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Socioeconomic inequalities in the self-reported use of antibiotics in the European Union, 2009–2022: a repeated cross-sectional analysis

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ABSTRACT

Objectives This study aims to explore trends in the use of antibiotics, in the context of the COVID-19 pandemic, across the European Union (EU), focusing on socioeconomic inequalities.

Design Repeated cross-sectional analysis.

Setting 26 EU member states.

Participants Analyses were conducted using data from five waves of the Eurobarometer survey (2009–2022, n=1 27 299).

Primary and secondary outcome measures We used multilevel logistic regression, stratified by financial difficulty, to examine changes in the past-year use of antibiotics and in obtaining antibiotics inappropriately over time, adjusting for gender, age, type of community, children under 10 years in the household and antibiotic-related knowledge.

Results We found that the odds of self-reported use of antibiotics decreased between 2009 and 2022 in those with (OR=0.59, 95% CI 0.55–0.63) and without financial difficulties (OR=0.53, 95% CI 0.50 to 0.56), with a substantial reduction between 2018 and 2022. However, a relatively higher proportion of Europeans who used antibiotics in the past year were obtaining them inappropriately in those with (OR=2.03, 95% CI 1.68 to 2.45) and without financial difficulties (OR=1.83, 95% CI 1.53 to 2.19) in 2022. Among those with financial difficulties, higher self-reported use of antibiotics and inappropriately obtaining antibiotics were associated with lesser knowledge about antibiotics.

Conclusion Despite notable progress made in the EU in reducing antibiotic use, current efforts fall short in addressing the issue of inappropriate antibiotic use. A targeted approach prioritising outreach to vulnerable populations to advance attitudes and behaviours related to appropriate antibiotic use may be required to achieve further progress.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ We analysed data covering 26 countries over a 13-year period.
⇒ We used consistent measures across countries and over time.
⇒ The cross-sectional study design limits causal inference.
⇒ Data on antibiotic use is self-reported and does not include information on frequency and duration.

INTRODUCTION

Antimicrobial resistance (AMR), a phenomenon whereby causative microorganisms develop the ability to resist antimicrobial medicines, poses a significant threat to global health security, prompting the European Commission to highlight AMR as a top priority concern for the European Union (EU).[1] According to the latest estimates by the European Centre for Disease Prevention and Control (ECDC), the health and financial burden of AMR is increasing overall, with over 800 000 reported cases of bacteria-resistant infections and more than 35 000 attributable deaths in 2020, costing the EU member states €1.1 billion annually.[2 3]

Global commitments towards the fight against AMR, supported by the 2015 WHO 'Global action plan on AMR' and the 2016 political declaration of the United Nations on AMR have driven enhanced efforts at the EU level, centred on the multisectoral 'One Health' approach.[4 5] Continued efforts, including the 2017 EU One Health Action Plan against Antimicrobial Resistance and the more recent adoption of a proposal with key objectives to 'strengthen antimicrobial stewardship and prudent use of antimicrobials' have resulted in AMR National Action Plans (NAPs) in 23 member states, as of 2021.[6] These efforts are complemented by public health campaigns, including the annual World Antimicrobial Awareness Week and the European Antibiotics Awareness Day (EAAD).[7] However, considerable variation and gaps exist in the design and implementation of AMR-NAPs; the direct impact of these initiatives, which are aimed at encouraging antimicrobial stewardship among all stakeholders, remains unclear across the EU.[6 8]

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Inappropriate use of antibiotics is a key driver of AMR globally, and a significant issue in Europe.[9 10] Self-medication with antibiotics, as well as low patient awareness regarding antibiotics and AMR, is associated with their unnecessary and unregulated use.[10 11] This issue is further exacerbated by poor antimicrobial stewardship by healthcare professionals, in particular overprescribing and misprescribing.[10] Within the context of an ageing population in Europe, there has been increased use of antibiotics among elderly populations, attributable to their greater susceptibility to infections.[12] Substantial regional variation in antibiotic prescribing rates and patterns of use within this vulnerable population has been observed, with the southern EU member states displaying higher antibiotic use.[13]

Wider socioeconomic determinants, including factors such as income and education, contribute to and exacerbate the inappropriate use of antibiotics. Low health literacy levels and awareness about prudent use, as well as inadequate access to quality healthcare, are associated with higher levels of inappropriate antibiotic use, especially in vulnerable groups, such as migrants.[14 15] However, there are limitations applying these findings at the EU level, particularly as most studies have been country level.[14] Furthermore, direct comparisons between studies are challenging as different measures of socioeconomic status are used, including levels of educational attainment, occupation and experiences of financial hardship.[14] To the best of our knowledge, no studies have comprehensively explored the socioeconomic determinants associated with the inappropriate use of antibiotics among all the EU member states, and the implications these inequalities may have on policy.

An additional gap in knowledge relates to the impact of the COVID-19 pandemic on AMR. Globally, overwhelming pressure on healthcare systems, and consequential prioritisation of resources towards the pandemic, saw a reduced capacity for controlling AMR in the acute period of the pandemic, especially with the disruption to surveillance and antimicrobial stewardship.[16 17] On the other hand, pandemic responses such as national lockdowns, social distancing and further restrictions may be responsible for the decline in antibiotic consumption. Between 2019 and 2020, there was an 18% decline in the mean total consumption of antibiotics in the EU, which is further supported by a global decline in pharmaceutical sales of antibiotics.[18 19] Finally, discussions and information campaigns around infections and viruses may have indirectly influenced use of antibiotics.

Within this context, there is a lack of evidence on the attitudes and behaviours regarding appropriate use of antibiotics and AMR of the general public in the EU, as well as very limited data exploring the possible implications of the COVID-19 pandemic on this domain. This paper aims to explore trends in the overall use of antibiotics in Europe, in the context of the COVID-19 pandemic, across sociodemographic groups and the EU member states.

METHODS

Data sources

This analysis was conducted using data collected in the 26 EU member states from waves 72.5 (November–December 2009, n for 26 included member states=25 439), 79.4 (May–June 2013, n=25 366), 85.1 (April 2016, n=25 582), 90.1 (September 2018, n=25 424) and 97.1 (February–March 2022, n=25 488) of the Eurobarometer survey.[20] Eurobarometer is a series of surveys, with repeated cross-sectional design and target population of individuals aged ≥15 years in the EU member states, conducted by the European Commission.

New and independent samples are selected in each wave using a multi-stage and random probability sampling method. All interviews conducted between 2009 and 2018 were face-to-face in households of participants in the appropriate language. In wave 97.1, face-to-face interviewing was conducted where feasible in all the member states (n=26). However, this was supplemented by online computer-assisted web interviewing in some member states (n=11) where the target number of face-to-face interviews was unmet as a consequence of COVID-19 restrictions. Post-stratification weighting along with the sampling method ensures samples are representative of the population by age, gender, region and size of locality, at the national level as well as at the EU level.

Croatia and former member state UK were excluded from this analysis as they were not member states in 2009 and 2022 respectively, and therefore lacked datapoints across all the five waves.

Variables

Online supplemental table 1 outlines the questions included in the study and highlights the variation in response options across waves.

Self-reported use of antibiotics

Antibiotic consumption was assessed with the question ‘Have you taken any antibiotics orally such as tablets, powder or syrup in the last 12 months?’ Responses other than ‘yes’ or ‘no’, such as ‘don’t know’ or ‘refusal’ were excluded from analysis.

Those who responded ‘yes’ to the above question were also asked how they obtained their last course of antibiotics. Responses were recoded into two categories: ‘from a medical practitioner’ (‘from a medical prescription’ or ‘administered by a medical practitioner’), and ‘not appropriate’ (‘you had some left over from a previous course’, ‘without prescription from a pharmacy’, or ‘without prescription from elsewhere’). Other responses, such as ‘don’t remember’, ‘don’t know’ or ‘refusal’ were excluded from the analysis.

Knowledge about antibiotics

Overall levels of knowledge on antibiotic use were assessed by collating responses from four knowledge statements to generate a knowledge score ranging from zero correct answers to a maximum of four correct answers. The four

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knowledge statements, with 'true', 'false' or 'don't know' response options, were: antibiotics kill viruses (correct response: false), antibiotics are effective against colds (correct response: false), unnecessary use of antibiotics makes them become ineffective (correct response: true), and taking antibiotics often has side effects, such as diarrhoea (correct response: true).

Impact of the COVID-19 pandemic on use, need and access to antibiotics

The impact of the pandemic, particularly concerning antibiotics consumption, was ascertained through two questions in 2022. Respondents were asked, "If you suffered from COVID-19, did you take any antibiotics?" Responses were coded into four categories: 'No' ('no I did not take any antibiotics'), 'Yes, appropriately' ('yes, from a medical prescription' or 'yes, administered by a medical practitioner'), 'Yes, inappropriately' ('yes, I had some leftover from a previous course', 'yes, without prescription from a pharmacy' or 'yes, without prescription from elsewhere'), and 'N/A' ('I did not get COVID-19', 'don't remember', 'refusal' or 'don't know'). They were also asked, "What kind(s) of impact did the COVID-19 pandemic have on your need to take antibiotics?". Responses were coded into six categories: 'Increased need', 'Restricted access' ('It restricted my access to antibiotics as I couldn't go to the doctor to get a prescription' or 'It restricted my access to antibiotics as I couldn't go to the pharmacy'), 'Decreased need' ('It decreased my need for antibiotics because I fell ill less often during the containment period' or 'It decreased my need for antibiotics because I fell ill less often due to strengthened personal protective measures'), 'Same access', 'Same need', and 'Other or N/A' ('don't remember', 'refusal' or 'don't know'). Both questions allowed for multiple responses.

Sociodemographic data

Sociodemographic data collected by Eurobarometer included gender ('man' and 'woman'), age ('15–24', '25–39', '40–54' and '≥55 years'), difficulties paying bills ('yes', comprising 'most of the time' and 'from time to time', and 'no' comprising 'almost never or never') as an indicator of financial difficulty, type of community ('rural area or village' and 'town') and children under 10 years old in the household ('none' and 'one or more'). Refusal and missing responses were excluded from the relevant analysis. The gender response 'none of the above/non-binary/do not recognise yourself in above categories', only offered in the 2022 wave, was also excluded as the proportion of individuals providing this response was small (0.07%).

Statistical analysis

Weighted data for variables of interest was analysed using basic descriptive statistics at the country level and for the EU as a whole, considering sociodemographic variables.

A multilevel logistic regression analysis of individual-level data was conducted, allowing for the clustering of observations within the member states. This allowed an analysis of the association of antibiotic use in the past 12 months (dependent variable) with time (by survey year), gender, age, difficulty paying bills, type of community, children under 10 years old in the households and knowledge score (continuous variable). Two additional multilevel logistic regression models were fitted with obtaining antibiotics inappropriately as the outcome, adjusting for the same covariates as above: one among those who have used antibiotics in the last 12 months and the second in the entire sample.

Final model specification was guided by the Akaike and Bayesian Information Criteria, in addition to conceptual considerations. The regression models were unweighted; however, the factors that were used to calculate weights (age, gender and region, and size of locality) were adjusted for, and the clustering of observations within the member states also accounted for.

For each of the outcomes, various interaction terms between time and each of the other independent variables were explored. A statistically significant interaction was observed between time and difficulty paying bills for antibiotic use in the past 12 months and for obtaining antibiotics inappropriately in both samples; therefore, the regression analysis was stratified by difficulty paying bills for these outcomes. All analyses were conducted using the statistical software package STATA/SE V.15.1.

Patient and public involvement

There was no patient or public involvement in this study.

RESULTS

We analysed a total of 127 299 observations from the 26 member states, across five waves of the Eurobarometer surveys. A summary of the demographic characteristics of the analysed samples can be found in online supplemental table 2.

Self-reported use of antibiotics

In the EU, the self-reported use of antibiotics declined substantially with less than a quarter of Europeans (22.8%, 95% CI 21.9% to 23.6%) having taken antibiotics in the last year in 2022, resulting in a record low since 2009 (40.2%, 95% CI 39.2% to 41.1%; figure 1). This represents the largest relative decrease from the previous survey (−30.3% from 2018), compared with any other wave. There was noticeable variation across the member states, with respondents from southern EU more likely to use antibiotics. This variation was less marked in 2022 (27.7% difference between the country with the highest use: Malta, and the lowest: Sweden) than in 2009 (34.7% difference between the country with the highest use: Italy, and the lowest: Sweden). Furthermore, the proportion of respondents using antibiotics was consistently higher in those with financial difficulties than those without across the years. The self-reported use in the EU between 2009 and 2022 decreased from 44.7% (95% CI 43.1% to

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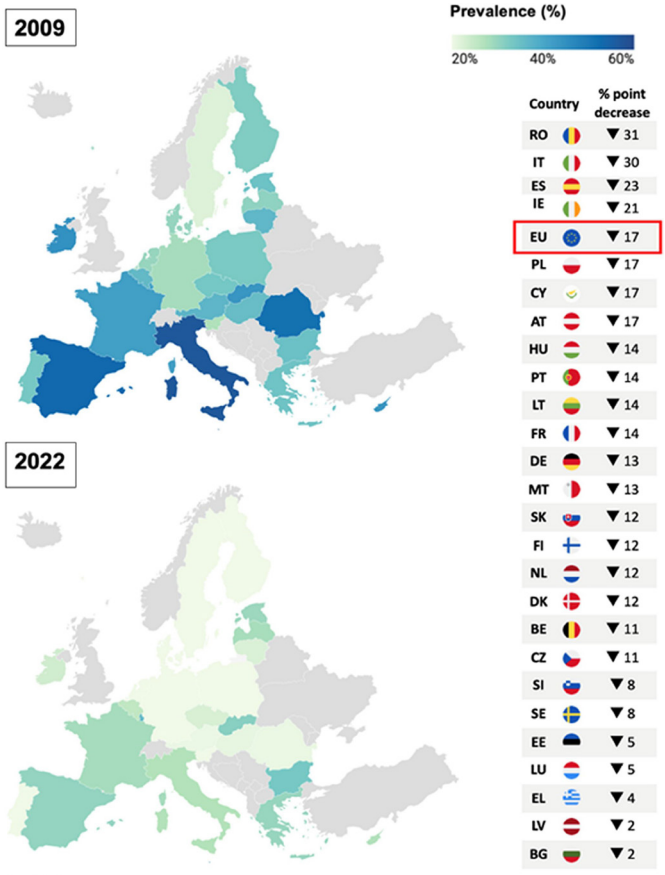


Figure 1 Choropleth maps of the prevalence of self-reported use of antibiotics in the last year across the European Union in 2009 and 2022.

46.3%) to 27.9% (95% CI 26.3% to 29.6%) among those with financial difficulties, and from 37.3% (95% CI 36% to 38.5%) to 20.5% (95% CI 19.5% to 21.5%) among those without.

In the overall regression model, people with financial difficulty were 19% more likely to have used antibiotics in the last year than those without. In the stratified analyses, the odds of using antibiotics in the last year significantly decreased over time, with a particularly large decline between 2018 (OR 0.85 vs year 2009, 95% CI 0.80 to 0.91) and 2022 (OR 0.59, 95% CI 0.55 to 0.63) among those with financial difficulties (table 1). A noticeable decrease between 2018 (OR 0.79, 95% CI 0.75 to 0.83) and 2022 (OR 0.53, 95% CI 0.50 to 0.56) was also observed among those without financial difficulty (OR shown are compared with year 2009). The odds of using antibiotics in the last year were lower for respondents who were men, middle-aged (40–54 years), living in rural communities, had no children under 10 years in the household and those with higher knowledge score (OR 0.92, 95% CI 0.91 to 0.94 for those with financial difficulties and OR 0.96, 95% CI 0.95 to 0.98 in those without difficulties).

Methods of obtaining antibiotics

The overwhelming majority of Europeans in 2022 obtained their last course of antibiotics through a healthcare professional (92.8%, 95% CI 91.7% to 93.7%). However, a small proportion of respondents obtained antibiotics inappropriately, among those who had used antibiotics in the past year (2022: 7.2% (95% CI 6.3% to 8.3%), 2009: 5.2% (95% CI 4.6% to 5.9%)) and among the entire sample (2022: 1.6% (95% CI 1.4% to 1.9%), 2009: 2.1% (95% CI 1.8% to 2.4%)). At the country level, there was wide variation in the percentage of those who obtained antibiotics inappropriately. There was a gradual increase in the proportion of respondents obtaining antibiotics inappropriately—among those that had used antibiotics—over time, which was consistently higher among those with financial difficulties (figure 2).

The overall regression model indicated that respondents with financial difficulties were 27% more likely to obtain antibiotics inappropriately among those who had used antibiotics in the past year and 37% more likely in the entire sample. Table 2 shows that over time, the odds of obtaining antibiotics inappropriately significantly increased in 2022 among respondents with financial difficulties who used antibiotics in the past year (OR 2.03 compared with year 2009, 95% CI 1.68 to 2.45) and among the entire sample (OR 1.23, 95% CI 1.03 to 1.47). Respondents who were men, 24–39 years old, lived in rural communities and had at least one child under 10 in the household had lower odds of obtaining their last course of antibiotics inappropriately. The odds of obtaining antibiotics inappropriately were lower among respondents with a higher knowledge score in both samples. However, these odds did not differ substantially between those with and without financial difficulties.

Impact of the COVID-19 pandemic on use, need and access to antibiotics

As a whole, the majority of Europeans who reported having had COVID-19 did not take any antibiotics (76.4%, 95% CI 75.1% to 77.7%). However, among those who had COVID-19 and used antibiotics, a small minority (7.2%, 95% CI 6.4% to 8%) obtained them inappropriately. There was considerable variation between the member states in overall use, as well as use of antibiotics obtained inappropriately among those who contracted COVID-19, as illustrated in figure 3. Although Bulgaria had the highest proportion of respondents using antibiotics overall (56.8%, 95% CI 52.5% to 61%), the highest proportions of respondents using antibiotics obtained inappropriately were found in Romania (18.1%, 95% CI 14.9% to 21.9%) and Italy (15.1%, 95% CI 11.9% to 18.9%).

Almost half of Europeans (42%, 95% CI 41% to 42.9%) responded that the pandemic decreased their need for antibiotics, with a smaller proportion (10.7%, 95% CI 10.1% to 11.3%) reporting restricted access to antibiotics. Among those with financial difficulties, 46.2% (95% CI 44.4% to 48.0%) of respondents reported decreased need and 16.1% (95% CI 14.8% to 17.4%) reported restricted access. Among those without financial difficulties, the

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Table 1 Multilevel logistic regression analysis, stratified by difficulties paying bills, for self-reported use of antibiotics in the last 12 months

	Self-reported use of antibiotics in the last 12 months			
	Difficulty paying bills (n=44 882)		No difficulties paying bills (n=79 032)	
	OR	95% CI	OR	95% CI
Year				
2009 (reference)	1	–	1	–
2013	0.95	0.90 to 1.01	0.96	0.91 to 1.01
2016	0.92	0.86 to 0.97*	0.83	0.79 to 0.87*
2018	0.85	0.80 to 0.91*	0.79	0.75 to 0.83*
2022	0.59	0.55 to 0.63*	0.53	0.50 to 0.56*
Gender				
Women (reference)	1	–	1	–
Men	0.72	0.69 to 0.75*	0.81	0.78 to 0.84*
Age (in years)				
15 to 24 (reference)	1	–	1	–
25 to 39	0.96	0.89 to 1.03	0.83	0.78 to 0.89*
40 to 54	0.94	0.88 to 1.01	0.82	0.77 to 0.87*
≥55	1.04	0.97 to 1.12	0.92	0.87 to 0.98*
Type of community				
Town (reference)	1	–	1	–
Rural area or village	0.94	0.90 to 0.98*	0.96	0.93 to 0.99*
Children under 10 years in the household				
None (reference)	1	–	1	–
One or more	1.10	1.05 to 1.16*	1.09	1.04 to 1.15*
Knowledge (per 1 additional correct answer)	0.92	0.91 to 0.94*	0.96	0.95 to 0.98*

*p<0.05

corresponding proportions were 40.7% (95% CI 39.5% to 41.8%) and 8.4% (95% CI 7.8% to 9.1%).

DISCUSSION

This study shows that the self-reported use of antibiotics has declined over time in all the EU member states, with a considerable reduction between 2018 and 2022. However, although the inappropriate use of antibiotics has overall remained relatively consistent over time, a relatively higher proportion of Europeans who used antibiotics in the past year were obtaining them inappropriately as of 2022. Individuals experiencing financial difficulty had higher odds of both self-reported use of antibiotics in the past year and obtaining antibiotics inappropriately. Overall, almost half of Europeans reported decreased need for antibiotics while a smaller proportion reported limited access to antibiotics as a consequence of the COVID-19 pandemic. Notably, a higher proportion of those with financial difficulty reported reduced need and restricted access than those without.

The declining trend in self-reported use of antibiotics in the EU is not in line with global trends. For instance, Klein *et al* found a 65% increase in antibiotic consumption, expressed in defined daily doses, between 2000 and 2015, predominantly driven by improved access in low-income and middle-income countries.[21] The majority of the EU member states are high-income countries which have prioritised antimicrobial stewardship at the EU level, including legislation in all the member states mandating that antibiotics are only dispensed with a valid medical prescription.[22] Hence, the observed decline should not be surprising, although we measured the percentage of the population that used antibiotics rather than defined daily doses.

Beyond legislative measures, attempts to enhance knowledge by raising awareness about AMR have included the introduction of the Europe-wide health initiative EAAD in 2009 which supports national campaigns aimed at encouraging appropriate antibiotic use.[23] Indeed, our study found a correlation between higher levels of knowledge and reduced odds of both self-reported antibiotic use within the past year and obtaining antibiotics inappropriately. Approaches focused on improving knowledge and adequately informing patients generally result in reduced

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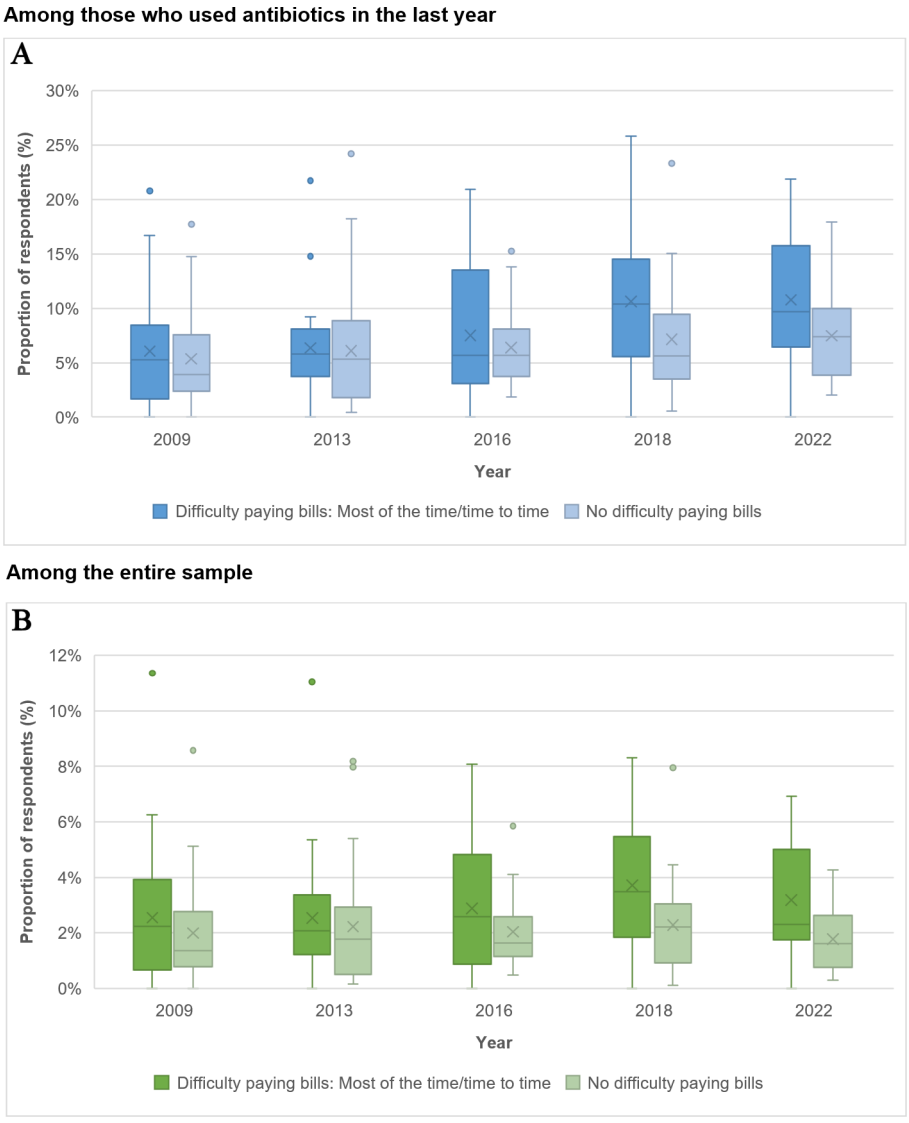


Figure 2 Box plots showing the trend in the proportion of respondents obtaining antibiotics inappropriately from 2009 to 2022 in the 26 EU member states, (a) among those who used antibiotics in the last year, and (b) among those who used antibiotics in the last year.

rates of antibiotic consumption, while lower levels of knowledge regarding antibiotics and AMR have been associated with higher prevalence of self-medication.[24] This emphasises the potential significance of knowledge as a focal point for policy intervention. Specifically, the importance of addressing knowledge gaps through targeted educational initiatives and awareness campaigns, which may foster responsible antibiotic use and address the issue of inappropriately obtaining antibiotics.[25] Nevertheless, there may not be a single most effective strategy to achieve this goal. Targeting both younger and older individuals, the general public and health professionals may all contribute to more appropriate use of antibiotics, depending on the context.

Despite the general decline in antibiotic use, the issue of using antibiotics obtained inappropriately persists. Although healthcare professionals may be implementing improved antimicrobial stewardship practices in response to policy interventions,[22] self-medication with antibiotics remains prevalent in some EU member states.[26] Morgan *et al* proposed that this inadequate regulation of antimicrobials largely arises from the lack of enforcement of existing policies, as evident in some southern European countries.[26] Similarly, approaches aimed at reducing self-medication are not consistent across the EU member states. Grigoryan *et al* found that poor dispensing practices were a key determinant in self-medication and that dispensing the exact tablet quantities from pharmacies, which have been implemented in some countries like the Netherlands and Czech Republic, should be considered at the EU level.[27] Developing and adopting standardised protocols for prescribing antibiotics in places where these are not available may also support health professionals to establish better prescribing practices.

This study brings to light significant socioeconomic inequalities regarding the use of antibiotics within and between the EU member states. Individuals with financial difficulties were found to be more likely to use antibiotics

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Table 2 Multilevel logistic regression analysis stratified by difficulty paying bills for obtaining antibiotics inappropriately among those who used antibiotics in the last 12 months and among the entire population

	Among those who used antibiotics in the last 12 months				Among entire sample			
	Difficulty paying bills (n=16 379)		No difficulties paying bills (n=23 454)		Difficulty paying bills (n=44 812)		No difficulties paying bills (n=78 947)	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Year								
2009 (reference)	1	–	1	–	1	–	1	–
2013	1.04	0.87 to 1.24	1.06	0.88 to 1.28	0.98	0.83 to 1.16	1.00	0.83 to 1.19
2016	1.50	1.26 to 1.78*	1.27	1.06 to 1.52*	1.36	1.15 to 1.61*	1.07	0.90 to 1.28
2018	2.06	1.73 to 2.45*	1.53	1.28 to 1.83*	1.63	1.38 to 1.93*	1.19	1.01 to 1.42*
2022	2.03	1.68 to 2.45*	1.83	1.53 to 2.19*	1.23	1.03 to 1.47*	1.08	0.91 to 1.28
Gender								
Women (reference)	1	–	1	–	1	–	1	–
Men	1.31	1.17 to 1.46*	1.34	1.20 to 1.50	1.01	0.91 to 1.13	1.11	1.00 to 1.24
Age								
15 to 24 (reference)	1	–	1	–	1	–	1	–
25 to 39	1.02	0.85 to 1.23	0.91	0.75 to 1.10	1.03	0.87 to 1.24	0.85	0.70 to 1.02
40 to 54	0.85	0.71 to 1.03	0.78	0.65 to 0.94*	0.87	0.73 to 1.04	0.72	0.61 to 0.87*
≥55	0.47	0.39 to 0.57*	0.44	0.37 to 0.53*	0.55	0.46 to 0.66*	0.47	0.40 to 0.56*
Type of community								
Town (reference)	1	–	1	–	1	–	1	–
Rural area or village	0.90	0.80 to 1.02	0.85	0.75 to 0.97*	0.86	0.76 to 0.96*	0.83	0.74 to 0.94*
Children under 10 years in the household								
None (reference)	1	–	1	–	1	–	1	–
One or more	0.84	0.73 to 0.97*	0.97	0.83 to 1.14	0.92	0.80 to 1.06	1.03	0.89 to 1.20
Knowledge score								
Knowledge (per 1 additional correct answer)	0.73	0.69 to 0.77*	0.75	0.71 to 0.79*	0.72	0.69 to 0.76*	0.75	0.71 to 0.78*

*p<0.05.

and obtain them inappropriately. This could partly explain why patients with antibiotic-resistant infections have been found to be more likely to be unemployed, have lower educational attainment and lowest income.[28] Lower levels of income and residence in areas of higher deprivation could be linked to higher incidence of disease and inadequate water and sanitary hygiene practices.[14] Also, lower educational attainment may be associated with inadequate health literacy, and hence limited access to appropriate health services; however, even in countries with government-funded, universal healthcare systems such as Sweden, socioeconomic inequalities relating to antibiotic use and knowledge persist.[28] This observation implies that merely implementing a universal healthcare system is insufficient to eliminate these inequalities. This can only be achieved by addressing the underlying structural inequalities and wider social determinants of health.

Although this study does not explicitly investigate the multifactorial causes for the noticeably large decline in self-reported use between 2018 and 2022, it is plausible that the COVID-19 pandemic might have played a significant role. Our findings indicate a decline, although self-reported, in the need for antibiotics among a large proportion of Europeans during the pandemic. This aligns with previous research which reported a reduction in the spread of bacterial infections with respiratory droplet transmission, coinciding with measures implemented to contain the pandemic and increased emphasis on hygiene awareness.[29] It is also consistent with an observed decrease in antibiotic consumption in the EU between 2019 and 2020, which predominantly happened in the primary healthcare sector (−18% compared with −5% in the hospital sector).[30] Findings from the EU member states suggest this decrease may be attributable to a reduction in the use of primary healthcare services, and the challenges in accessing them due to national lockdown measures and reallocation of resources towards the pandemic response.[31] Nevertheless, we did not have

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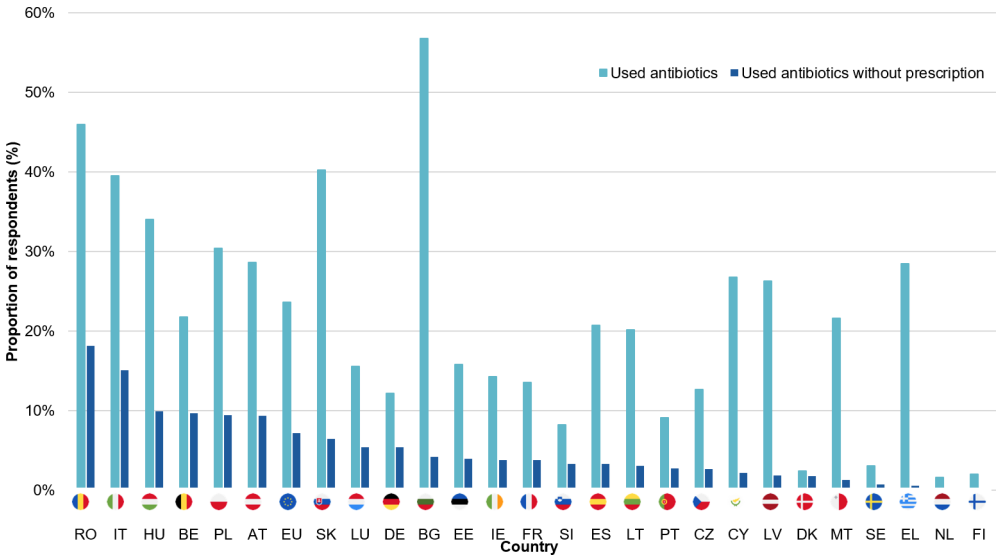


Figure 3 Variation in the overall and inappropriate use of antibiotics among Europeans who got COVID-19 and in 26 EU member states in 2022.

detailed data for each year during the 2018–2022 period; hence, interpretation of these changes in relation to the pandemic should be cautious. For instance, the sharp decline in global pharmaceutical sales of antibiotics when the pandemic was first declared was followed by sales gradually rising back to pre-pandemic levels shortly after.[19]

Strengths and limitations

To the authors' knowledge, this is the first repeated cross-sectional study which analysed data on antibiotic use from the 26 EU member states across a period of 13 years. Consistent measures across the EU have enabled trends to be identified over time. This approach further allowed for valid comparisons between countries and socioeconomic groups. Although this study revealed significant associations between socioeconomic factors and self-reported antibiotic use and knowledge, the repeated cross-sectional study design does not allow for causal inferences to be made. However, we were able to adjust for sociodemographic factors and use individual-level data which should limit the risk of confounding.

This study focuses on the self-reported use of antibiotics in the last 12 months as a measure of antibiotic consumption. This measure provides an insight into individual behaviours towards antibiotics. However, we had no data on the frequency and duration of antibiotic use, and the selection of the most appropriate antibiotic, which are fundamental aspects of effective antimicrobial stewardship. An additional limitation was the lack of more granular data during the period of the pandemic. Furthermore, we relied on self-reported data which may be biased due to inaccurate recall and social desirability, although studies have shown self-reported recent antibiotic use to have acceptable reliability.[32] Therefore, our findings should be considered with these limitations in mind and used in conjunction with other sources of data, such as ECDC Annual Epidemiological Reports on antimicrobial consumption, to fully grasp their implications for public health. Finally, we had no detailed data on reasons for inappropriate antibiotic use; therefore, our suggestions for potential strategies that could address the issue may not be applicable to all settings.

CONCLUSION

This study has provided valuable insight into the self-reported use of antibiotics in the EU. Though promising progress has been achieved in terms of declining use of antibiotics since 2009, there is still room for improvement, particularly in addressing their inappropriate use and socioeconomic inequalities. Further research could explore additional factors that may influence antibiotic use in Europe, including national policies and Europe-wide initiatives. Nevertheless, implementing targeted interventions, especially among Europeans in vulnerable groups, as well as ensuring equitable access to knowledge and health services, could improve antibiotic stewardship and combat AMR. A collaborative approach addressing all key stakeholders, with a specific focus on reaching disadvantaged groups, is needed to advance knowledge, attitudes and behaviours surrounding appropriate antibiotic use and facilitate 'making the EU a best practice region' in line with the EU One Health Action Plan.

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