# The burden of antimicrobial resistance (AMR) in North Macedonia

Executive summary

- Antimicrobial Resistance (AMR) is a major global health threat, over **300 lives** have been lost each year since 1990 in North Macedonia due to AMR.

- In 2021, there were an estimated **344 UI (284-403)** deaths attributable to AMR and **1,310 UI (1,080-1,530)** deaths associated with AMR in this location.

- The largest number of deaths associated with AMR in 2021 occurred among those aged **70+** in the country.

- Among the most deadly pathogen-drug combinations in 2021 were *Staphylococcus aureus* resistant to methicillin, *Acinetobacter baumannii* resistant to carbapenems and *Streptococcus pneumoniae* resistant to carbapenems.

Figure 1 Number of deaths by underlying cause, and those associated with AMR in 2021
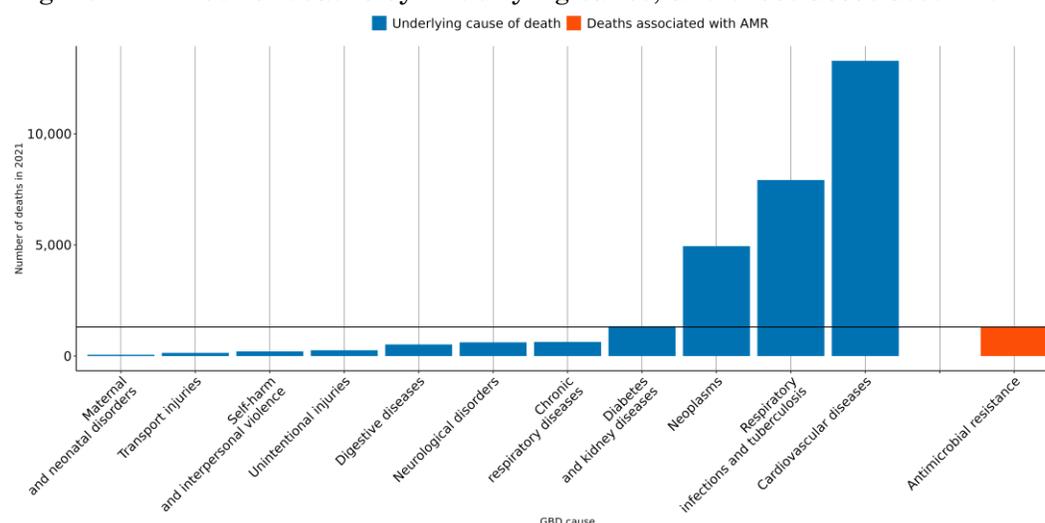

- In 2021, the number of deaths associated with AMR (orange bar in *figure 2*) were high compared to the most relevant underlying causes of death (depicted in blue) in the country. AMR associated deaths occur within multiple Global Burden of Disease (GBD) causes of death and AMR is not an underlying cause of death by itself.

- At the 2024 United Nations General Assembly high level meeting on antimicrobial resistance, country members agreed to aim for a **10% reduction** compared to 2019 baseline **(from 4.95 to 4.45 million)** in the global number of deaths associated with AMR by 2030. But our forecast indicates that in absence of concerted action, deaths associated with AMR could reach **5.5 million** (UI 4.8 - 6.2) if current trends continue. For North Macedonia, a 10% reduction means to decrease the number of deaths associated with AMR to **1,260**, but currently the trend for this country could reach up to **1,500 UI [1,130-1,960]** AMR-associated deaths in 2030.

AMR in North Macedonia

Key takeaways

- Antimicrobial Resistance (AMR) is a major global health threat, over *a million lives* have been lost each year since 1990.

- Globally, 4.71 (95% Uncertainty Interval (UI) 4.2-5.2) million deaths were associated with bacterial drug-resistant infections in 2021.

- And 1.14 (UI 1 - 1.3) million deaths were attributable to bacterial drug-resistant infection in the same year.

- *39 (UI 33 - 46) million deaths* directly attributable to bacterial AMR are projected to occur between 2025-2050 unless concerted action is taken. This equates to three deaths every minute.

Figure 2 Comparing 30 years of infection related deaths, and those associated with and attributable to AMR in North Macedonia between 1990 and 2019.
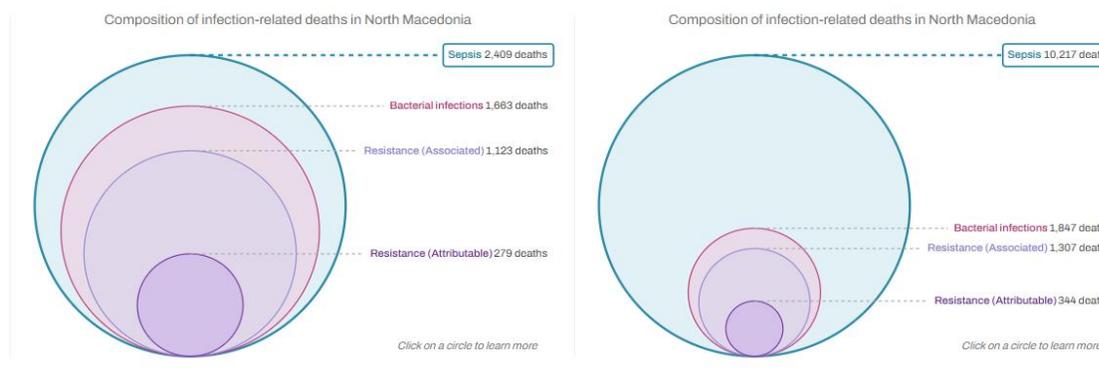
- To look at these and more visualization interactively visit [Measuring Infectious Causes and Resistance Outcomes for Burden Estimation (MICROBE)](link)

- In **North Macedonia** in 2021, there were an estimated **344 UI (284-403)** deaths attributable to AMR and **1,310 UI (1,080-1,530)** deaths associated with AMR. Here *"attributable deaths"* are considered to be those that would have been prevented had the drug-resistant bacteria causing the infections not been drug-resistant. *"Associated deaths"* are considered to be those that would not have occurred had the infections been prevented entirely.

- Across 204 countries, **North Macedonia has the 86th lowest** age-standardized mortality rate associated with AMR in 2021.

- *Table 1* shows the bacteria which caused most deaths in 2021 (↑ indicates an increasing estimated annual rate between 1990-2021, ↓ indicates a decreasing annual trend), and *table 2* shows the pathogen-drug combinations which caused most deaths in 2021.

Table 1. Bacteria which cause most deaths in 2021 (Number of deaths in parenthesis)

Burden rank	Overall susceptible and resistant		Associated		Attributable	
	Staphylococcus aureus 444 UI (373-515)	↑	Staphylococcus aureus 284 UI (230-338)	↑	Staphylococcus aureus 87 UI (70-104)	↑
	Streptococcus pneumoniae 251 UI (209-293)	↓	Escherichia coli 205 UI (172-238)	↑	Acinetobacter baumannii 49 UI (41-57)	↑
	Escherichia coli 219 UI (184-254)	↑	Streptococcus pneumoniae 184 UI (143-226)	↓	Escherichia coli 45 UI (36-54)	↑
	Pseudomonas aeruginosa 194 UI (161-226)	↑	Klebsiella pneumoniae 141 UI (116-167)	↓	Klebsiella pneumoniae 39 UI (32-47)	↑
	Klebsiella pneumoniae 162 UI (134-189)	↓	Pseudomonas aeruginosa 133 UI (102-164)	↑	Streptococcus pneumoniae 39 UI (27-52)	↓
	Acinetobacter baumannii 122 UI (100-143)	↑	Acinetobacter baumannii 121 UI (100-142)	↑	Pseudomonas aeruginosa 34 UI (24-44)	↑
	Enterococcus faecalis 77 UI (64-89)	↑	Enterococcus faecalis 57 UI (47-66)	↑	Enterobacter spp. 14 UI (9-18)	↑
	Enterobacter spp. 66 UI (55-77)	↑	Enterobacter spp. 47 UI (38-56)	↑	Enterococcus faecium 10 UI (8-12)	↑
	Group A Streptococcus 50 UI (38-62)	↑	Enterococcus faecium 41 UI (33-48)	↑	Enterococcus faecalis 10 UI (6-13)	↑
	Enterococcus faecium 49 UI (40-57)	↑	Proteus spp. 27 UI (19-35)	↑	Serratia spp. 6 UI (4-7)	↓

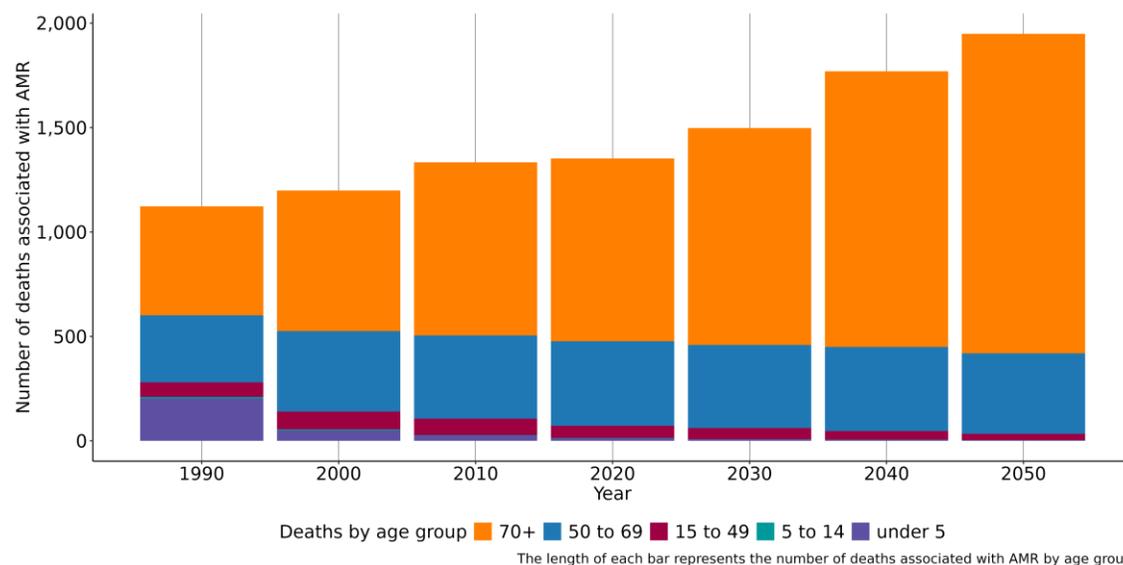Annualized rate of change (1990-2021): <-3%   -1.5% to 0%   1.5% to 3%   >5.0%   -3% to -1.5%   0% to 1.5%   3% to 5%

Table 2. Combinations which cause most deaths in 2021 (Number of deaths in parenthesis)

Burden Rank	Associated			Attributable		
	Staphylococcus aureus Methicillin	268 UI (204-332)	↑	Staphylococcus aureus Methicillin	73 UI (54-91)	↑
	Escherichia coli Aminopenicillin	192 UI (156-227)	↑	Acinetobacter baumannii Carbapenems	28 UI (22-34)	↑
	Escherichia coli TMP-SMX	158 UI (126-190)	↑	Streptococcus pneumoniae Carbapenems	18 UI (10-27)	↓
	Escherichia coli 3GC	155 UI (128-183)	↑	Escherichia coli 3GC	17 UI (11-23)	↑
	Escherichia coli Fluoroquinolones	152 UI (120-184)	↑	Pseudomonas aeruginosa Carbapenems	15 UI (9-21)	↑
	Streptococcus pneumoniae Macrolides	139 UI (109-169)	↑	Acinetobacter baumannii Fluoroquinolones	14 UI (11-17)	↑
	Staphylococcus aureus Macrolides	132 UI (93-172)	↑	Streptococcus pneumoniae Penicillin	10 UI (7-12)	↑
	Klebsiella pneumoniae 3GC	132 UI (108-155)	↓	Klebsiella pneumoniae Fluoroquinolones	10 UI (7-13)	↑
	Klebsiella pneumoniae Fluoroquinolones	122 UI (99-146)	↑	Klebsiella pneumoniae Carbapenems	10 UI (7-12)	↑
	Acinetobacter baumannii 3GC	120 UI (99-141)	↑	Escherichia coli Fluoroquinolones	10 UI (6-14)	↑

Annualized rate of change (1990-2021): <-3%   -1.5% to 0%   1.5% to 3%   >5.0%   -3% to -1.5%   0% to 1.5%   3% to 5%

 - Independently of antimicrobial resistance, the infectious syndromes accounting for the most deaths in 2021 were as follows (estimated thousands of deaths in parenthesis) bloodstream infections (1,100 UI (927-1,280)), lower respiratory infection (excl. COVID) (740 UI (592-888)), peritoneal and intra-abdominal infections (229 UI (183-275)), urinary tract infections and pyelonephritis (113 UI (79-147)) and infections of the skin and subcutaneous systems (112 UI (79-146)).

Figure 3. Number of deaths associated with AMR by age group between 1990-2020 and 2050 projection

Deaths by age group ▇ 70+ ▇ 50 to 69 ▇ 15 to 49 ▇ 5 to 14 ▇ under 5
The length of each bar represents the number of deaths associated with AMR by age group

- In North Macedonia, people aged 70+ saw the largest number of deaths associated with AMR both in 1990 and 2021, which indicates that 70+ continues to be particularly vulnerable to infections which are resistant to antibiotics. In 2021, the number of deaths associated with AMR among the 70+ was 838 UI (702-975), whereas the mortality rate per 100,000 was 441 UI (370-513).

Data sources for North Macedonia

In total, 520 million individual records or isolates covering 19,513 study-location-years were used as input data to our estimation process. The subset of input data for this country is shown below.

Table 3. Data inputs for North Macedonia by source type

Source type	Years	Sample size	Sample size units
Antibiotic use	1990-2021	268	Study-year datapoints
Microbial or laboratory data with outcome	1990-2021	124	Isolates
Single drug resistance profile data	2010-2021	5,654	Antibiotic susceptibility test

More information

About GRAM:

The purpose of the Global Research on AntiMicrobial resistance (GRAM) project is to **generate accurate and timely estimates of the magnitude and trends in antimicrobial resistance (AMR) burden** across the world, which can be used to inform treatment guidelines and agendas for decision-making and research, detect emerging problems and monitor trends to inform global strategies, as well as facilitate the assessment of interventions over time.

GRAM is the flagship project of the University of Oxford–IHME Strategic Partnership. GRAM was launched with support from the United Kingdom Department of Health and Social Care's Fleming Fund, and the Wellcome Trust.

All resources:

For all resources on AMR analysis at IHME, visit https://www.healthdata.org/antimicrobial-resistance.

To look at these and more visualization interactively visit Measuring Infectious Causes and Resistance Outcomes for Burden Estimation (MICROBE).

Data sources:

To download the list of data input sources by country, and AMR results by region, visit the Global Health Data Exchange (GHDx).

Contact us:

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