Global Antibiotic Resistance Analysis (WHO GLASS Data)

This project demonstrates exploratory data analysis and visualization using Microsoft Excel.

Exploratory Data Analysis using Microsoft Excel
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Data Source: WHO GLASS 2022
Time Period: 2017–2020

1. Problem Statement

Antibiotic resistance is one of the most critical global public health challenges. Rising resistance reduces the effectiveness of commonly used antibiotics, leading to longer hospital stays, higher medical costs, and increased mortality. This project aims to analyse global antibiotic resistance patterns using real-world WHO GLASS data to understand how resistance varies across regions, bacteria, and antibiotics over time.

2. Data Overview

- **Source:** World Health Organization – GLASS (Global Antimicrobial Resistance and Use Surveillance System)
- **Coverage:** Multiple countries aggregated into WHO regions
- **Time Period:** 2017 to 2020
- **Key Fields Used:**

  - WHO Region
  - Year
  - Specimen Type
  - Bacteria (Pathogen)
  - Antibiotic
  - Total Tested
  - Valid Tests
  - Resistant Count
  - Resistant Percentage

The dataset represents laboratory-confirmed antimicrobial susceptibility testing results reported by participating countries.

3. Data Preparation & Validation

The raw dataset was cleaned and standardized before analysis:

1. Renamed columns to industry-standard, meaningful names
2. Validated data types for all columns
3. Removed blank and invalid records
4. Ensured Resistant_Count ≤ Total_Tested for all observations
5. Validated resistance percentages to remain between 0–100%
6. Applied Excel-based logical validation rules to flag inconsistent records

These steps ensured data consistency and reliable analysis outcomes.

4. Data Analysis & Visualization-Overview

Microsoft Excel was used as the primary analysis tool. The following techniques were applied:

1. Created pivot tables to analyse **Year vs Average Resistance %**
2. Analysed **WHO Region–wise resistance patterns**
3. Built **line charts** to track resistance trends over time
4. Developed **Bacteria vs Antibiotic heatmap** using conditional formatting
5. Developed **column chart** to clearly compare the **Top 5 most resistant and least resistant antibiotics**, making high-risk drugs and effective treatment options easy to identify

The analysis focused on identifying time trends and regional differences in resistance levels.

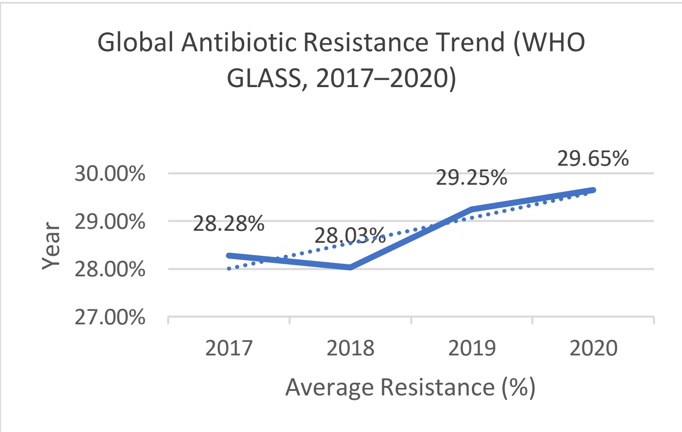
5. Detailed Analysis & Findings

5.1 Region-wise Resistance Trends (2017–2020)

Average of Resistant_Percent	WHO_Region					
Year	African Region	Eastern Mediterranean Region	European Region	Region of the Americas	South-East Asia Region	Western Pacific Region
2017	31.08%	35.50%	21.98%	21.65%	43.22%	20.48%
2018	25.60%	35.74%	23.64%	21.16%	38.99%	20.23%
2019	38.63%	36.81%	21.14%	26.19%	40.54%	19.24%
2020	25.34%	39.87%	24.02%	22.90%	40.16%	20.67%
Grand Total	35.86%	36.93%	22.09%	23.58%	40.67%	20.04%

- Eastern Mediterranean, European, and Region of the Americas show a clear upward trend in antibiotic resistance.
- South-East Asia Region demonstrates a gradual decline, suggesting possible improvements in surveillance or antibiotic stewardship.
- Western Pacific Region remains largely stable over the observed period.
- African Region shows variable trends, likely influenced by inconsistent reporting and surveillance coverage.

5.2 Trend Analysis (Average Resistance % VS Year)



- Antibiotic resistance shows a gradual global increase, rising from ~28% in 2017 to nearly 30% in 2020, indicating increasing antimicrobial pressure worldwide.

- This indicates increasing antimicrobial pressure over time.

5.3 Heatmap Analysis – Bacteria vs Antibiotic Resistance

- Shows average antibiotic resistance across different **bacteria–antibiotic combinations** using colour intensity
- Helps quickly identify high-risk (high resistance) and low-risk (low resistance) antibiotics

Average of Resistant_Percent	Antibiotic										
Bacteria	**Amikacin**	**Ampicillin**	**Azithromycin**	**Benzylpenicillin**	**Cefepime**	**Cefixime**	**Cefotaxime**	**Cefoxitin**	**Ceftazidime**	**Ceftriaxone**	**Ciprofloxacin**
Acinetobacter	45.7%										
Escherichia coli		72.7%			32.6%		39.0%		33.8%	43.2%	40.9%
Klebsiella pneumoniae					43.3%		49.2%		46.7%	50.0%	38.4%
Neisseria gonorrhoeae			8.5%			5.8%				1.5%	74.1%
Salmonella							5.2%		4.9%	6.5%	16.6%
Shigella			10.8%				18.5%		4.2%	22.1%	18.6%
Staphylococcus aureus								25.6%			
Streptococcus pneumoniae				13.6%			2.4%			1.9%	
Grand Total	**45.7%**	**72.7%**	**9.0%**	**13.6%**	**37.9%**	**5.8%**	**32.7%**	**25.6%**	**31.7%**	**30.6%**	**35.5%**

Bacteria	**Colistin**	**Doripenem**	**Ertapenem**	**Gentamicin**	**Imipenem**	**Levofloxacin**	**Meropenem**	**Meticillin**	**Minocycline**	**Oxacillin**	**Spectinomycin**	**Tigecycline**	**Tinidazole**	**Trimethoprim/sulfamethoxazole**
Acinetobacter	4.4%	57.0%		51.8%	56.9%		56.1%		17.1%			13.8%		
Escherichia coli	3.1%	4.2%	4.4%		4.2%	39.7%	3.3%						32.1%	50.6%
Klebsiella pneumoniae	7.9%	12.5%	24.1%		18.3%	34.0%	15.7%							46.1%
Neisseria gonorrhoeae				2.0%							0.0%			
Salmonella		0.0%	0.6%		0.3%	13.2%	0.1%							
Shigella						26.6%								
Staphylococcus aureus								23.8%		29.4%				
Streptococcus pneumoniae										27.3%				29.5%
Grand Total	**5.4%**	**13.9%**	**12.1%**	**49.6%**	**17.4%**	**33.1%**	**16.4%**	**23.8%**	**17.1%**	**28.4%**	**0.0%**	**13.8%**	**32.1%**	**46.3%**

Overall

- Antibiotic resistance varies widely across bacteria and antibiotics
- No single antibiotic is effective against all bacteria

High-Resistance Antibiotics (Poor Performance)

- Ampicillin shows very high resistance (~73%), especially against *Escherichia coli*
- Trimethoprim/Sulfamethoxazole shows moderately high resistance (~46%)
- These antibiotics may no longer be suitable as first-line treatments

Low-Resistance Antibiotics (Good Performance)

- Colistin, Doripenem, and Ertapenem show low resistance (<15%)
- Spectinomycin shows near-zero resistance
- These antibiotics remain highly effective treatment options

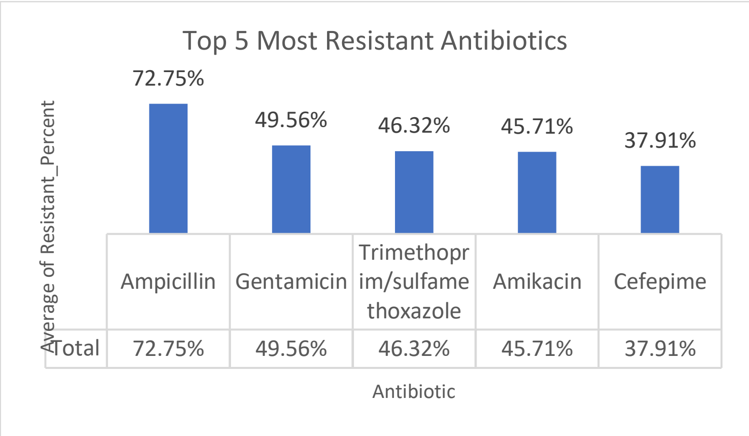
Bacteria-Wise Patterns

- *Escherichia coli* and *Klebsiella pneumoniae* show high resistance to commonly used antibiotics (e.g., Ampicillin, Cefotaxime)
- *Neisseria gonorrhoeae* shows low resistance for several antibiotics, with resistance limited to specific drugs

Additional Insights

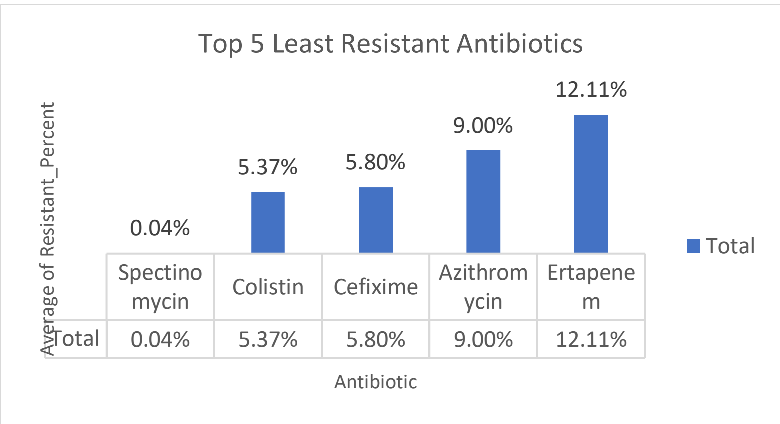
- Older and frequently used antibiotics show higher resistance
- Newer or restricted antibiotics show lower resistance
- Overuse of antibiotics likely contributes to increased resistance

5.4 Top 5 Most Resistant Antibiotics (High-Risk)



- **Ampicillin (~72.8%)** shows extremely high resistance, indicating poor effectiveness against common bacteria such as *E. coli*.
- Other widely used antibiotics (**Gentamicin, Trimethoprim/Sulfamethoxazole, Amikacin, Cefepime**) show moderate to high resistance, reflecting overuse-driven resistance.

Top 5 Least Resistant Antibiotics (Low-Risk / Effective)



- **Spectinomycin, Colistin, and Cefixime** show very low resistance, indicating high effectiveness and controlled usage.
- **Azithromycin and Ertapenem maintain** low resistance levels, reflecting restricted or targeted use.

6. Interpretation

- Older and commonly prescribed antibiotics show **significantly higher resistance**, indicating reduced effectiveness.
- Restricted, newer, and last-resort antibiotics maintain **lower resistance levels** due to controlled usage.
- High resistance percentages are linked to **increased treatment failure risk**.
- Low resistance percentages indicate **better treatment outcomes** when antibiotics are used appropriately.
- These findings are **consistent with global antimicrobial resistance trends** reported in public health research.

7. Key Takeaway: Antibiotic Stewardship and Bacteria-Specific Treatment

- Antibiotic resistance is **driven by usage patterns**, not random occurrence.
- Overuse of broad-spectrum and older antibiotics accelerates resistance development.
- Controlled use of restricted and last-resort antibiotics helps **preserve long-term effectiveness**.
- Resistance varies across **bacteria–antibiotic combinations**, making generalized treatment ineffective.
- **Bacteria-specific treatment selection**, guided by resistance data, improves clinical outcomes.
- Strong **antibiotic stewardship practices** are essential to slow resistance growth and ensure safer healthcare outcomes.

Overall Conclusion & Project Purpose

This project analyses global antibiotic resistance trends using WHO GLASS data to demonstrate practical data analysis skills in Microsoft Excel. Through data cleaning, validation, pivot analysis, and visualizations, it identifies key resistance patterns across regions, bacteria, and antibiotics. The findings emphasize the importance of data-driven, bacteria-specific treatment decisions and antibiotic stewardship, showcasing the ability to convert real-world data into meaningful insights.

THE END