/EEA**	22.3	22.0	21.7	22.3	22.2	21.7	21.7	21.1	17.8	18.1		N/A	N/A

All country data are shown as they are reported to The European Surveillance System.

= Total care data (community and hospital sectors) not reported.

\* EU/EEA refers to the population-weighted mean consumption based on reported or imputed antimicrobial consumption data from all 29 EU/EEA countries. Country adjustments were applied as detailed in the Methods chapter.

\*\* Crude EU/EEA refers to the population-weighted mean consumption based on reported data available for the specific year, with no imputations for missing data or adjustments for change in data source and includes the UK for the years 2013–2019.

N/A = Not applicable. Trend analyses were not performed and CAGR not calculated because of missing data, changes in the type of data or change in data process.

† = Spain reported reimbursement data for 2012–2015 and changed to sales data in 2016.

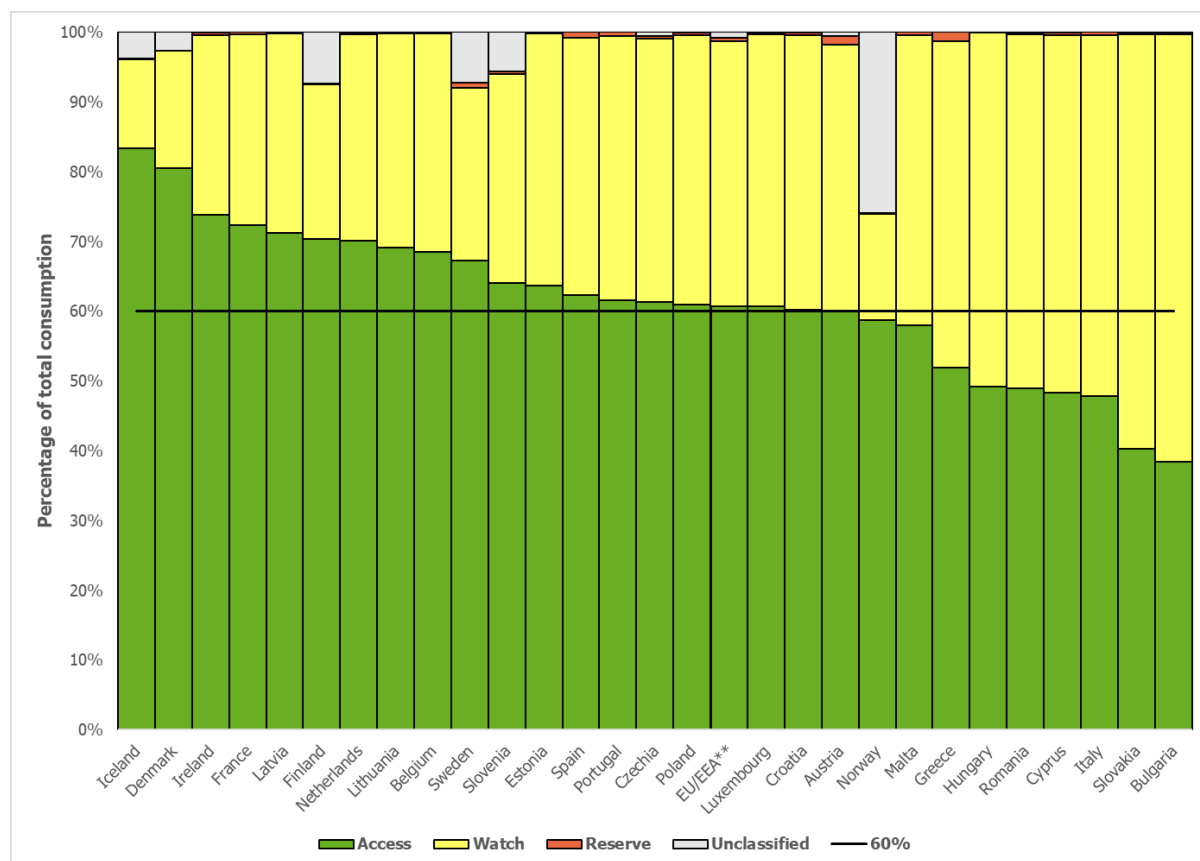
Luxembourg changed data process in 2020, which could have an impact on comparability with previous years.

For details, please refer to the Methods chapter.

## WHO 'Access', 'Watch' and 'Reserve' classification of antibiotics for evaluation and monitoring of use

Among 28 EU/EEA countries reporting consumption in both the community and hospital sectors in 2021, the mean percentage of 'Access' group antibiotics of all consumed antibiotics was 60.7%. Nineteen countries met or exceeded WHO's country-level target of at least 60% of antibiotic consumption being from agents in the 'Access' group. Nine countries had less than 60% of antibiotic consumption from the 'Access' group (Figure 1).

**Figure 1. Total consumption of antibacterials\* according to WHO AWaRe classification, percentage by class, EU/EEA countries, 2021**



Only the 28 countries reporting data for both the community and the hospital sector are included.

AWaRe: Access, Watch and Reserve classification of antimicrobials (WHO, 2021).

Sum of percentages of all groups may not add up 100% due to rounding of individual percentages during analysis.

\* Agents included in this analysis: antibacterials for systemic use, neomycin, streptomycin, polymyxin B, kanamycin, vancomycin, colistin, rifamixin, fidaxomicin, rifamycin, rifampicin, rifamycin, rifabutin, metronidazole, tinidazole, ornidazole and secnidazole. Consumption of 'Unclassified' mainly consisted of benzathine phenoxymethylpenicillin, combinations of benzylpenicillin/procaine-benzylpenicillin/benzathine-benzylpenicillin and methenamine.

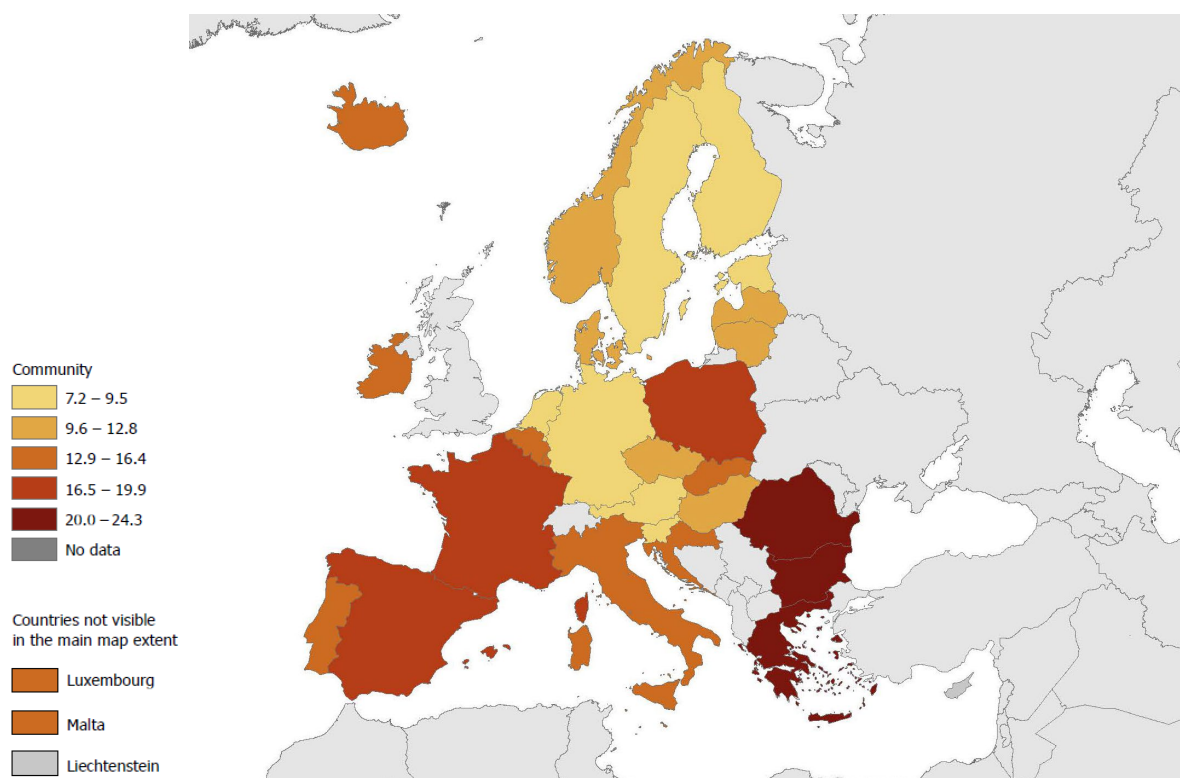
\*\* EU/EEA refers to the population-weighted mean percentage based on reported data for 2021 from the 28 countries included.



## Community consumption of antibacterials for systemic use (ATC group J01)

In 2021, the EU/EEA population-weighted mean consumption of antibacterials for systemic use in the community (i.e. outside of hospitals) was 15.0 DDD per 1 000 inhabitants per day, ranging from 7.2 in Austria to 24.3 in Romania (Figure 2).

**Figure 2. Community consumption of antibacterials for systemic use (ATC group J01), EU/EEA countries, 2021 (expressed as DDD per 1 000 inhabitants per day)**



Consumption of major sub-groups of antibacterials for systemic use (ATC group J01) in the community for 2021 is presented in Table 2 and Figure 3. Among the 28 countries reporting community data, penicillins (J01C) were the most frequently consumed antibacterials in all but two countries (Bulgaria and Slovakia), where macrolides, lincosamides and streptogramins (J01F) were the most frequently consumed.

The proportion of other antibacterial sub-groups varied widely among countries. For example, the proportion of tetracyclines (J01A) ranged from 4% in Italy and Romania to 28% in Iceland; cephalosporins and other beta-lactams (J01D) ranged from 0.2% in Denmark to 24% in Slovakia; macrolides, lincosamides and streptogramins (J01F) ranged from 4% in Finland and the Netherlands to 30% in Slovakia, and quinolones (J01M) ranged from 2% in Ireland and Norway to 18% in Bulgaria.

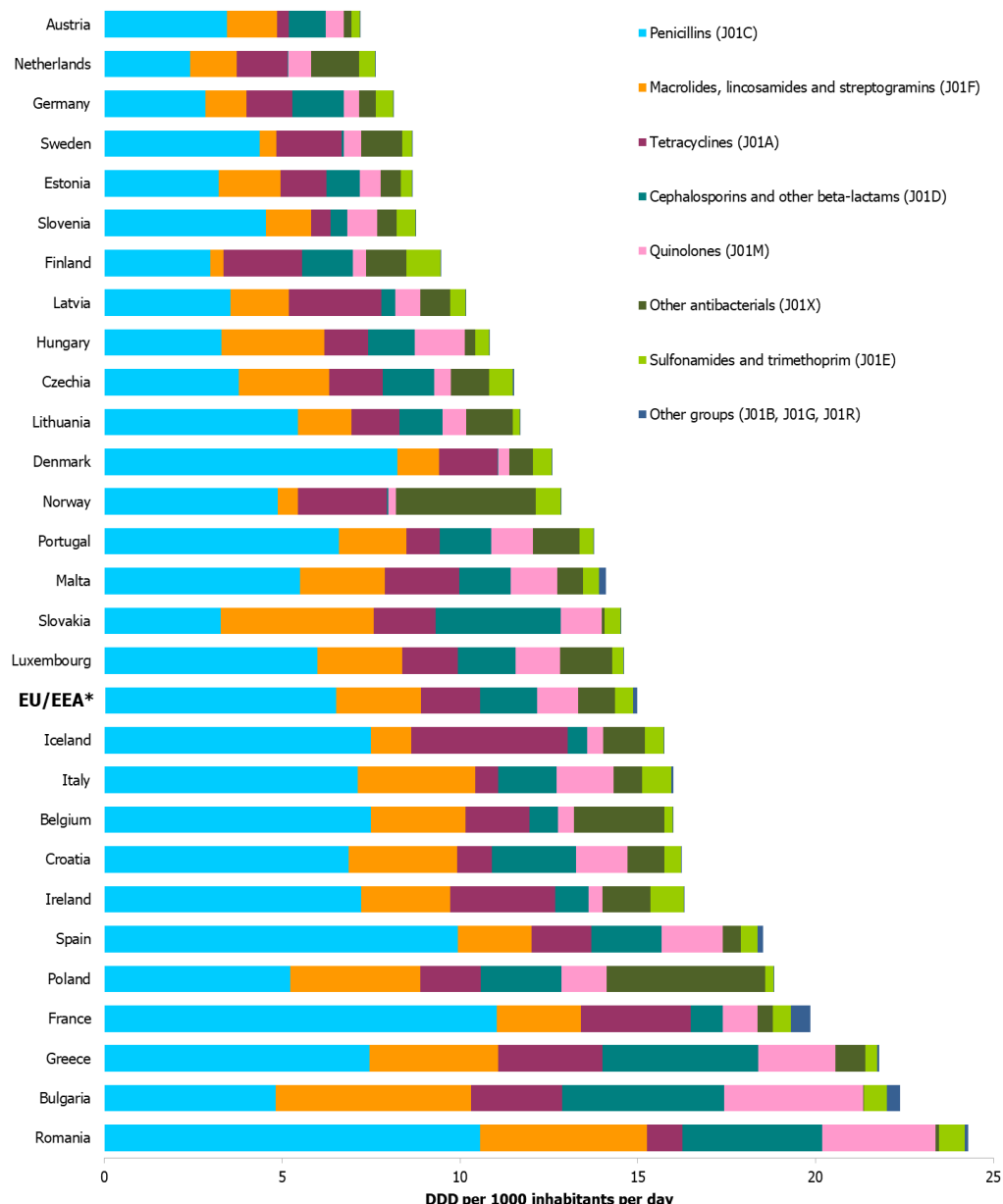
**Table 2. Community consumption of antibacterials for systemic use (ATC group J01) at ATC level 3 subgroup, EU/EEA countries, 2021 (expressed as DDD per 1 000 inhabitants per day)**

Country	Tetracyclines (J01A)	Beta-lactams, penicillins (J01C)	Other beta-lactam antibacterials (J01D)	Sulfonamides and trimethoprim (J01E)	Macrolides, lincosamides and streptogramins (J01F)	Quinolones (J01M)	Other antibacterials (J01X)	Other groups (J01B, J01G, and J01R)*	Total (ATC group J01)
Austria	0.3	3.5	1.0	0.2	1.4	0.5	0.2	0.0	7.2
Belgium	1.8	7.5	0.8	0.2	2.7	0.4	2.5	0.0	16.0
Bulgaria	2.6	4.8	4.5	0.7	5.5	3.9	0.0	0.4	22.4
Croatia	1.0	6.9	2.4	0.5	3.1	1.4	1.0	0.0	16.2
Czechia	1.5	3.8	1.4	0.7	2.5	0.5	1.1	0.0	11.5
Denmark	1.6	8.2	0.0	0.5	1.2	0.3	0.7	0.0	12.6
Estonia	1.3	3.2	0.9	0.3	1.7	0.6	0.6	0.0	8.7
Finland	2.2	3.0	1.4	0.9	0.4	0.4	1.1	0.0	9.4
France	3.1	11.0	0.9	0.5	2.4	1.0	0.4	0.5	19.9
Germany	1.3	2.8	1.4	0.5	1.2	0.4	0.5	0.0	8.1
Greece	2.9	7.4	4.4	0.3	3.6	2.2	0.8	0.1	21.8
Hungary	1.2	3.3	1.3	0.4	2.9	1.4	0.3	0.0	10.8
Iceland	4.4	7.5	0.5	0.5	1.1	0.5	1.2	0.0	15.7
Ireland	3.0	7.2	0.9	0.9	2.5	0.4	1.4	0.0	16.3
Italy	0.7	7.1	1.6	0.8	3.3	1.6	0.8	0.0	16.0
Latvia	2.6	3.5	0.4	0.4	1.7	0.7	0.8	0.0	10.2
Lithuania	1.4	5.5	1.2	0.2	1.5	0.7	1.3	0.0	11.7
Luxembourg	1.6	6.0	1.6	0.3	2.4	1.3	1.5	0.0	14.6
Malta	2.1	5.5	1.5	0.5	2.4	1.3	0.7	0.2	14.1
Netherlands	1.4	2.4	0.0	0.5	1.3	0.6	1.3	0.0	7.6
Norway	2.5	4.9	0.0	0.7	0.6	0.2	3.9	0.0	12.8
Poland	1.7	5.2	2.3	0.2	3.7	1.3	4.5	0.0	18.8
Portugal	0.9	6.6	1.4	0.4	1.9	1.2	1.3	0.0	13.7
Romania	1.0	10.6	3.9	0.7	4.7	3.2	0.1	0.1	24.3
Slovakia	1.7	3.3	3.5	0.5	4.3	1.2	0.1	0.0	14.5
Slovenia	0.5	4.6	0.5	0.5	1.3	0.9	0.5	0.0	8.7
Spain	1.7	9.9	2.0	0.5	2.1	1.7	0.5	0.2	18.5
Sweden	1.8	4.4	0.1	0.3	0.5	0.5	1.2	0.0	8.7
<b>EU/EEA**</b>	<b>1.7</b>	<b>6.5</b>	<b>1.6</b>	<b>0.5</b>	<b>2.4</b>	<b>1.2</b>	<b>1.0</b>	<b>0.1</b>	<b>15.0</b>

\* J01B: Amphenicols; J01G: Aminoglycoside antibacterials; J01R: Combinations of antibacterials.

\*\* EU/EEA refers to the population-weighted mean consumption based on countries that provided community sector data in 2021 (28 countries).

**Figure 3. Community consumption of antibacterials for systemic use (ATC group J01) at ATC level 3 sub-group, EU/EEA countries, 2021 (expressed as DDD per 1 000 inhabitants per day)**



\* EU/EEA refers to the population-weighted mean consumption based on countries that provided community sector data for 2021 (28 countries).

The EU/EEA population-weighted mean consumption of antibacterials for systemic use in the community decreased from 19.3 DDD per 1 000 inhabitants per day in 2012 to 15.0 in 2020, then remained constant at 15.0 in 2021. The decrease over the 10-year period was statistically significant (Table 3). Statistically decreasing trends were observed for 15 countries, while a significant increasing trend was observed for one country (Bulgaria).

There were statistically significant decreases in the EU/EEA population-weighted mean 10-year trends for consumption of sub-groups of antibacterials in the community for tetracyclines (J01A), cephalosporins and other beta-lactams (J01D), macrolides, lincosamides, streptogramins (J01F) and quinolones (J01M). No significant EU/EEA trends were detected for penicillins (J01C), sulfonamides or trimethoprim (J01E). Trends in consumption of sub-groups of antibacterials in the community are available as downloadable tables (D1–D7) on ECDC's website<sup>3</sup>.

<sup>3</sup> Downloadable tables: ESAC-Net 2021 Annual Epidemiological Report: <https://www.ecdc.europa.eu/en/publications-data/downloadable-tables-antimicrobial-consumption-annual-epidemiological-report-2021>

**Table 3. Community consumption of antibacterials for systemic use (ATC group J01), EU/EEA and UK, 2012–2021 (expressed as DDD per 1 000 inhabitants per day)**

Country	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Time series 2012–2021	Trend	Compound annual growth rate (CAGR)
Austria	12.2	14.2	12.1	12.1	11.4	11.9	10.4	9.8	7.1	7.2		↓	-5.7%
Belgium	23.9	22.6	22.4	22.8	22.5	21.1	20.7	19.8	15.3	16.0		↓	-4.4%
Bulgaria	16.1	17.3	18.6	18.8	17.6	18.9	19.5	19.1	20.7	22.4		↑	3.7%
Croatia	18.3	17.6	17.8	18.0	17.1	16.8	17.0	16.9	14.0	16.2		↓	-1.3%
Cyprus												N/A	N/A
Czechia	15.7	16.9	17.1	17.4						11.5		N/A	N/A
Denmark	15.7	15.7	15.2	15.3	15.2	14.3	13.6	13.4	12.5	12.6		↓	-2.4%
Estonia	10.3	10.3	10.2	10.5	10.4	9.9	10.2	10.2	8.8	8.7		↓	-2.0%
Finland	18.0	16.9	16.6	15.8	15.0	13.6	13.2	12.6	10.0	9.4		↓	-6.9%
France	24.0	24.1	23.1	23.8	23.9	23.0	23.6	23.3	18.7	19.9		↓	-2.1%
Germany	13.7	14.5	13.4	13.1	12.8	12.6	11.7	11.4	8.9	8.1		↓	-5.6%
Greece	28.2	28.0	29.2	31.3	31.0	32.1	32.5	32.4	26.4	21.8		-	-2.8%
Hungary	13.0	13.4	14.0	14.7	13.3	13.4	13.7	13.3	10.0	10.8		↓	-2.0%
Iceland			17.2	17.5	18.3	19.1	18.8	18.0	15.4	15.7		-	-1.3%
Ireland	19.5	20.0	19.5	21.3	20.4	19.3	20.7	21.0	17.1	16.3		-	-1.9%
Italy	22.5	23.3	22.6	22.4	21.8	19.0	19.5	19.8	16.5	16.0		↓	-3.7%
Latvia	11.0	11.3	10.6	11.1	11.1	12.1	11.5	12.0	10.0	10.2		-	-0.8%
Lithuania	13.3	15.1	13.1	13.6	14.3	14.4	14.0	13.8	11.9	11.7		-	-1.4%
Luxembourg	23.1	23.1	21.6	21.8	21.4	20.9	20.7	19.8	14.8	14.6		N/A	N/A
Malta	19.5	20.7	20.5	18.8	18.4	19.8	18.0	18.7	14.4	14.1		↓	-3.5%
Netherlands	10.1	9.6	9.4	9.5	9.2	8.9	8.9	8.7	7.8	7.6		↓	-3.1%
Norway	16.5	15.8	15.5	15.4	14.9	14.4	14.0	13.6	12.8	12.8		↓	-2.8%
Poland	19.9	20.5	19.9	22.8	20.7	23.8	23.0	22.2	17.1	18.8		-	-0.6%
Portugal	18.7	16.1	16.6	17.3	17.5	16.9	17.7	17.9	13.7	13.7		-	-3.4%
Romania								24.0	23.7	24.3		N/A	N/A
Slovakia	17.9	21.1	18.9	22.0	21.3	18.5	20.2	18.0	13.2	14.5		-	-2.3%
Slovenia	11.8	11.9	11.6	11.9	11.5	11.6	11.7	11.5	8.8	8.7		↓	-3.3%
Spain	15.7†	16.2†	17.1†	17.5†	25.6	25.0	24.6	23.3	18.2	18.5		N/A	N/A
Sweden	13.7	12.6	12.5	11.9	11.7	11.3	10.8	10.3	8.9	8.7		↓	-5.0%
<b>EU/EEA*</b>	<b>19.3</b>	<b>19.8</b>	<b>19.4</b>	<b>19.9</b>	<b>19.2</b>	<b>18.7</b>	<b>18.6</b>	<b>18.3</b>	<b>15.0</b>	<b>15.0</b>		↓	<b>-2.8%</b>
United Kingdom	17.7	18.3	18.5	17.9	17.5	17.0	16.3	15.6				N/A	N/A
Crude EU/EEA**	18.1	18.6	18.2	18.5	18.9	18.4	18.2	18.0	15.0	15.0		N/A	N/A

All country data are shown as they are reported to The European Surveillance System.

 = Community sector data not reported.

\* EU/EEA refers to the population-weighted mean consumption based on reported or imputed antimicrobial consumption data from all 29 EU/EEA countries. Country adjustments were applied as detailed in the Methods chapter.

\*\* Crude EU/EEA refers to the population-weighted mean consumption based on reported data available for the specific year, with no imputations for missing data or adjustments for change in data source. This includes the UK for the years 2012–2019.

N/A = Not applicable. Trend analyses were not performed and CAGR not calculated because of missing data, changes in the type of data or change in data process.

† = Spain reported reimbursement data for 2012–2015 and changed to sales data in 2016.

Luxembourg changed data process in 2020, which could have an impact on comparability with previous years.

For details, please refer to the Methods chapter.

## ECDC/EFSA/EMA secondary indicator for consumption of antibacterials for systemic use (ATC group J01) in the community

The ratio of consumption of broad-spectrum penicillins, cephalosporins, macrolides (except erythromycin) and fluoroquinolones (J01(CR+DC+DD+(FA-FA01)+MA)) to the consumption of narrow-spectrum penicillins, cephalosporins and erythromycin (J01(CA+CE+CF+DB+FA01)) is presented in Table 4.

**Table 4. Ratio of consumption (DDD per 1 000 inhabitants per day) of broad-spectrum penicillins, cephalosporins, macrolides (except erythromycin) and fluoroquinolones to consumption of narrow-spectrum penicillins, cephalosporins and erythromycin in the community, EU/EEA and UK, 2012–2021**

Country	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Time series, 2012–2021	Trend	Compound annual growth rate (CAGR)
Austria	4.4	4.4	4.4	4.4	4.2	4.2	3.9	3.6	3.5	3.7		↓	-1.9%
Belgium	2.4	2.0	2.2	2.2	2.2	2.2	2.1	1.9	2.1	1.9		↓	-2.3%
Bulgaria	2.1	2.3	3.0	3.5	4.2	4.0	4.2	4.5	4.9	5.6		↑	11.6%
Croatia	3.5	3.1	3.2	3.4	3.3	3.8	4.3	4.5	5.7	6.4		↑	7.0%
Cyprus												N/A	N/A
Czechia	2.9	2.6	2.9	3.0						5.0		N/A	N/A
Denmark	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3		↓	-3.0%
Estonia	2.2	2.5	2.5	2.7	2.8	2.9	3.0	3.0	3.3	3.3		↑	4.5%
Finland	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3		↓	-6.6%
France	1.7	1.5	1.4	1.3	1.2	1.1	1.0	0.9	1.1	1.0		↓	-5.2%
Germany	1.9	1.9	1.9	2.0	1.9	1.8	1.7	1.5	1.6	1.6		↓	-1.8%
Greece	4.5	4.4	7.0	4.8	3.8	4.9	4.9	5.1	4.4	4.3		-	-0.4%
Hungary	6.0	6.6	9.6	11.3	10.9	11.6	12.7	13.6	15.2	20.7		↑	14.6%
Iceland			0.8	0.9	0.8	0.7	0.6	0.5	0.5	0.5		↓	-7.6%
Ireland	1.9	1.7	1.4	1.4	1.6	1.4	1.3	1.2	1.0	0.9		↓	-8.2%
Italy	5.6	6.1	6.6	6.9	6.9	7.1	7.5	7.5	8.1	8.3		↑	4.5%
Latvia	1.1	1.2	1.3	1.3	1.4	1.5	1.7	1.9	2.2	2.6		↑	10.0%
Lithuania	0.9	0.9	0.9	0.9	1.0	1.1	1.1	1.1	1.2	1.6		↑	6.6%
Luxembourg	4.5	4.4	4.4	3.9	3.6	3.7	3.5	3.2	3.2	3.1		N/A	N/A
Malta	22.1	23.4	31.4	32.7	19.2	23.2	24.0	20.1	19.1	18.5		-	-2.0%
Netherlands	1.6	1.4	1.4	1.4	1.4	1.4	1.5	1.4	1.6	1.5		-	-0.1%
Norway	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1		↓	-6.0%
Poland	2.3	2.4	2.5	2.6	2.6	2.9	3.2	3.0	3.3	3.5		↑	4.4%
Portugal	5.0	5.3	5.2	5.2	5.1	4.1	4.1	5.0	5.8	5.8		-	1.6%
Romania								4.1	4.7	5.3		N/A	N/A
Slovakia	4.9	5.3	5.6	6.6	6.5	6.6	8.0	8.3	9.3	12.5		↑	11.0%
Slovenia	1.3	1.4	1.5	1.5	1.4	1.4	1.4	1.5	2.1	2.3		↑	6.2%
Spain	3.1†	3.1†	3.0†	3.1†	2.4	2.4	2.4	2.3	2.5	2.5		N/A	N/A
Sweden	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2		-	3.1%
<b>EU/EEA*</b>	<b>2.7</b>	<b>2.8</b>	<b>3.0</b>	<b>3.1</b>	<b>3.0</b>	<b>3.1</b>	<b>3.2</b>	<b>3.2</b>	<b>3.5</b>	<b>3.7</b>		↑	<b>3.5%</b>
United Kingdom	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5				N/A	N/A
Crude EU/EEA**	2.5	2.6	2.8	2.8	2.7	2.7	2.8	2.8	3.4	3.7		N/A	N/A

All country data are shown as they are reported to The European Surveillance System.

= Community sector data not reported.

\* EU/EEA refers to the population-weighted mean ratio based on reported or imputed antimicrobial consumption data from all 29 EU/EEA countries. Country adjustments were applied as detailed in the Methods chapter.

\*\* Crude EU/EEA refers to the population-weighted mean ratio based on reported data available for the specific year, with no imputations for missing data or adjustments for change in data source and includes the UK for the years 2012–2019.

N/A = Not applicable. Trend analyses were not performed and CAGR not calculated because of missing data, changes in the type of data or change in data process.

† = Spain reported reimbursement data for 2012–2015 and changed to sales data in 2016.

Luxembourg changed data process in 2020, which could have an impact on comparability with previous years.

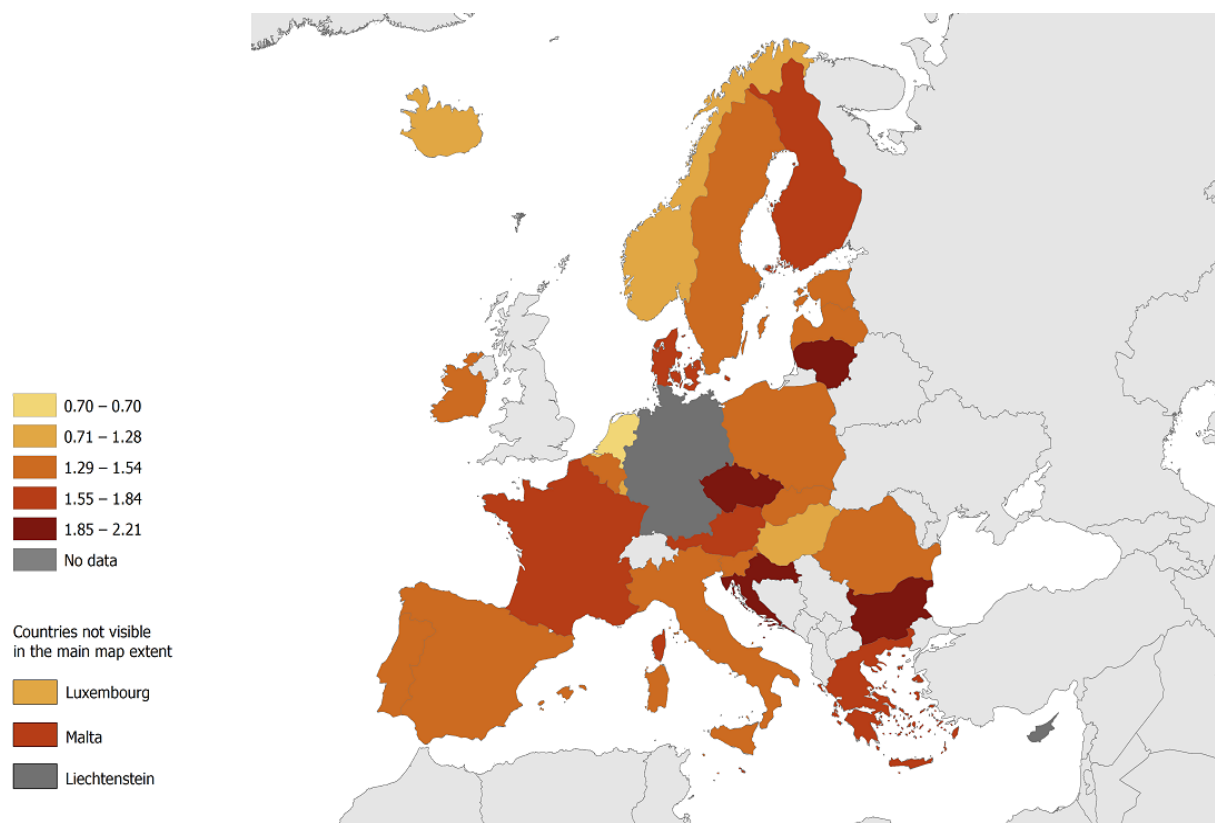
For details, please refer to the Methods chapter.

In 2021, the population-weighted mean ratio was 3.7 (country range: 0.1–20.7). During the period 2012–2021, a statistically significant increasing trend was observed for the EU/EEA overall and for 10 individual countries. Statistically significant decreasing 10-year trends were observed for nine countries.

## Hospital sector consumption of antibacterials for systemic use (ATC group J01)

In 2021, the EU/EEA population-weighted mean consumption of antibacterials for systemic use in the hospital sector among reporting countries was 1.5 DDD per 1 000 inhabitants per day, ranging from 0.7 in the Netherlands to 2.21 in Czechia (Figure 4).

**Figure 4. Hospital sector consumption of antibacterials for systemic use (ATC group J01), EU/EEA countries, 2021 (expressed as DDD per 1 000 inhabitants per day)**



Administrative boundaries: © EuroGeographics © UN-FAO © Turkstat. The boundaries and names shown on this map do not imply official endorsement or acceptance by the European Union. Map produced on: 22 Sep 2022

*Finland: data include consumption in remote primary healthcare centres and nursing homes.*

Consumption of major sub-groups of antibacterials for systemic use (ATC group J01) in the hospital sector in 2021 is presented in Table 5 and Figure 5. Substantial variations were reported across countries: the percentage of penicillins (J01C) consumed out of hospital sector consumption of antibacterials for systemic use ranged from 6% (Bulgaria) to 59% (Denmark). For cephalosporins and other beta-lactams (J01D, including carbapenems), this percentage ranged from 11% (Denmark) to 59% (Bulgaria). For macrolides, lincosamides and streptogramins (J01F), it ranged from 3% (Lithuania and Romania) to 13% (Czechia and Hungary), and for quinolones (J01M) from 3% (Ireland and Norway) to 17% (Bulgaria).

**Table 5. Hospital sector consumption of antibacterials for systemic use (ATC group J01) at ATC level 3 sub-group, EU/EEA countries, 2021 (expressed as DDD per 1 000 inhabitants per day)**

Country	Tetracyclines (J01A)	Beta-lactams, penicillins (J01C)	Other beta-lactam antibacterials (J01D)	Sulfonamides and trimethoprim (J01E)	Macrolides, lincosamides and streptogramins (J01F)	Quinolones (J01M)	Other antibacterials (J01X)	Other groups (J01B, J01G, and J01R)*	Total (ATC group J01)
Austria	0.05	0.62	0.49	0.05	0.11	0.12	0.18	0.01	1.63
Belgium	0.02	0.64	0.34	0.04	0.09	0.13	0.11	0.02	1.40
Bulgaria	0.06	0.12	1.21	0.01	0.13	0.34	0.08	0.11	2.07
Croatia	0.03	0.47	0.60	0.03	0.21	0.24	0.27	0.09	1.93
Czechia	0.05	0.88	0.57	0.09	0.29	0.12	0.13	0.07	2.21
Denmark	0.05	1.06	0.20	0.14	0.09	0.10	0.11	0.04	1.80
Estonia	0.03	0.53	0.46	0.05	0.12	0.11	0.09	0.01	1.41
Finland (a)	0.10	0.53	0.77	0.08	0.11	0.12	0.12	0.01	1.84
France	0.06	0.74	0.33	0.05	0.12	0.17	0.16	0.04	1.69
Greece	0.08	0.33	0.57	0.02	0.08	0.20	0.41	0.07	1.77
Hungary	0.06	0.22	0.41	0.03	0.15	0.12	0.11	0.02	1.12
Iceland	0.03	0.45	0.28	0.03	0.06	0.05	0.10	0.01	1.02
Ireland	0.05	0.72	0.21	0.08	0.15	0.05	0.17	0.06	1.49
Italy	0.03	0.45	0.38	0.21	0.11	0.15	0.17	0.03	1.54
Latvia	0.19	0.25	0.59	0.03	0.09	0.11	0.19	0.03	1.48
Lithuania	0.04	0.68	0.72	0.09	0.06	0.12	0.24	0.03	1.97
Luxembourg	0.02	0.46	0.40	0.03	0.12	0.12	0.12	0.02	1.28
Malta	0.09	0.70	0.20	0.03	0.17	0.16	0.28	0.05	1.68
Netherlands	0.02	0.24	0.23	0.02	0.04	0.06	0.07	0.02	0.70
Norway	0.06	0.54	0.24	0.07	0.05	0.03	0.08	0.07	1.14
Poland	0.04	0.23	0.54	0.05	0.09	0.16	0.23	0.04	1.37
Portugal	0.02	0.55	0.47	0.07	0.16	0.09	0.12	0.06	1.54
Romania	0.05	0.18	0.72	0.02	0.04	0.16	0.15	0.06	1.38
Slovakia	0.06	0.27	0.47	0.04	0.16	0.19	0.17	0.06	1.43
Slovenia	0.02	0.61	0.32	0.06	0.10	0.13	0.13	0.05	1.42
Spain	0.02	0.47	0.41	0.03	0.12	0.17	0.21	0.07	1.49
Sweden	0.12	0.80	0.16	0.05	0.05	0.13	0.08	0.01	1.40
<b>Crude EU/EEA**</b>	<b>0.04</b>	<b>0.49</b>	<b>0.43</b>	<b>0.07</b>	<b>0.11</b>	<b>0.15</b>	<b>0.17</b>	<b>0.05</b>	<b>1.5</b>

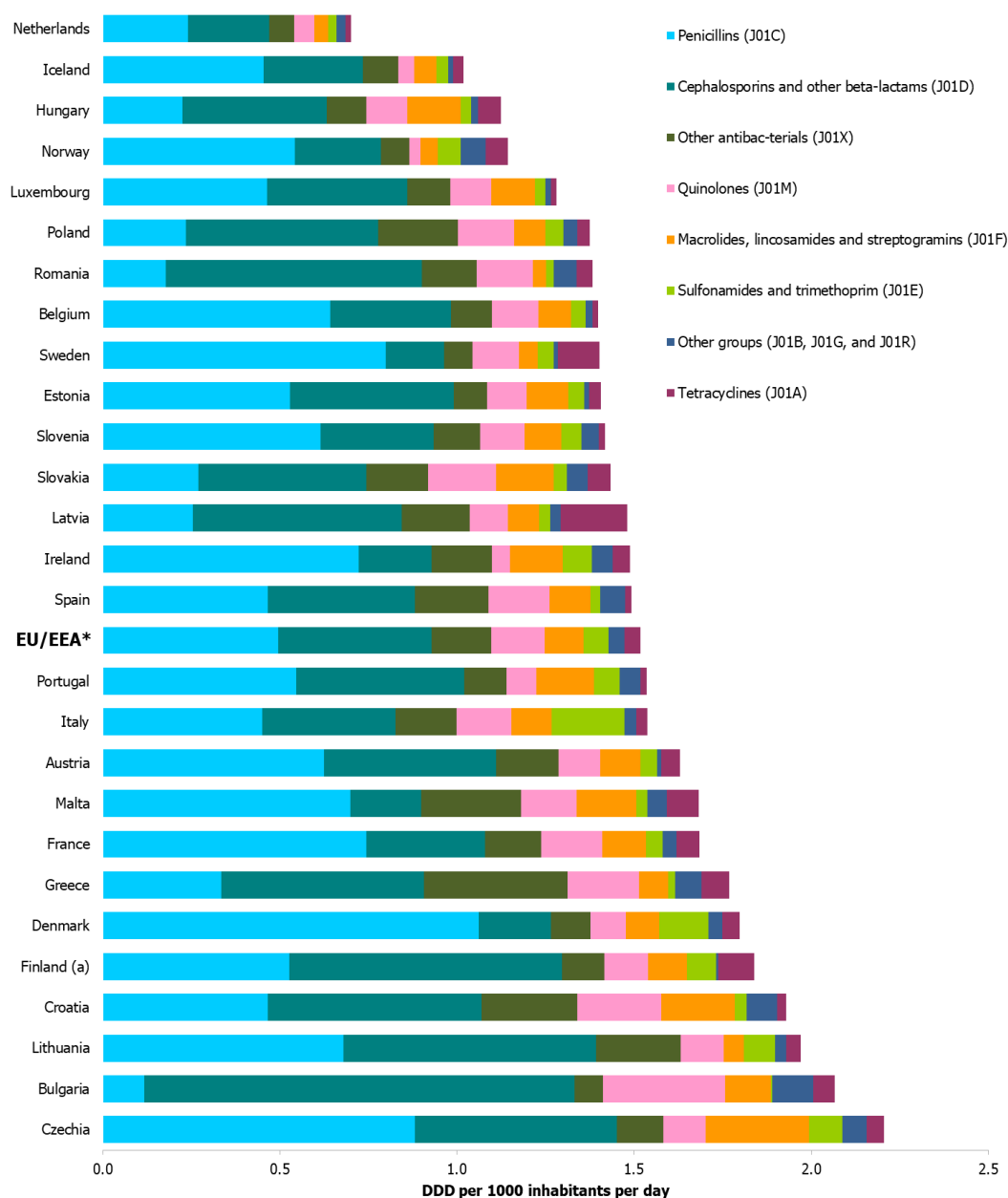
(a) Finland: data include consumption in remote primary healthcare centres and nursing homes.

\*J01B: Amphenicols; J01G: Aminoglycoside antibacterials; J01R: Combinations of antibacterials.

\*\* Crude EU/EEA refers to the population-weighted mean consumption based on countries that provided hospital sector data for 2021 (27 countries).



**Figure 5. Hospital sector consumption of antibacterials for systemic use (ATC group J01) at ATC level 3 sub-group, EU/EEA countries, 2021 (expressed as DDD per 1 000 inhabitants per day)**



\* EU/EEA refers to the population-weighted mean consumption based on countries that provided hospital sector data for 2021 (27 countries).

(a) Finland: data include consumption in remote primary healthcare centres and nursing homes.

The EU/EEA population-weighted mean consumption of antibacterials for systemic use in the hospital sector decreased from 1.65 DDD per 1 000 inhabitants per day in 2012 to 1.41 in 2021. The 10-year decreasing trend was statistically significant, with the largest annual decrease occurring between 2019 and 2020. In the individual countries, statistically decreasing trends were observed for seven countries, and a significant increasing trend was observed for one country (Table 6).

There were statistically significant decreases in the EU/EEA mean 10-year trends for hospital sector consumption of antibacterial sub-groups for penicillins (J01C) and quinolones (J01M), and a statistically significant increase for tetracyclines (J01A), cephalosporins and other beta-lactams (J01D), and sulfonamides and trimethoprim (J01E). No significant EU/EEA trend was detected for macrolides, lincosamides and streptogramins (J01F). Trends in consumption of sub-groups of antibacterials are available as downloadable tables (D8–D16) on ECDC's website<sup>4</sup>.

<sup>4</sup> Downloadable tables: ESAC-Net 2021 Annual Epidemiological Report: <https://www.ecdc.europa.eu/en/publications-data/downloadable-tables-antimicrobial-consumption-annual-epidemiological-report-2021>

**Table 6. Hospital sector consumption of antibacterials for systemic use (ATC group J01), EU/EEA and UK, 2012–2021 (expressed as DDD per 1 000 inhabitants per day)**

Country	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Time series 2012–2021	Trend	Compound annual growth rate (CAGR)
Austria								1.82	1.67	1.63		N/A	N/A
Belgium	1.70	1.64	1.62	1.64	1.64	1.62	1.62	1.59	1.40	1.40		↓	-2.2%
Bulgaria	1.33	1.34	1.35	1.32	1.58	1.52	1.62	1.63	1.98	2.07		↑	5.0%
Croatia	1.75	1.58	1.65	1.70	1.65	1.74	1.80	1.85	1.61	1.93		-	1.1%
Cyprus												N/A	N/A
Czechia										2.21		N/A	N/A
Denmark	1.65	1.88	1.97	2.19	1.84	1.91	1.94	1.86	1.75	1.80		-	0.9%
Estonia	1.88	1.69	1.71	1.62	1.58	1.65	1.55	1.54	1.65	1.41		↓	-3.2%
Finland (a)	2.65	2.63	2.51	2.36	2.38	2.11	2.28	2.10	1.94	1.84		↓	-4.0%
France	1.73	1.76	1.79	1.77	1.76	1.73	1.77	1.74	1.64	1.69		-	-0.3%
Germany												N/A	N/A
Greece	1.66	1.79	1.87	1.91	2.15	2.07	1.66	1.68	1.74	1.77		-	0.7%
Hungary	1.11	1.08	1.13	1.11	1.07	1.13	1.12	1.16	1.21	1.12		-	0.2%
Iceland						1.66	1.53	1.33	1.11	1.02		N/A	N/A
Ireland	1.58	1.59	1.48	1.71	1.66	1.60	1.78	1.77	1.47	1.49		-	-0.7%
Italy	2.13	1.87	1.86	2.09	2.21	1.89	1.91	1.89	1.92	1.54		-	-3.6%
Latvia	1.98	1.96	1.94	1.94	1.83	1.89	1.89	1.88	1.92	1.48		↓	-3.2%
Lithuania	2.06	1.98	1.96	2.15	2.29	2.29	2.25	2.25	2.21	1.97		-	-0.5%
Luxembourg	1.83	1.82	1.64	1.61	1.57	1.62	1.40	1.38	1.27	1.28		N/A	N/A
Malta	1.31	1.56	1.95	2.49	2.52	2.78	2.24	1.99	2.17	1.68		-	2.8%
Netherlands	0.85	0.84	0.85	0.87	0.85	0.83	0.84	0.80	0.76	0.70		↓	-2.1%
Norway	1.39	1.35	1.36	1.36	1.34	1.38	1.30	1.30	1.16	1.14		↓	-2.2%
Poland			1.32	1.31	1.25	1.62	1.36	1.42	1.36	1.37		-	0.6%
Portugal	1.36	1.51	1.43	1.45	1.46	1.44	1.40	1.40	1.45	1.54		-	1.4%
Romania								1.73	1.43	1.38		N/A	N/A
Slovakia	1.85	2.03	2.30	2.22	2.31	1.45	1.81	1.38	1.27	1.43		↓	-2.8%
Slovenia	1.39	1.38	1.43	1.49	1.50	1.52	1.50	1.50	1.32	1.42		-	0.2%
Spain					1.83	1.75	1.73	1.63	1.56	1.49		N/A	N/A
Sweden	1.57	1.60	1.49	1.59	1.56	1.51	1.65	1.47	1.42	1.40		-	-1.2%
<b>EU/EEA*</b>	<b>1.65</b>	<b>1.66</b>	<b>1.65</b>	<b>1.69</b>	<b>1.69</b>	<b>1.65</b>	<b>1.61</b>	<b>1.57</b>	<b>1.46</b>	<b>1.41</b>		↓	<b>-1.7%</b>
United Kingdom		2.18	2.30	2.25	2.27	2.30	2.47	2.53				N/A	N/A
Crude EU/EEA**	1.72	1.78	1.76	1.80	1.82	1.78	1.79	1.77	1.56	1.52		N/A	N/A

All country data are shown as they are reported to The European Surveillance System.

= Hospital sector data not reported.

(a) Finland: data include consumption in remote primary healthcare centres and nursing homes.

\* EU/EEA refers to the population-weighted mean consumption based on reported or imputed antimicrobial consumption data from all 29 EU/EEA countries.

\*\* Crude EU/EEA refers to the population-weighted mean consumption based on reported data available for the specific year, with no imputations for missing data or adjustments for change in data source and includes the UK for the years 2013–2019.

N/A = Not applicable. Trend analyses were not performed and CAGR not calculated because of missing data, changes in the type of data or change in data process.

Luxembourg changed data process in 2020, which could have an impact on comparability with previous years.

For details, please refer to the Methods chapter.

## ECDC/EFSA/EMA secondary indicator for consumption of antibacterials for systemic use (ATC group J01) in the hospital sector

The proportion of glycopeptides (ATC group J01XA), third- and fourth-generation cephalosporins (J01DD and J01DE), monobactams (J01DF), carbapenems (J01DH), fluoroquinolones (J01MA), polymyxins (J01XB), piperacillin and enzyme inhibitor (J01CR05), linezolid (J01XX08), tedizolid (J01XX11), and daptomycin (J01XX09) out of the total hospital consumption of antibacterials for systemic use is presented in Table 7.

The population-weighted mean proportion in 2021 among reporting countries was 41.0% and ranged from 19.5% in Finland to 70.9% in Bulgaria.

During the period 2012–2021, statistically significant increasing trends were observed for the EU/EEA overall and for nine countries, while no country showed a statistically significant decreasing trend (Table 7). The three countries with the highest proportion of 'broad-spectrum' antimicrobials as defined by this indicator during 2021 (Bulgaria, Greece and Romania) were also among the top four countries with the largest increases in percentage between 2020 and 2021.

**Table 7. Proportion (%) of glycopeptides, third- and fourth-generation cephalosporins, monobactams, carbapenems, fluoroquinolones, polymyxins, piperacillin and enzyme inhibitor, linezolid, tedizolid and daptomycin out of total hospital consumption (DDD per 1 000 inhabitants per day) of antibacterials for systemic use, EU/EEA and UK, 2012–2021**

Country	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Time series 2012–2021	Trend	Compound annual growth rate (CAGR)
Austria								34.0	34.7	36.5		N/A	N/A
Belgium	31.1	31.3	31.5	31.7	31.0	30.9	30.2	29.8	31.4	30.6		-	-0.2%
Bulgaria	55.2	52.7	57.5	55.2	59.8	58.2	57.5	58.5	62.6	70.9		↑	2.8%
Croatia	26.5	27.8	31.0	31.7	30.9	32.3	32.2	33.5	36.8	39.5		↑	4.5%
Cyprus												N/A	N/A
Czechia										23.5		N/A	N/A
Denmark	21.3	22.7	22.6	20.6	23.7	21.4	22.9	23.9	24.7	24.1		↑	1.4%
Estonia	23.2	19.3	20.0	20.0	20.6	23.2	19.8	21.7	24.6	24.8		-	0.7%
Finland (a)	19.0	22.2	22.7	21.9	22.9	23.2	19.4	18.1	21.4	19.5		-	0.3%
France	32.0	31.3	32.3	32.3	31.3	31.6	32.6	30.1	32.4	33.4		-	0.5%
Germany												N/A	N/A
Greece	39.5	35.9	35.7	38.6	35.8	36.9	49.1	50.8	50.8	59.8		↑	4.7%
Hungary	37.2	37.8	37.4	38.8	39.4	40.1	40.6	36.3	40.8	42.4		↑	1.5%
Iceland						16.4	18.1	17.0	18.7	21.3		N/A	N/A
Ireland	26.3	32.3	36.9	29.5	30.1	29.4	28.7	28.1	30.3	31.1		-	1.9%
Italy	44.2	49.1	48.4	42.8	37.0	48.6	48.5	44.5	42.8	44.4		-	0.0%
Latvia	37.1	40.3	40.0	38.9	40.5	38.4	38.7	40.6	36.9	41.9		-	1.4%
Lithuania	26.8	19.6	20.4	25.2	23.1	22.8	21.2	23.8	25.2	21.8		-	-2.3%
Luxembourg	31.3	31.1	31.9	33.3	36.0	34.0	35.7	35.1	37.9	37.5		N/A	N/A
Malta	29.3	30.2	34.8	33.5	27.5	27.4	37.9	37.0	38.6	41.2		↑	3.9%
Netherlands	24.8	25.2	25.2	25.1	25.2	24.6	25.1	24.3	26.8	28.7		-	1.7%
Norway	21.5	21.8	22.1	22.1	22.3	19.8	20.7	19.4	19.5	21.7		-	0.1%
Poland			23.6	24.1	34.2	24.3	31.8	29.2	34.3	44.1		↑	9.4%
Portugal	41.0	42.6	43.8	43.6	43.5	42.2	42.8	42.6	43.3	44.2		-	0.8%
Romania								55.4	55.1	64.8		N/A	N/A
Slovakia	27.1	27.4	28.0	30.5	30.8	35.1	32.6	32.3	35.1	38.6		↑	4.0%
Slovenia	32.4	31.5	32.1	32.8	32.1	31.2	31.3	30.7	31.3	32.2		-	-0.1%
Spain					47.8	45.3	44.6	45.7	47.9	50.3		N/A	N/A
Sweden	25.0	25.2	27.1	26.5	27.4	26.9	24.5	27.9	28.6	30.4		↑	2.2%
<b>EU/EEA*</b>	<b>34.9</b>	<b>35.9</b>	<b>36.1</b>	<b>35.2</b>	<b>34.7</b>	<b>35.7</b>	<b>37.2</b>	<b>35.6</b>	<b>37.1</b>	<b>40.3</b>		↑	1.6%
<i>United Kingdom</i>		15.8	16.8	17.4	17.6	16.6	16.7	16.6				N/A	N/A
<i>Crude EU/EEA**</i>	34.7	31.6	31.3	30.5	32.5	32.8	33.8	33.7	38.5	41.0		N/A	N/A

All country data are shown as they are reported to The European Surveillance System.

= Hospital sector data not reported.

(a) Finland: data include consumption in remote primary healthcare centres and nursing homes.

\* EU/EEA refers to the population-weighted mean consumption based on reported or imputed antimicrobial consumption data from all 23 EU/EEA countries where data were reported or imputations possible.

\*\* Crude EU/EEA refers to the population-weighted mean consumption based on reported data available for the specific year, with no imputations for missing data, or adjustments for change in data source and includes the UK for the years 2013–2019.

N/A = Not applicable. Trend analyses were not performed and CAGR not calculated because of missing data, changes in the type of data or change in data process.

Luxembourg changed data process in 2020, which could have an impact on comparability with previous years.

For details, please refer to the Methods chapter.

## Consumption of specific antimicrobial groups used to treat patients infected with resistant bacteria in the hospital sector

Trends in consumption of carbapenems (ATC group J01DH) and polymyxins (J01XB) in the hospital sector are available in downloadable tables on ECDC's website<sup>5</sup> (Tables D11 and D16, respectively).

In 2021, the EU/EEA population-weighted mean consumption of carbapenems was stable, compared to 2020, at 0.05 DDD per 1 000 inhabitants per day. Between 2012 and 2021, the EU/EEA population-weighted mean consumption of carbapenems did not show a statistically significant increase. However, a statistically significant increase was observed for 10 countries (Bulgaria, Croatia, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland and Slovakia) during this period. A statistically significant decrease was observed in four countries (Belgium, Finland, Norway, and Portugal).

The ten countries with the highest hospital carbapenem consumption in 2020 also had the highest carbapenem consumption in 2021. The top three countries for hospital carbapenem consumption for 2021 (Bulgaria, Croatia and Greece) were also among the top four countries with the largest increases in consumption between 2020 and 2021.

The EU/EEA population-weighted mean consumption of polymyxins showed a statistically significant increase between 2012 and 2021. During this period, a statistically significant increase was observed for seven countries (Bulgaria, Croatia, Denmark, Greece, Hungary, Latvia, Portugal) and a statistically significant decreasing trend was seen in two countries (Ireland and the Netherlands).

Polymyxin consumption in the hospital sector ranged from less than 0.001 DDD per 1 000 inhabitants per day (Finland and Norway) to 0.084 DDD per 1 000 inhabitants per day (Spain). The three countries with the highest hospital polymyxin consumption in 2020 remained the top three countries for consumption in 2021 (Greece, Portugal and Spain).

The trends in the percentage of 'Reserve' antibiotics (according to WHO AWaRe classification, antibiotics that should be reserved for treatment of confirmed or suspected multidrug-resistant infections) among total hospital antibiotic consumption are displayed in downloadable table D22. In 2021, the EU/EA population-weighted mean percentage of 'Reserve' antibiotics was 3.7%. This percentage showed a statistically significant increase between 2012 and 2021, and has grown each year since 2016. Statistically significant increases in this percentage were observed for 16 countries during the period, and no country had a statistically significant decrease.

## Changes in the consumption of antibacterials for systemic use (ATC group J01) between 2019 and 2021

### *Total consumption (community and hospital sectors)*

The largest annual decrease in total (community and hospital sectors combined) consumption of antibacterials for systemic use (ATC group J01) seen in ESAC-Net's two-decade history was between 2019 and 2020. The overall EU/EEA population-weighted mean decreased from 19.8 DDD per 1 000 inhabitants per day in 2019 to 16.4 DDD per 1 000 inhabitants per day in 2020, representing a 17% decrease. Prior to 2020, smaller annual decreases (less than 4%) were seen in total consumption, starting in 2016. In 2021, total consumption stabilised, mainly reflecting a stabilisation in the community sector, as shown in Table 3.

An examination of annual changes in consumption of antibacterials for systemic use at the country-level between 2019 and 2021 shows that one country (Bulgaria) had an increase in the total consumption (community and hospital sectors combined) between 2019 and 2020, and 15 countries had increases in the total consumption between 2020 and 2021. However, in 2021 total consumption remained below 2019 levels for all but one country (Bulgaria).

Crude EU/EEA consumption increased between 2020 and 2021; this measure excludes imputed total consumption values for Germany based on community-only reporting. The impact of Germany's large reductions in community consumption during 2020 and 2021 (Table 3) are therefore not reflected in this measure.

### *Community sector*

For community consumption, one country (Bulgaria) had an increase in consumption between 2019 and 2020. Between 2020 and 2021, 14 countries showed increases in community consumption, although only two countries (Bulgaria and Romania) had higher community consumption in 2021 than in 2019.

While community consumption of ATC level 2 group J01 stabilised in 2021, changes were observed among ATC sub-groups and summarised in the composite ECDC/EFSA/EMA secondary indicator for consumption of antibacterials for systemic use in the community. Between 2019 and 2020, the EU/EEA population-weighted mean ratio of 'broad-spectrum' to 'narrow-spectrum' antibiotics as defined by this indicator saw the largest annual increase in the past 10 years, from 3.2 to 3.5. In 2021, this ratio further increased to 3.7. A two-year consecutive increase of this magnitude had not been previously observed.

<sup>5</sup> Downloadable tables: ESAC-Net 2021 Annual Epidemiological Report: <https://www.ecdc.europa.eu/en/publications-data/downloadable-tables-antimicrobial-consumption-annual-epidemiological-report-2021>

As seen in Table 4, among the 10 countries with statistically significant increasing 10-year trends in the ECDC/EFSA/EMA secondary indicator for consumption of antibacterials for systemic use in the community, nine had consecutive increases in their ratios during the past two years. The other country (Estonia) had an increase from 2019 to 2020 and then remained the same for 2021. In contrast, only one of the nine countries with statistically significant decreasing 10-year trends showed consecutive decreases over the past two years (Ireland). The other eight had an annual increase between 2019 and 2021, or remained stable.

### **Hospital sector**

As hospital consumption represents only 9% of the overall EU/EEA total consumption of antibacterials for systemic use, the continued decline in consumption between 2020 and 2021 is not immediately apparent when hospital and community sectors are combined. The overall EU/EEA population-weighted mean consumption in the hospital sector decreased linearly by 0.04 DDD per 1 000 inhabitants per day between 2016 and 2019. The largest annual decrease occurred in 2020 (0.11 DDD per 1 000 inhabitants per day), followed by a reduction of 0.05 DDD per 1 000 inhabitants per day in 2021.

At the country-level, eight countries had increases in hospital consumption between 2019 and 2020, and 11 had increases between 2020 and 2021. Five countries (Bulgaria, Croatia, Greece, Portugal, and Slovakia) had higher hospital consumption in 2021 than in 2019.

The overall EU/EEA population-weighted proportion of AMC from 'broad spectrum' sub-groups, as defined by ECDC/EFSA/EMA secondary indicator for hospital consumption of antibacterials for systemic use, also showed consecutive annual increases during the period 2019–2021. The largest annual increase in the past 10 years occurred between 2020 and 2021 (Table 7). The five countries with the highest proportion of 'broad-spectrum' antibiotic consumption in the hospital sector during 2020 remained those with the highest proportions in 2021.

## **Consumption of antimicrobials from other ATC groups**

### **Consumption of antibacterials against *Clostridioides difficile* in the hospital sector**

Hospital consumption of oral vancomycin (ATC code A07AA09) and fidaxomicin (A07AA12), and oral and rectal metronidazole (P01AB01) is presented in Table D17.

In 2021, hospital consumption of oral vancomycin (A07AA09) and fidaxomicin (A07AA12) combined was below 0.01 DDD per 1 000 inhabitants per day for each of the 19 countries that reported consumption.

Oral and rectal metronidazole (P01AB01) consumption in the hospital sector was reported by 25 countries and ranged from below 0.01 DDD per 1 000 inhabitants per day to 0.03 DDD per 1 000 inhabitants per day.

### **Consumption of antimycotics and antifungals for systemic use (ATC groups J02 & D01B) in the community**

Twenty-eight countries reported data on consumption of antimycotics and antifungals for systemic use (ATC groups J02 & D01B) in the community for 2021. The EU/EEA population-weighted mean consumption was 0.90 DDD per 1 000 inhabitants per day and consumption varied by a factor of 11 (Table D18).

Terbinafine (ATC code D01BA02), fluconazole (J02AC01) and itraconazole (J02AC02) comprised between 90% and 100% of the total consumption of antimycotics and antifungals for systemic use in the community among the reporting countries.

### **Consumption of antimycotics and antifungals for systemic use (ATC groups J02 & D01B) in the hospital sector**

Twenty-five countries reported data on consumption of antimycotics and antifungals for systemic use (ATC groups J02 & D01B) in the hospital sector for 2021. The EU/EEA population-weighted mean consumption was 0.14 DDD per 1 000 inhabitants per day. Consumption varied from 0.03 to 0.23 DDD per 1 000 inhabitants per day (Table D19).

## Consumption of antimycobacterials (ATC group J04) in both sectors (community and hospital sectors combined)

Twenty-eight countries reported data on antimycobacterials (ATC group J04) for 2021. The data were pooled for the two sectors (Table D20). Germany, the Netherlands and Spain only reported data for the community.

The total EU/EEA population-weighted mean consumption of antimycobacterials (ATC group J04) was 0.19 DDD per 1 000 inhabitants per day in 2021 and had a statistically significant trend downwards over the five-year period 2017–2021.

In 2021, consumption of antimycobacterials differed by a factor of 11 between countries, from 0.05 DDD per 1 000 inhabitants per day in Estonia to 0.59 in Romania. Statistically significant decreasing trends were observed for 12 countries (Bulgaria, Croatia, Denmark, Finland, Hungary, Latvia, Lithuania, Norway, Romania, Slovakia, Spain and Sweden). Slovenia showed a significantly increasing trend during the period 2017–2021.

## Consumption of antivirals for systemic use (ATC group J05) in both sectors (community and hospital sectors combined)

Twenty-eight countries reported data on antivirals for systemic use (ATC group J05) in 2021. The data were pooled for the two sectors (Table D21). Germany, the Netherlands and Spain only reported data for the community.

The total EU/EEA population-weighted mean consumption of antivirals for systemic use (ATC group J05) was 2.73 DDD per 1 000 inhabitants per day and did not show any statistically significant trend over the five-year period 2017–2021.

In 2021, reported consumption of antivirals for systemic use showed a 22-fold difference between countries, from 0.28 DDD per 1 000 inhabitants per day in Spain (community data only) to 6.25 in Portugal. Statistically significant increasing trends were observed for seven countries (Croatia, Cyprus, France, Germany, Hungary, Norway and Spain). Italy showed a significantly decreasing trend during the period 2017–2021.



## Discussion

Antimicrobial resistance (AMR) is considered one of the main threats to public health in the EU/EEA [12,13]. High levels of AMR are reported for several important bacterial species in the EU/EEA [14], with over 35 000 deaths attributable to infections with antibiotic-resistant bacteria estimated in 2020 [15]. Excessive and inappropriate antibiotic use promotes development of AMR, in conjunction with inadequate infection prevention and control practices [16].

For the past two decades, considerable efforts have been made in the EU/EEA to optimise antimicrobial consumption and use as a means of addressing increasing AMR [12, 13, 17]. While the significantly decreasing trends in the EU/EEA population-weighted mean consumption of antibacterials for systemic use (ATC group J01) across both the community and hospital sectors between 2012 and 2021 are encouraging, the most recent data from ESAC-Net also highlight opportunities for further significant reductions through antimicrobial stewardship initiatives and other public health investments [13, 16, 17].

### Rebounds in antibiotic consumption in the community sector

Large reductions in community AMC seen consistently across almost all EU/EEA countries in 2020 [18, 19] did not continue in 2021. Dramatic changes in population behaviour [20], healthcare delivery [21, 22], and general communicable disease epidemiology during 2020 due to the COVID-19 pandemic [23, 24] were not sustainable to the same degree in 2021 and the dwindling positive effects of the pandemic are reflected in 2021 ESAC-Net data (Table 3). Among the 14 EU/EEA countries with increases in community consumption during 2021, 12 experienced rebounds that did not reach their 2019 levels of community consumption, in keeping with their downward trajectories prior to the COVID-19 pandemic.

The two countries that exceeded their 2019 community consumption in 2021 (Bulgaria and Romania) were also the two countries with the highest community consumption, exhibiting a worrying divergence from improvements shown in the other EU/EEA countries. Examination of trends in consumption of ATC level 3 sub-groups for the community sector (downloadable tables D1–D7) and proportional consumption of these groups compared to the EU/EEA mean (Table 2, Figure 3) can help countries determine where there is potential for reductions.

Such an assessment of the drivers of antimicrobial use is a key step in developing and implementing effective National Action Plans (NAPs) on AMR [25]. With changing patterns in antimicrobial consumption during 2020 and 2021, renewed efforts are warranted to ensure prudent use in the community, where most antibiotics are consumed. Even if overall consumption has decreased, examination at the level of ATC sub-groups, or even at the level of individual antimicrobial agents, can identify areas for improvement. Antimicrobial consumption rates above the EU/EEA mean and consecutive increases year after year warrant further investigation for drivers of increased consumption and reasons for increased use. As most countries were experiencing decreases in community consumption prior to the COVID-19 pandemic, 2019 consumption rates can be used as a benchmark for consumption, as well as the EU/EEA mean.

### Variations in antibiotic consumption in the hospital sector

The effects of the COVID-19 pandemic on AMC were less consistent in the hospital sector than in the community sector [18]. The variations in hospital sector AMC patterns during 2020 and 2021 could be due to variations in the degree to which hospital systems needed to change healthcare delivery in response to the demands of the COVID-19 pandemic [26]. Countries which experienced a greater strain on hospitals and healthcare due to COVID-19 probably saw fewer emergency and planned hospital admissions for chronic conditions [27, 28]. On the other hand, antibiotics for empiric therapy and secondary bacterial infection might have increased in hospitals with more COVID-19 cases [29]. The extent to which hospital systems revert to pre-pandemic practices or continue to evolve remains to be seen. Shifting priorities in healthcare related to COVID-19 and pandemic response can also undermine antimicrobial stewardship efforts and these changed priorities may continue in varying degrees across EU/EEA countries.

Comparisons of hospital consumption between countries was challenging even before the COVID-19 pandemic. Differences in sector (hospital or community) attribution of elective surgical interventions and convalescent care can lead to wide variations in AMC, and these variations are more apparent in the hospital sector due to smaller volumes being reported. Hospital AMC expressed as 'DDD per 1 000 inhabitants per day' should therefore be interpreted with caution. Another denominator such as 'occupied bed-days' might reveal additional findings in hospital AMC, accounting for differences in per capita hospitalisation volumes [30]. Use of another denominator for hospital AMC, such as 'occupied bed-days' has therefore been recommended for measuring hospital AMC [6] and this is being explored for future analyses of ESAC-Net data.

## Unprecedented increases in secondary indicators for antibiotic consumption

While overall community consumption stabilised and overall hospital consumption continued to decrease in 2021, some countries saw worrying increases in certain ATC sub-groups. Secondary indicators of antimicrobial consumption, such as percentage of 'Access' or 'Reserve' antibiotics per WHO AWaRe classification and the ECDC/EFSA/EMA secondary indicators of 'broad' to 'narrow' spectrum antibiotic consumption, have been useful composite indicators for evaluating the relative distribution of certain ATC sub-groups and identifying areas for improvement.

### WHO AWaRe classification

The WHO AWaRe classification can inform not only decisions about prudent use of antibiotics, but also decisions about antibiotic availability. The AWaRe classification can be used at the healthcare facility or government level to develop financial incentives for prudent use of antibiotics. Financial penalties and pay-for-performance schemes have been associated with decreases in inappropriate antibiotic prescriptions [31].

The WHO AWaRe classification is included in the ESAC-Net Annual Epidemiological Report for the first time this year, adding an additional indicator for AMC: the percent of total AMC from the 'Access' group antibiotics. As this classification scheme does not include all antimicrobials, a limitation of our analysis is apparent in countries that use high proportions of unclassified agents not considered to have an impact on AMR. For example, methenamine (ATC J01XX05), an oral antimicrobial not considered to be an AMR-inducing agent, is commonly used in Norway for prophylaxis of urinary tract infections [32]. Norway has less than 60% of AWaRe antibacterials in the 'Access' group but would be among the countries with the highest percentage of 'Access' antibacterials if the 'unclassified' category were eliminated from the analysis.

A recent publication based on ESAC-Net data reported an increasing trend in consumption of 'Reserve' antibiotics in the hospital sector in European countries during 2010–2018 [33]. Downloadable table D22 from this report shows that the trend has continued into 2021, with even larger increases in recent years. Continued evaluation of this indicator can strengthen data-driven antimicrobial stewardship efforts and public health decisions, such as those that make 'Access' group antibiotics more accessible and reserve 'Reserve' group antibiotics for when they are necessary.

### ECDC/EFSA/EMA secondary indicators for consumption of antibacterials for systemic use (ATC group J01) in the community and hospital sectors

The ECDC/EFSA/EMA secondary indicators indicate a recent acceleration in the increased proportion of 'broad-spectrum' antimicrobials consumed in both the community and hospital sectors. Both sectors saw consecutive increases in these indicators during the past two years, with the increases between 2019 and 2021 being greater than any other two-year increases previously seen. In the community sector, the greatest increase in the 'broad-to-narrow' ratio was in 2020 (Table 4), while the greatest increase in the proportion of 'broad-spectrum' antibiotics in the hospital sector was in 2021 (Table 7).

The annual increase in the proportion of 'broad-spectrum' antibiotics in the hospital sector more than doubled between 2020 and 2021, which is of concern. While the highest annual increase in 2020 was 5.1% (Poland), in 2021 four countries (Bulgaria, Greece, Poland, and Romania) had annual increases above 5.1% (range 8.4%–9.8%).

### Increases in consumption of last-line antimicrobials in the hospital sector

Statistically significant increases in the percentage of 'Reserve' antibiotic consumption were seen in 80% of EU/EEA countries for which a trend analysis could be performed (downloadable table D22). As 'Reserve' antibiotics should be treated as 'last-resort' options for treatment when all alternatives have failed or are not suitable, initiatives to strengthen stewardship programmes targeting these antibiotics are warranted to preserve their effectiveness.

While some countries with a high 'Reserve' percentage (e.g. Greece) also had a high proportion of 'broad-spectrum' antibiotic consumption in the hospital sector, other countries (Bulgaria, Poland, Romania) had high values for only the latter composite secondary indicator. These countries reported high consumption of individual antimicrobial agents (ATC level 5) at varying degrees within the ATC level 4 sub-groups for tetracyclines (J01AA), third- and fourth-generation cephalosporins (J01DD and J01DE), fluoroquinolones (J01MA), polymyxins (J01XB) and other antibacterials (J01XX). It should be noted that tigecycline (J01AA12) is included in the 'Reserve' group but not in the 'broad-spectrum' group for the ECDC/EFSA/EMA indicator. On the other hand, fourth-generation cephalosporins (J01DE) are not in the 'Reserve' group but in the 'broad-spectrum' group for the ECDC/EFSA/EMA indicator. Therefore countries with low tigecycline consumption but high cefepime (J01DE01) consumption such as Bulgaria can have one of the highest values for the ECDC/EFSA/EMA indicator, yet one of the lowest proportions of 'Reserve' antibiotic consumption in the hospital sector.

The acceleration of consumption of last-line antibiotics such as carbapenems (J01DH) and polymyxins (J01XB) in the hospital sector is worrying, although increasing use of such last-line antibiotics might be necessary in some countries with high levels of AMR. Other studies, such as point prevalence surveys of antimicrobial use in hospitals, [34] can help determine if high percentages of 'Reserve' and 'broad-spectrum' antibiotics are associated with unnecessary or appropriate use in meeting the demand of increased AMR infections [14].

Effective efforts to curb use of broad-spectrum and last-line antibiotics therefore necessitate integration of AMC data with country and local AMR data. Availability of timely diagnostics, including antimicrobial susceptibility testing, is another critical element of antimicrobial stewardship, as the timely availability of microbiology results facilitates the possible de-escalation or even discontinuation of antimicrobial treatment and helps clinicians reduce use of broad-spectrum antibiotics [17].

## Public health conclusions

While the EU/EEA saw overall reductions in AMC between 2012 and 2021, secondary indicators for AMC reveal that there are further opportunities for antimicrobial stewardship. Additional efforts to support appropriate use of antimicrobials, in particular that of broad-spectrum and last-line antibiotics, are essential for addressing AMR and improving patient outcomes. EU-wide initiatives, along with national and regional level initiatives tailored to local AMR and AMC data, can reduce the selective pressure that contributes to the development of multidrug-resistant microorganisms.

EU efforts to combat AMR with a 'One Health' approach are being intensified during a period when the challenges of AMR are increasing [35]. As effective antimicrobial stewardship requires a continuous feedback loop of AMC and AMR data, continued enhancement of AMC and AMR surveillance and analyses at all levels (e.g. local, national and international) will strengthen the effectiveness of public health action to reduce the burden of AMR.

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# Annex 1. List of downloadable tables

## Tables

- Table D1.** Trends in consumption of tetracyclines (ATC group J01A) in the community, EU/EEA countries, 2012–2021, expressed as DDD per 1 000 inhabitants per day
- Table D2.** Trends in consumption of beta-lactam antibacterials, penicillins (ATC group J01C) in the community, EU/EEA countries, 2012–2021, expressed as DDD per 1 000 inhabitants per day
- Table D3.** Trends in consumption of other beta-lactam antibacterials (ATC group J01D) in the community, EU/EEA countries, 2012–2021, expressed as DDD per 1 000 inhabitants per day
- Table D4.** Trends in consumption of sulfonamides and trimethoprim (ATC group J01E) in the community, EU/EEA countries, 2012–2021, expressed as DDD per 1 000 inhabitants per day
- Table D5.** Trends in consumption of macrolides, lincosamides and streptogramins (ATC group J01F) in the community, EU/EEA countries, 2012–2021, expressed as DDD per 1 000 inhabitants per day
- Table D6.** Trends in consumption of quinolones (ATC group J01M) in the community, EU/EEA countries, 2012–2021, expressed as DDD per 1 000 inhabitants per day
- Table D7.** Trends in consumption of other antibacterials (ATC group J01X) in the community, EU/EEA countries, 2012–2021, expressed as DDD per 1 000 inhabitants per day
- Table D8.** Trends in consumption of tetracyclines (ATC group J01A) in the hospital sector, EU/EEA countries, 2012–2021, expressed as DDD per 1 000 inhabitants per day
- Table D9.** Trends in consumption of beta-lactam antibacterials, penicillins (ATC group J01C) in the hospital sector, EU/EEA countries, 2012–2021, expressed as DDD per 1 000 inhabitants per day
- Table D10.** Trends in consumption of other beta-lactam antibacterials (ATC group J01D) in the hospital sector, EU/EEA countries, 2012–2021, expressed as DDD per 1 000 inhabitants per day
- Table D11.** Trends in consumption of carbapenems (ATC group J01DH) in the hospital sector, EU/EEA countries, 2012–2021, expressed as DDD per 1 000 inhabitants per day
- Table D12.** Trends in consumption of sulfonamides and trimethoprim (ATC group J01E) in the hospital sector, EU/EEA countries, 2012–2021, expressed as DDD per 1 000 inhabitants per day
- Table D13.** Trends in consumption of macrolides, lincosamides and streptogramins (ATC group J01F) in the hospital sector, EU/EEA countries, 2012–2021, expressed as DDD per 1 000 inhabitants per day
- Table D14.** Trends in consumption of quinolones (ATC group J01M) in the hospital sector, EU/EEA countries, 2012–2021, expressed as DDD per 1 000 inhabitants per day
- Table D15.** Trends in consumption of other antibacterials (ATC group J01X) in the hospital sector, EU/EEA countries, 2012–2021, expressed as DDD per 1 000 inhabitants per day
- Table D16.** Trends in consumption of polymyxins (ATC group J01XB) in the hospital sector, EU/EEA countries, 2012–2021, expressed as DDD per 1 000 inhabitants per day
- Table D17.** Consumption of oral vancomycin (A07AA09), fidaxomicin (A07AA12) and oral and rectal metronidazole (P01AB01) in the hospital sector, EU/EEA countries, 2021, expressed as DDD per 1 000 inhabitants per day
- Table D18.** Consumption of antimycotics (ATC group J02) and antifungals (ATC group D01B) for systemic use in the community, EU/EEA countries, 2021, expressed as DDD per 1 000 inhabitants per day
- Table D19.** Consumption of antimycotics (ATC group J02) and antifungals (ATC group D01B) for systemic use in the hospital sector, EU/EEA countries, 2021, expressed as DDD per 1 000 inhabitants per day
- Table D20.** Trends in total consumption (community and hospital sectors) of antimycobacterials (ATC group J04), EU/EEA countries, 2017–2021, expressed as DDD per 1 000 inhabitants per day
- Table D21.** Trends in total consumption (community and hospital sectors) of antivirals for systemic use (ATC group J05), EU/EEA countries, 2017–2021, expressed as DDD per 1 000 inhabitants per day
- Table D22.** Trends in percentage of 'Reserve' antibiotics among all antibiotic consumption in the hospital sector, EU/EEA countries, 2012–2021