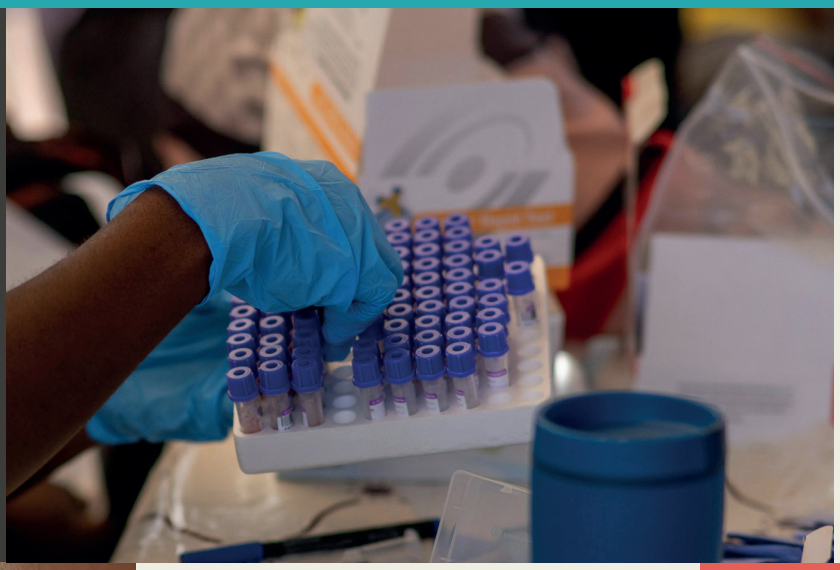
GEAR UP

2025 | GENDER, EQUITY, AND ANTIMICROBIAL RESISTANCE

Guidance on analysing bacteriology laboratory and antimicrobial use data



CONTENTS

ACKNOWLEDGEMENTS

The development of this guideline was made possible through the valuable collaboration and contributions of the Fleming Fund Country Grantees in Tanzania, Uganda, Ghana, and Lao PDR. GEAR up appreciates their willingness to collaborate in analysing AMR surveillance data through a gender and equity lens. This document was written by Ralalicia Limato.

ABBREVIATIONS AND ACRONYMS

AMR	Antimicrobial resistance
AMU	Antimicrobial use
AWaRe	Access, Watch, Reserve
BSIs	Bloodstream infections
CAI	Community acquired infection
DDD	Defined Daily Dose
GLASS	Global Antimicrobial Resistance Surveillance System
HAI	Healthcare-associated infection
NSTGs	National Standard Treatment Guidelines
PPS	Point prevalence survey
UTIs	Urinary tract infections
WHO	World Health Organization

GUIDANCE

GENDER, EQUITY, AND ANTIMICROBIAL RESISTANCE

Guidance on analysing bacteriology laboratory and antimicrobial use data

1. INTRODUCTION

Antimicrobial resistance (AMR) is a major global public health problem that makes antimicrobial drugs less effective and leads to higher illness, death, and healthcare costs. One of the important components of addressing AMR is systematic collection, analysis, and interpretation of AMR and antimicrobial use (AMU) data to inform evidence-based interventions. However, current AMR and AMU surveillance systems often overlook the influence of sociodemographic factors, including gender and equity dimensions, on resistance and prescribing patterns.[1] Biological factors, occupational exposures, disability status, differences in healthcare access, education level, and socioeconomic status can lead to disparities in AMR and AMU between men, women and people of other genders, including among marginalised groups. Integrating gender and equity analysis into AMR and AMU data assessment can uncover hidden trends, ensuring more targeted and inclusive policy responses.[2]

AMR surveillance data are collected by laboratories when bacteriological investigations are carried out. Surveillance focuses on pathogens rather than people and are currently not designed to tell us much about those who have the infections. In addition, AMR surveillance data is liable to a number of known and suspected biases. Some of these biases arise because data is collected mainly at the tertiary level of the health system where bacteriology laboratory services are available. Such tertiary healthcare facilities are usually located in urban areas, and which patients can access them impacts how representative of the population the specimens that are collected are. In the settings where unique patient identifiers are unavailable, there is the potential for data duplication, which can skew results. Therefore, caution is advised when interpreting findings derived from analysis of AMR surveillance data. Care must be taken not to extrapolate far beyond the specific population and health system setting where the specimens were collected.

GEAR up has undertaken preliminary analysis of AMR surveillance data and AMU data disaggregated by sex and age. Using this experience, we developed this guideline with the aim of providing a structured, stepwise approach to analysing AMR and AMU data with attention to gender and equity indicators. The expected outcome is to demonstrate the importance of sex-disaggregated and equity-focused data analysis from clinical and health systems perspectives. By identifying equity disparities, it is hoped that healthcare providers can tailor local antibiotic stewardship and policymakers can formulate improved national policy to reduce inequities in AMR burden.

IMAGE CREDIT: Miodrag Ignjatovic

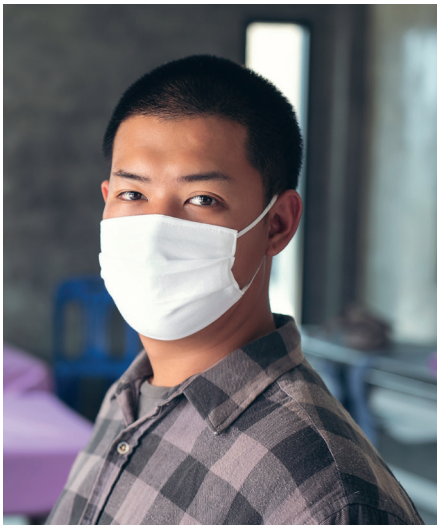
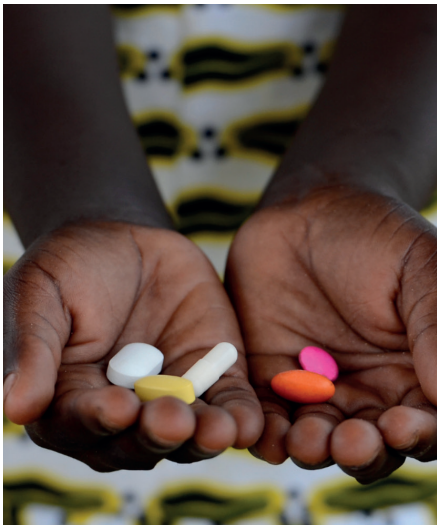


IMAGE CREDIT: Wirestock



2. ANTIMICROBIAL RESISTANCE SURVEILLANCE DATA ANALYSIS

The variables used to collect antimicrobial resistance (AMR) data are varied between countries and settings. In most countries, the routinely collected data that would permit gender and equity analyses of AMR is limited to sex and age. With the caveats above, useful information relating to gender and equity can be gleaned from disaggregating data by sex and age.

GEAR up has undertaken preliminary analysis of national AMR data disaggregated by age and sex. Below we describe the step-by-step approach that teams took so you can conduct an equity analysis of your own data.

STEP 1.
Identifying available variables and data sources

The first step in analysing AMR data is to identify the variables available in your dataset. Typically, AMR data collection captures two main variables: sex and age.

- **Sex.** Often recorded as male, female or intersex.
- **Age.** Often recorded in years for adults and children, in months for infants and young children, or in days for neonates.
- **Other variables** such as patient location, education level, and insurance status may be available in your dataset. Refer to 'Intersectional indicators in surveillance of antimicrobial resistance and use' for information on gender and equity indicators.

Testing laboratories are typically situated within tertiary healthcare settings, such as hospitals. Where possible, it is important to categorise the sources of data based on the origins of the patients, as they may reflect different pathogens and resistance patterns. Common sources of data include:

- **Hospitals.** Where possible, distinguish between data from inpatients (patients with hospital admission) and outpatients (patients without hospital admission).
- **Community settings.** Includes outpatient clinics and primary care facilities.
- **Long-term care facilities.** For example, nursing homes and rehabilitation centres.

STEP 2.
Defining stratifiers

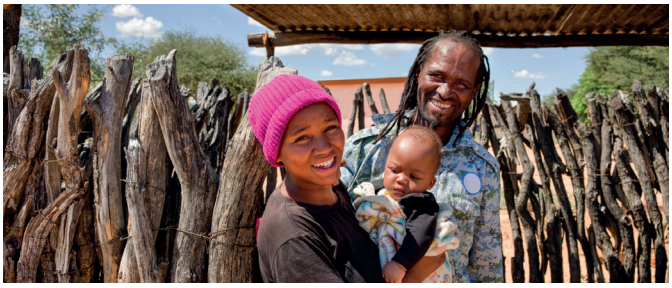
Once you have identified the available variables, determine the stratifiers of these variables. The suggested categories below can be adapted based on the specific context and needs of your data analysis.

Sex. Consider dividing sex into two or three categories, for example:

- Male
- Female
- Intersex

Age. Age can be grouped based on categories with healthcare significance, for example:

- Neonates (<1 month)
- Under-five years (1 month – <5 years)
- Children (5 - 12 years)
- Adolescents (13 - 19 years)
- Adults (20 - 59 years)
- Elderly (≥ 60 years)



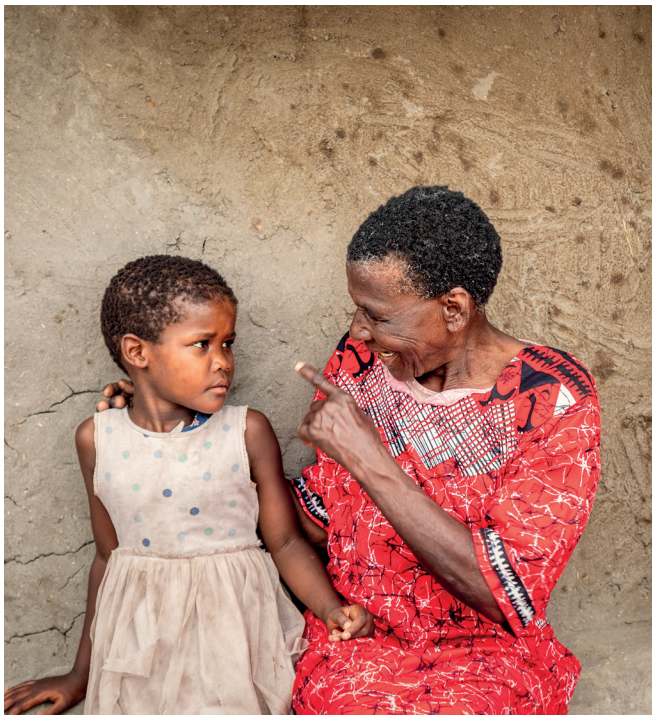


IMAGE CREDIT: Poco bw

Combination of sex and age. You may also consider creating combined categories that capture both sex and age, for example:

- Female children
- Reproductive age males
- Reproductive age females
- Elderly males

To add granularity in the analysis, where possible, further stratify the data based on **specific population groups**, for example:

- Reproductive age females attending antenatal care clinics
- Reproductive age males from HIV treatment centres
- Elderly patients from infectious disease wards

Step 3. Identifying specimen types of interest

The next step is to select the specimen types you want to focus on. There are different types of specimens (**Table 1**). Decisions to collect certain types of specimens often serve as proxies for specific infections.

Table 1. Types of specimens[3]

SPECIMEN TYPE	CLINICAL RELEVANCE
Blood	May indicate suspected bloodstream infections (BSIs).
Urine	May indicate suspected urinary tract infections (UTIs).
Genital	Genital specimens, such as urethral and cervical discharge, may indicate suspected gonorrhoea.
Stool	May indicate suspected gastrointestinal infections.
Wound	Wound specimens are samples collected from a wound, which can include pus, tissue, and fluid, to identify suspected wound infections.
Body fluids	There is a range of body fluid specimens beyond blood and urine, including cerebrospinal fluid, amniotic fluid, pericardial fluid, synovial fluid, pleural fluid, gastric fluid, and peritoneal fluid. The collection of these specimens can indicate suspected infections in the corresponding organs or systems.
Respiratory	Respiratory specimens include samples from the upper and lower respiratory tracts, such as nasal and throat swabs, sputum, and bronchoalveolar lavage fluid. These specimens may indicate suspected respiratory infections, for example, pneumonia, tuberculosis, and other respiratory infections.

Once you have selected the specimen types of interest, examine the patterns in submission across different sex and age groups. For example:

- Are there differences in the number of urine specimens among males and females across age groups?
- Could this reflect variations in the number of suspected UTIs, differences in symptom presentation, or differences in healthcare practices (e.g., routine screening of asymptomatic women for UTIs in antenatal clinics)?

Be cautious when interpreting specimen submission data. Not every specimen necessarily represents a unique infection, as multiple specimens can be taken from the same individual. However, this too can provide valuable insights. For instance, are there significant differences in multiple specimen submissions across sex and age groups?

STEP 4.
Identifying bacteriologically confirmed infections

After selecting the specimen type and reviewing the overall submission numbers, the next step is to assess the number and proportion of specimens that yielded a bacterial pathogen (positive), were negative, and contained contaminants (**Table 2**).

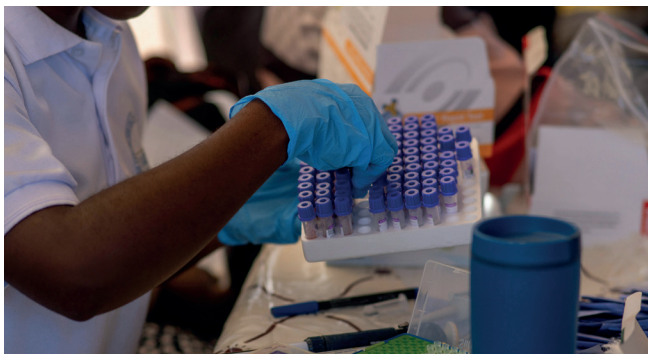


Table 2. Culture results

RESULTS	INTERPRETATION
Positive	Microorganisms were detected and grew in the culture medium, indicating the presence of an infectious bacterial pathogen or a bacteriologically confirmed infection.
Negative	No microorganisms grew in the culture, implying that no infectious agent or target organism was detected.
Contaminant	Microorganisms that are not clinically significant or are not the target of the test. Contamination can occur during the collection or processing of the sample, introducing non-target microorganisms.

The next step is to analyse the results by sex and age. For instance, you may observe that while an equal number of urine specimens were collected from males and females, specimens that yielded positive results, i.e., bacteriologically confirmed UTIs, might be significantly more common among women of childbearing age.

If your data are segregated by data source, consider further comparing the bacteriologically confirmed infections across different settings, for example, hospitals, primary care facilities, HIV clinics, and nursing homes. This approach helps to identify disparities in infection rates that may reflect biological, behavioural, or healthcare access differences.

Step 5.
Identifying the types of bacterial pathogens isolated

The next step is to classify the isolated bacterial pathogens based on factors such as sex, age, or a combination of both. It is helpful to think in terms of how your analysis can be useful in healthcare or clinical practice.

Using an example of bacteriologically confirmed UTIs, the next step is to analyse what the most common pathogens are (e.g., top five pathogens) from urine specimens across different sex and age groups. For example, in women of childbearing age, over 80% of UTIs may be caused by *Escherichia coli*, *Klebsiella pneumoniae*, *Enterobacter spp.*, and *Enterococci*. Meanwhile, among men of the same age group, the most commonly isolated pathogen from bacteriologically confirmed UTIs was *Staphylococcus aureus*, and a different set of pathogens accounted for most infections in the men. Such a finding might have implications for treatment.

The World Health Organisation (WHO) developed a list of priority bacterial pathogens and their associated common infections as part of the Global Antimicrobial Resistance Surveillance System (GLASS) (**Table 3**). These pathogens have been selected based on their significant contribution to common infections and their high potential for antibiotic resistance, making them critical targets for surveillance and intervention. This guideline can be used as a reference when performing data analysis, noting that these pathogens may also cause infections beyond the listed infections.

Table 3. Priority bacterial pathogens in the WHO GLASS[4]

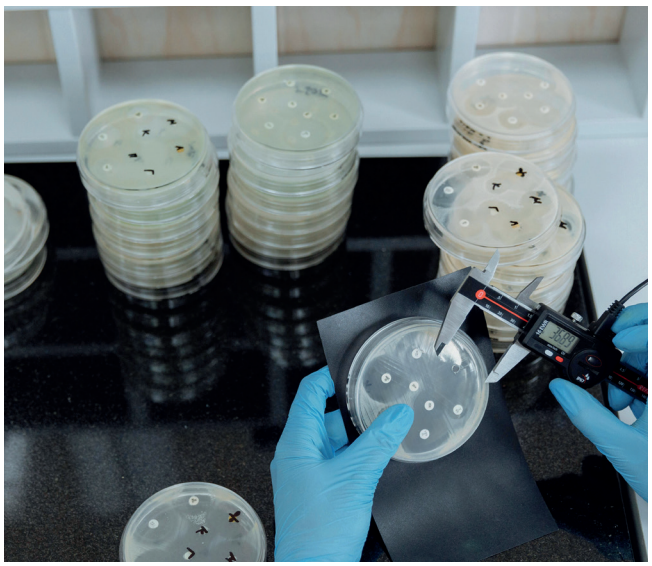
BACTERIAL PATHOGENS	COMMON INFECTIONS
Acinetobacter spp.	Bloodstream infections (BSIs)
Escherichia coli	BSIs, urinary tract infections (UTIs)
Klebsiella pneumoniae	BSIs, UTIs
Salmonella spp.	BSIs, gastrointestinal infections
Staphylococcus aureus	BSIs
Streptococcus pneumoniae	BSIs
Shigella spp.	Gastrointestinal infection
Neisseria gonorrhoeae	Gonorrhoea

STEP 6.
Analysing resistance and susceptibility patterns

In this step, you will analyse the AMR patterns of the priority pathogens identified in the previous stage. This analysis is critical for understanding local resistance trends across different sexes, age groups, or other relevant indicators, providing critical insights for guiding appropriate treatment decisions.

When performing this analysis, consider the practical implications for healthcare settings. Most countries have National Standard Treatment Guidelines (NSTGs) which outline recommended antibiotics, dosages, and treatment durations for common infections. These guidelines typically differentiate between:

- First-line treatment: Used for initial presentations of the infection, often involving antibiotics from the Access category of the WHO's AWaRe (Access, Watch, Reserve) classification. These drugs are generally effective, widely available, and have a lower risk of promoting resistance.
- Second-line treatment: Used when the first-line therapy fails or the infection recurs, often involving antibiotics from the Watch category, which are broader-spectrum and associated with a higher risk of resistance.
- Last resort or last-line treatment: Used to treat infections caused by bacteria that are resistant to multiple other antibiotics, often involving antibiotics from the Reserve category.



For your analysis, refer to the relevant NSTGs for the specific infection you are investigating, such as UTIs, to identify the recommended first-line and second-line treatment options. In the example provided, over 80% of UTIs in women of childbearing age were caused by *Escherichia coli*, *Klebsiella pneumoniae*, *Enterobacter spp.*, and *Enterococci*. To assess the effectiveness of current treatment guidelines, consider:

1. Assessing first-line resistance

- What proportion of *Escherichia coli* isolates from urine in this population were resistant to the recommended first-line treatment?
- What proportion were resistant to the recommended second-line treatment?
- What proportion were resistant to both first-line and second-line treatments?

2. Evaluating resistance in other pathogens

- What proportion of *Klebsiella pneumoniae*, *Enterobacter spp.*, and *Enterococci* isolates were resistant to first-line and/or second-line treatments?

3. Assessing treatment appropriateness

- If 82% of all UTIs in this group are caused by these four pathogens, what proportion of these infections would be appropriately treated based on the NSTGs?

4. Implications for clinical practice

- Based on these findings, what are the implications for the use of NSTGs for UTIs in women of childbearing age in certain populations or healthcare settings?

Step 7. Adding granularity to the analysis

Comparing to specific population. In Step 2, we recommended further stratifying the data by specific population groups, for example, women of reproductive age attending antenatal care clinics or female patients in obstetrics and gynaecology wards. These subgroups can then be compared with the broader population, stratified by sex and age, to highlight potential differences in AMR patterns, for example, for UTI cases.

Integrating antimicrobial use (AMU) data. AMU data can help determine whether antimicrobial prescribing practices align with clinical guidelines or with culture and susceptibility testing results. Where AMU data are available, the following aspects should be assessed:

- Whether the AMU data originate from the same sites contributing the laboratory data.
- Whether there is information on the specific antimicrobials being used to treat certain infections (e.g., UTIs, BSIs), disaggregated by sex and age groups.

Where both AMR and AMU data are available and disaggregated by sex and age, they should be analysed in parallel to identify patterns, inconsistencies, or gaps in prescribing practices relative to resistance trends.

IMAGE CREDIT: Chris Bucanac

3. ANTIMICROBIAL USE DATA ANALYSIS

There are two main categories of antimicrobial use (AMU) data collection: Quantity metrics and quality indicators. Within these two categories, the methodologies of, and protocols for, data collection are different between inpatient and outpatient settings. Therefore, the variables of AMU data collected may be varied between different datasets.

Quantity metrics

The purpose of quantity data collection is to measure how much antimicrobials are used over a specific time period in a certain setting, such as a hospital or clinic or primary healthcare. There are several methods to measure it, with the most commonly being Defined Daily Dose (DDD), Days of Therapy (DOT), Length of Therapy (LOT), and number of prescriptions. The utilisation of global protocols in data collection—for example, the WHO Anatomical Therapeutic Chemical (ATC)/DDD methodology allows surveillance data comparison within and between countries.[5]

IMAGE CREDIT: Sara Berdon

IMAGE CREDIT: TinusPhotoBooth

Quality indicators

Audits and point prevalence surveys (PPS) are the two main methodologies to assess the quality indicators of antimicrobial prescribing. AMU audits are typically conducted on a small scale, focusing on specific wards, departments, diagnoses, or patient groups. These audits may use detailed evaluation approaches, for example, algorithms, to assess prescribing practices. The main purpose of an audit is to examine specific aspects of antimicrobial prescribing–such as, choice of drug, duration, dose, and route–to evaluate the outcomes of stewardship intervention(s).

PPS is a standardised method to capture a snapshot of antibiotic prescribing practices among patients that can be conducted in a single healthcare facility or at the national and global scale. PPS follows a set protocol and uses predefined tools with consistent quality indicators. These indicators typically include the choice of drug, diagnosis, indication for prescription, compliance with guidelines, type of treatment, whether a culture sample was taken, and if available, the results of any positive cultures. The two most widely used PPS protocols are WHO PPS[6] (for inpatients) and Global-PPS[7] (for inpatients and outpatients).

This guideline outlines key equity aspects for analysing AMU data collected through the PPS methodology for inpatients. Where relevant, it also can be applied to other AMU data collection methods. Caution when interpreting equity analysis results from PPS data. PPS captures prescribing patterns on a single day only and therefore does not reflect trends over time or seasonal variations. Additionally, data quality depends on the completeness and accuracy of medical record documentation, which may vary across settings.

STEP 1.
Identifying available variables

Similar to the AMR data analysis, the first step is to identify the variables included in your dataset. As noted earlier, different protocol and tools capture different variables. Typically, PPS tools capture **sex** and **age**. Another important variable in PPS is **comorbidity**, which refers to the presence of two or more diseases in a patient at the same time. It provides information on whether a patient is at risk at developing complications or adverse outcomes. Example of comorbidities are including cardiovascular disease, hypertension, diabetes mellitus, malnutrition, and infectious diseases that require long-term treatment, such as tuberculosis and HIV.

STEP 2.
Defining stratifiers

Once you have identified the available variables, determine the stratifiers of these variables. Refer to Step 2 of AMR data analysis.

STEP 3.
Analysing antimicrobial prescriptions and quality indicators

The main purpose of PPS is to assess patterns of AMU and related quality indicators. This guideline outlines approaches and key consideration for analysing antimicrobial prescriptions by drug of choice, diagnosis, and indication. For quality indicators, the focus includes comparison between empirical and targeted treatment, and assessment of guideline compliance.

A. Drug of choice

There are several ways to classify the drug of choice of antimicrobial prescriptions. One of them is using the WHO AWaRe (Access, Watch, Reserve) classification (**Table 4**). The **AWaRe** categorises antibiotics according to their spectrum of activity and potential to develop resistance, with an aim to optimise appropriate prescribing practices.

Based on the AWaRe classification, compare antibiotic prescription patterns:

- Between males and females receiving Access, Watch, or Reserve antibiotics.
- Across different age groups receiving Access, Watch, or Reserve antibiotics.
- Between patients with and without comorbidities receiving Access, Watch, or Reserve antibiotics.

Table 4. The AWaRe classification[8]

AWaRe	
Access	• Includes narrow-spectrum antibiotics used as first- or second-line treatments for common infections. • Should be affordable, high-quality, and widely available.
Watch	• Includes broader-spectrum antibiotics with a higher risk of driving AMR. • While still suitable for first- or second-line use in certain cases, their use should be more controlled and closely monitored as part of stewardship programmes. • Some may be first choice for certain infections, and second choice for others, depending on available alternatives. • Access to both Access and Watch antibiotics is important but Watch antibiotics should be reserved for specific indications or pathogens.
Reserve	• Includes last-resort antibiotics used only in severe, life-threatening, or multidrug-resistant infections when other treatments fail.

AWaRe classification can reveal patterns in antibiotic selection across populations.

- Who are more likely to receive Watch and Reserve antibiotics? Are they women or patients with comorbidities? If some groups receive Watch or Reserve antibiotics more often without clear clinical indication, it may indicate overprescribing and bias in clinical decision-making.
- Low use Access antibiotics in certain populations may indicate limited availability and delayed-care seeking, where the condition has already progressed and require broader-spectrum antibiotics.

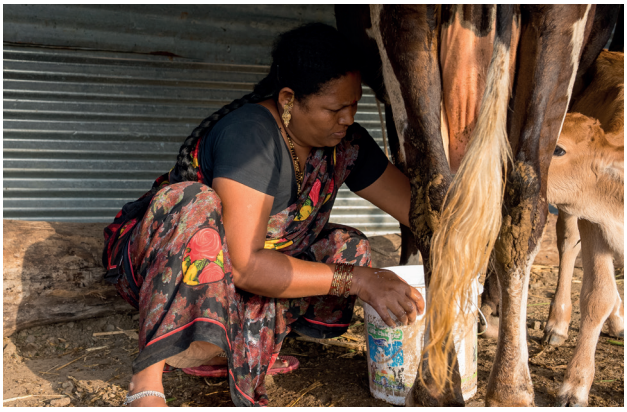


IMAGE CREDIT: Swati Kambles

B. Diagnosis

The term diagnosis refers to the clinical condition or reason for which the antimicrobial is prescribed at the time of the survey. Some examples of diagnosis are UTI, sepsis, pneumonia, gastrointestinal infection, and sexually transmitted disease.

Based on diagnosis, compare antibiotic prescription patterns between male and female, across different age groups, and between patients with and without comorbidities. The analysis will show which population groups are at what risk of what infection.

Antimicrobial prescriptions should reflect clinical diagnosis. Some conditions may be missed or underdiagnosed due to gender norms, stigma, or limited access to care. On the other hand, certain diagnoses may be over-used in specific populations due to stereotypes. For example, UTIs may be over diagnosed in women without confirmation, while similar symptoms in men are investigated more thoroughly.

C. Indications

In the PPS methodology, indications for antimicrobial prescriptions are categorised as therapeutic use for community acquired infection and healthcare-associated infection, and prophylactic use for surgical procedures and certain medical conditions (**Table 5**).

Based on indications of antimicrobial prescriptions above, compare antibiotic prescription patterns:

- Between males and females
- Across different age groups
- Between patients with and without comorbidities

By examining indications, we can see if certain groups are more likely to receive antibiotics for certain indication. For example, are those with comorbidities be more likely to receive antibiotics for HAI treatment or medical prophylaxis?

Table 5. Indications for antimicrobial prescribing

INDICATIONS	
Therapeutic	**1.** To treat **community acquired infection** (CAI), an infection contracted before admission to a healthcare facility.
	2. To treat **healthcare-associated infection** (HAI), an infection that develops while a patient is receiving care in a healthcare facility. It was not presented or incubating at the time of admission and typically occurs ≥48 hours after admission.
Prophylactic	**1. Surgical prophylaxis**, an antibiotic prescription intended to prevent infection related to surgical procedure. It is administered as single dose within 60 minutes before surgery and should be discontinued within 24 hours post-surgery.
	2. Medical prophylaxis, the use of antibiotics to prevent (not treat) infection in patients who are at increased risk due to underlying medical conditions or ongoing treatments.

D. Empirical versus targeted treatment

Within therapeutic use of antimicrobial (**Table 5**), type of treatment is divided into empirical and targeted.

- Empirical treatment is a treatment initiated based on clinical judgment before obtaining the microbiology results.
- Targeted treatment is a treatment based on confirmed microbiological results, such as culture and sensitivity, allowing for specific and often narrower-spectrum antibiotics.

Ideally, culture and sensitivity testing should be performed in highly suspected infections, with specimens are collected prior to empirical treatment. Once results are available, empirical therapy should be reviewed and adjusted accordingly.

From the PPS dataset, take the data from therapeutic use (CAI and HAI), and compare empirical and targeted treatment between males and females, across different age groups, and between patients with and without comorbidities. Equity issues around the type of treatment are related to access to diagnostics across population groups. For example, women with UTIs may not be tested with a urine culture because their symptoms are often assumed to be typical, which can lead to more frequent use of empirical treatment.

E. Guideline compliance

Guideline compliance in antimicrobial prescriptions refers to whether the prescribed antimicrobial (choice of drug, dose, route, and duration) aligns with local, national, or international treatment guidelines for a specific diagnosis and indication. Antimicrobial guidelines are used when culture and sensitivity results are pending or cannot be performed, but clinicians must begin empirical treatment due to highly suspected infection. In such situations, the guidelines help select the most likely effective drug, at the appropriate dose, route, and duration. To ensure their relevance and effectiveness, the guidelines should be adapted to local AMR data.

To assess guideline compliance:

- Stratify empirical treatment data into compliant and non-compliant groups, then compare these across sex (male and female), age groups, and presence or absence of comorbidities.
- Apply the same analysis to prophylactic use data, including both surgical and medical prophylaxis.

The equity issues around guideline compliance are related to biases surround prescribing practices. Clinicians may unconsciously prescribe differently for men and women, based on stereotypes or perceived adherence. For example, men may be perceived as more likely to delay care and thus receive broader-spectrum antibiotics. Neonates and children are more likely to receive guideline-compliant antibiotics because they are at greater risk of adverse drug effects. As a result, clinicians tend to be more cautious and strictly adhere to established guidelines to minimise these risks.

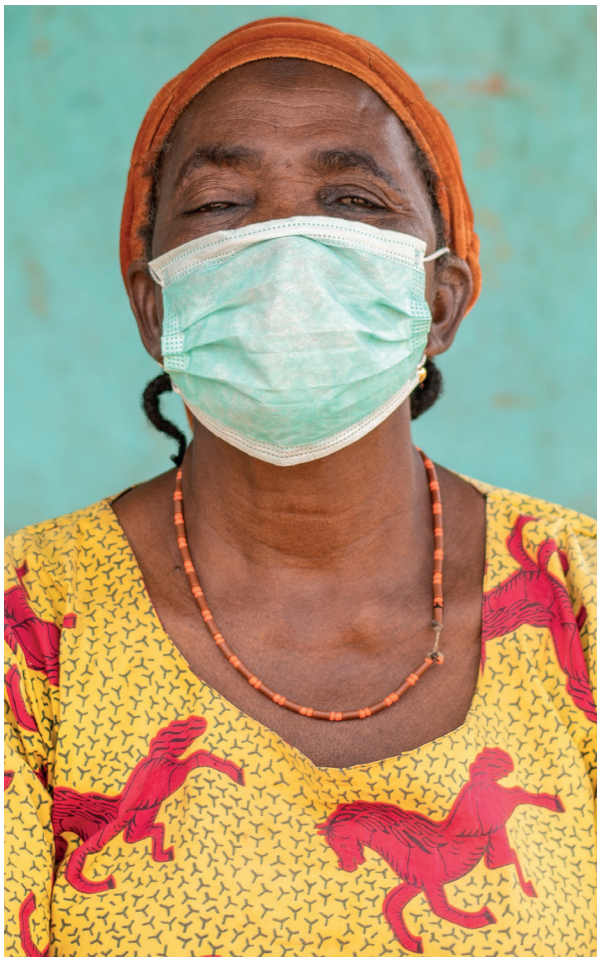


IMAGE CREDIT: Wirestock

SUMMARY

Incorporating gender and equity perspectives into AMR and AMU data analysis is crucial for designing more inclusive, effective, and context-sensitive interventions. This step-by-step guideline provides a structured approach to identify disparities in resistance patterns and antimicrobial use across different population groups, such as by sex and age, that may not be visible in aggregated data. It's important to interpret the results with care, considering limitations such as data quality.

There is already a significant amount of research on AMR and AMU being conducted in many countries. In some cases, the volume of work makes it challenging to keep track of ongoing developments. Before starting your own analysis, it's a good idea to conduct a literature review. This can help identify key research gaps, highlight relevant findings, and offer ideas on where to focus your efforts. Reviewing existing studies can also help you avoid duplicating work and ensure your analysis adds value to the broader evidence base.

REFERENCES

1. Batheja D, Saint V, Dobreva Z, Goel S, Lewycka S, Mutua E, et al. Integrating gender and equity commitments in the revised global action plan on antimicrobial resistance. Lancet. 2025.
2. Davis, K., Limato, R., Monga, M., Egid, B., Paul, S., Okioma, S., et al. (2025). Antimicrobial resistance, equity and justice in low-and middle-income countries: an intersectional critical interpretive synthesis. Nature Communications. DOI : 10.1038/s41467-025-64137-z
3. Pan American Health Organization. Recommendations for Implementing Antimicrobial Stewardship Programs in Latin America and the Caribbean: Manual for Public Health Decision-Makers Washington. D.C.: PAHO, FIU: Florida International University; 2018.
4. World Health Organization. Global Antimicrobial Resistance and Use Surveillance System (GLASS) report 2022. Geneva: WHO; 2022.
5. World Health Organization. Defined Daily Dose (DDD). Definition and General Considerations. WHO; 2022.
6. World Health Organization. WHO Methodology for Point Prevalence Survey on Antibiotic Use in Hospitals. Geneva: WHO; 2018.
7. GLOBAL-PPS. Global Point Prevalence Survey of Antimicrobial Consumption and Resistance. GLOBAL-PPS; 2024.
8. World Health Organization. The WHO AWaRe (Access, Watch, Reserve) Antibiotic Book. Geneva: WHO; 2022.