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Antibiotic Prescribing Patterns Among Outpatients Using the WHO AWaRe Classification in Health Facilities in Tete and Sofala, Mozambique

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Research Article

Keywords: Antibiotic prescribing, Outpatients, Antimicrobial stewardship, WHO AWaRe classification, Mozambique

Posted Date: May 11th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9291164/v1

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Additional Declarations: No competing interests reported.

Abstract

Background

Antibiotic overuse is a major driver of antimicrobial resistance (AMR), a global public health concern, particularly in sub-Saharan Africa where a high burden of infectious diseases and predominantly empirical diagnosis contribute to inappropriate use. The World Health Organization (WHO) AWaRe (Access, Watch, Reserve) classification supports rational prescribing by enabling the monitoring of antibiotic use patterns. However, data on AWaRe-based antibiotic use in Mozambique, especially in outpatient settings, remain limited. This study aimed to evaluate antibiotic prescribing patterns among outpatients using the WHO AWaRe classification in health facilities in Tete and Sofala, Mozambique.

Methods

Secondary data from outpatient prescriptions at two health facilities in Mozambique, Health Center No. 3 in Tete Province and Caia District Hospital in Sofala Province, were analyzed. Patients of all ages attended between November 2025 and January 2026 with at least one antibiotic prescribed were included (n = 387). Antibiotic prescribing patterns were evaluated using the WHO AWaRe classification and WHO/INRUD prescribing indicators.

Results

Among the 387 prescriptions included, a total of 435 antibiotics were prescribed. Most patients received one antibiotic (89.4%), while 6.7% received two and 3.9% received three or more. Cotrimoxazole was the most frequently prescribed antibiotic (42.8%), followed by amoxicillin (20.2%) and metronidazole (11.3%). According to the AWaRe classification, 85.7% of antibiotics belonged to the Access group and 12.4% to the Watch group, with no prescriptions from the Reserve group. All antibiotics were prescribed by their generic names and were included in the essential medicines list. Total antibiotic consumption was 121.91 DDD/1,000 inhabitants/day, with amoxicillin (50.22) and ciprofloxacin (23.59) showing the highest utilization rates.

Conclusion

Antibiotic prescribing among outpatients in this study met the WHO target for the Access group, indicating overall alignment with recommended practices. However, the use of Watch antibiotics, particularly macrolides, highlights the need to strengthen antimicrobial stewardship efforts to ensure more rational use. The implementation of WHO recommendations, including the AWaRe classification, together with improved adherence to clinical guidelines and targeted training of healthcare providers, is essential to optimize prescribing practices in outpatient settings.

Introduction

Excessive and inappropriate use of antibiotics is a major driver of antimicrobial resistance (AMR), which is widely recognized as a global public health challenge [1]. AMR affects not only human health but also animal health, agriculture, and the environment [2, 3]. Recent estimates indicate that millions of deaths are associated with bacterial resistance, representing an even greater concern in Sub-Saharan Africa (SSA), where the coexistence of a high burden of infectious diseases, limited diagnostic capacity, and reliance on empirical prescribing practices increases the likelihood of inappropriate antibiotic use [4]. In this context, strategies that promote rational prescribing are essential to curb the progression of resistance [1].

To guide clinical decision-making and improve prescribing quality, the World Health Organization (WHO) developed the AWaRe classification, which categorizes antibiotics into three groups: Access, Watch, and Reserve [5]. Antibiotics in the Access group are recommended as first- or second-line treatments for common infections and should be widely available. The Watch group includes antibiotics with a higher potential to drive resistance and therefore requires closer monitoring. The Reserve group consists of last-resort agents, intended for use only in specific situations to preserve their effectiveness. This classification, together with the WHO Model List of Essential Medicines, provides a practical framework for optimizing antimicrobial use [5].

Monitoring antibiotic consumption based on the AWaRe classification allows the identification of inappropriate prescribing patterns and supports antimicrobial stewardship interventions [5]. The WHO recommends that at least 60% of total national antibiotic consumption should come from the Access group, aiming to reduce selective pressure that contributes to the emergence of resistant microorganisms [5, 6].

Although some countries have made progress in implementing these recommendations, substantial regional variations in antibiotic prescribing and consumption patterns persist [7]. These differences are driven by multiple factors, including medicine availability, the local epidemiological profile of infections, access to laboratory diagnostics to guide treatment decisions, and the level of training of healthcare professionals [1, 8].

In Mozambique, despite several studies assessing antibiotic use [9–12], there is limited evidence evaluating prescribing practices using the AWaRe classification alongside WHO/INRUD indicators [13], particularly in outpatient settings within tertiary hospitals. To address this gap, this study aimed to assess antibiotic prescribing patterns among outpatients using the WHO AWaRe classification (Access, Watch, and Reserve) in tertiary hospitals in Tete and Sofala, Mozambique.

Methods

Study design, population, and sample size

A cross-sectional study was conducted using secondary data obtained from medical records and prescription forms. The study focused on outpatients attending Health Center No. 3 in Tete City, Tete Province, Mozambique, and Caia District Hospital in Sofala Province, Mozambique. The health center is a primary care facility responsible for outpatient services, including general consultations, management of acute and chronic conditions, and medication dispensing. The district hospital is a secondary-level facility providing both outpatient and inpatient care, including specialized consultations and the management of more complex cases.

The study was carried out between November 2025 and January 2026. During this period, a total of 387 outpatients, including both children and adults, received at least one antibiotic prescription and were included in the study.

Data collection and variables

The WHO AWaRe classification and WHO/INRUD prescribing indicators were used to assess antibiotic prescribing practices. Data were collected under the supervision of the principal investigator using a structured data collection tool that included patient-related and antibiotic-related information. Prescriptions with illegible handwriting that prevented clear identification of the prescribed antibiotic, as well as those containing only medical supplies, were excluded from the analysis.

Statistical analysis

Statistical analyses were performed using R software (R Foundation for Statistical Computing, Vienna, Austria), version 4.5.1 for Windows, within the RStudio environment. Descriptive statistics, including frequencies, percentages, means, medians, and standard deviations (SD), were used to summarize the data.

Results

Sociodemographic characteristics

As shown in Table 1, a total of 387 individuals were included in the study. There was a slight predominance of male participants (51%) compared to females (49%). The median age was 15 years. Regarding the place of care, most patients attended Health Center No. 3 (323; 83%), while 64 (17%) attended Caia District Hospital. In terms of diagnostic approach, clinical diagnosis was the most common (356; 93%), whereas laboratory-confirmed diagnosis was less frequent (28; 7%). Concerning antiretroviral therapy (ART), the majority of participants were not receiving treatment (357; 92%), and only 30 (8%) were on ART. Information on disease type was available for 77 participants, among whom 57 (74%) had infectious diseases and 20 (26%) had non-infectious conditions.

Table 1
Sociodemographic characteristics

Characteristics	N (%)
Age	
Children (0–11 years)	151 (39.0)
Adolescents (12–17 years)	47 (12.1)
Adults (18–59 years)	155 (40.1)
60 years and over	4 (1.0)
Not specified	30 (7.8)
Sex	
Female	190 (49.1)
Male	197 (50.9)
Name of the health centre	
Health Centre No. 3	323 (83.5)
Caia District Hospital	64 (16.5)
Type of diagnosis	
Clinical	359 (92.8)
Clinical and laboratory	28 (7.2)
Antiretroviral therapy (ART)	
No	357 (92.2)
Yes	30 (7.8)
Diagnostic	
Infectious disease	49 (12.7)
Non-infectious disease	29 (7.5)
Not specified	309 (79.8)
Number of antibiotics prescribed	
1	353 (91.2)
2	20 (5.2)
3	14 (3.6)

Characteristics	N (%)
Age	
Routes of administration	
Oral	385 (99.5)
Parenteral	2 (0.5)
Duration of tratment	
< 5	26 (6.7)
5–10	361 (93.3)

Antibiotic prescribing patterns

According to Table 1, most patients received a single antibiotic (261; 87%). The prescription of two antibiotics occurred in 22 cases (7%), and three antibiotics in 16 cases (5%). Regarding the route of administration, oral delivery predominated (385; 99%). As illustrated in Fig. 1, cotrimoxazole was the most frequently prescribed antibiotic (42.8%), followed by amoxicillin (20.0%). Metronidazole accounted for 11.3%, while erythromycin and ciprofloxacin each represented 7.1%. In terms of pharmacological classes (Fig. 1), the combination of sulfonamide + trimethoprim was the most commonly used (43.0%; n = 186), followed by penicillins (24.0%; n = 105). Macrolides accounted for 12.0%, and nitroimidazoles for 11.0%.

Distribution of prescribed antibiotics by age group, health facility, and prescriber

Table 2 shows that antibiotics were most frequently prescribed to adults (41.4%) and children aged 0–11 years (36.3%). Cotrimoxazole was predominantly prescribed among adolescents aged 12–17 years (65.3%) and children aged 0–11 years (45.6%). Amoxicillin was more frequently prescribed in children aged 0–11 years (23.4%) and adults (18.3%). Erythromycin was prescribed in 10.1% of cases among children. According to **S.**Table 1, cotrimoxazole was the most prescribed antibiotic in both health facilities, with a higher proportion at Health Center No. 3 (48.9%) compared to Caia District Hospital (16.9%). In contrast, amoxicillin was more frequently prescribed at Caia District Hospital (18.8%) than at Health Center No. 3 (6%).

Table 2
Distribution of prescribed antibiotics by age

Antibiotics	ATC code	Age					
		0–11 years N = 158	12–17 years N = 49	18–59 years N = 180	Above 60 years N = 4	Not specified N = 44	Overall N = 435
Amoxicillin	J01CA04	37 (23.4)	8 (16.3)	33 (18.3)	1 (25.0)	9 (20.5)	88 (20.2)
Azithromycin	J01FA10	5 (3.2)	1 (2.0)	12 (6.7)	0 (0.0)	5 (11.4)	23 (5.3)
Benzathine Penicillin	J01CE08	1 (0.6)	0 (0.0)	2 (1.1)	0 (0.0)	0 (0.0)	3 (0.7)
Ciprofloxacin	J01MA02	8 (5.1)	3 (6.1)	18 (10.0)	1 (25.0)	1 (2.3)	31 (7.1)
Cotrimoxazole	J01EE01	72 (45.6)	32 (65.3)	69 (38.3)	0 (0.0)	13 (29.5)	186 (42.8)
Erythromycin	J01FA01	16 (10.1)	1 (2.0)	10 (5.6)	1 (25.0)	3 (6.8)	31 (7.1)
Griseofulvin	D01BA01	3 (1.9)	1 (2.0)	1 (0.6)	0 (0.0)	0 (0.0)	5 (1.1)
Metronidazole	P01AB01	9 (5.7)	3 (6.1)	29 (16.1)	0 (0.0)	8 (18.2)	49 (11.3)
Nystatin	A07AA01	1 (0.6)	0 (0.0)	1 (0.6)	0 (0.0)	1 (2.3)	3 (0.7)
Phenoxymethylpenicillin	J01CE02	4 (2.5)	0 (0.0)	5 (2.8)	1 (25.0)	4 (9.1)	14 (3.2)
Tetracycline	J01A A01	2 (1.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (0.5)

As presented in **S.**Table 2, which describes antibiotic distribution by professional category, most prescriptions were issued by general medical technicians (71.5%), followed by physicians (20.0%) and general nurses (9.4%). Cotrimoxazole was most frequently prescribed by medical technicians (46.3%) and nurses (36.6%), while amoxicillin was more commonly prescribed by physicians (29.9%).

Defined daily dose (DDD) of prescribed antibiotics

The total antibiotic consumption was 121.91 DDD per 1,000 inhabitants per day, corresponding to a total DDD (DDDT) of 1,121.405. Amoxicillin showed the highest utilization rate (50.22 DDD/1,000/day), followed by ciprofloxacin (23.59), cotrimoxazole (13.58), erythromycin (11.32), and azithromycin (8.75).

Moderate levels of consumption were observed for phenoxymethylpenicillin (5.71) and benzathine penicillin (5.48). In contrast, metronidazole (2.80) and tetracycline (0.46) had the lowest utilization rates (Table 3).

Table 3
Defined daily dose (DDD) of prescribed antibiotics

Antibiotics	ATC Code	DDD (g)	DDDT	DDD/1,000/day
Amoxicillin	J01CA04	1	462	50.22
Azithromycin	J01FA10	0.5	80.5	8.75
Benzathine Penicillin	J01CE08	3.6	50.4	5.48
Ciprofloxacin	J01MA02	1	217	23.59
Cotrimoxazole	J01EE01	0.5	124.92	13.58
Erythromycin	J01FA01	2	104.16	11.32
Metronidazole	P01AB01	1.5	25.725	2.8
Phenoxymethylpenicillin	J01CE02	2	52.5	5.71
Tetracycline	J01AA01	1	4.2	0.46
Total			1.121.405	121.91

Note: ATC: Anatomical Therapeutic Chemical classification system; DDD (g): Defined Daily Dose in grams, as established by the WHO; DDDT: Total number of defined daily doses consumed during the study period; DDD/1,000 inhabitants/day: Defined daily doses per 1,000 inhabitants per day, indicating the intensity of antibiotic consumption.

Antibiotic prescription according to WHO AWaRe classification

As shown in Table 4, **85**.7% of the prescribed antibiotics belonged to the Access group, while 12.4% were classified in the Watch group. No antibiotics from the Reserve group were prescribed. Within the Access group, cotrimoxazole (49.9%), amoxicillin (23.6%), and metronidazole (13.1%) were the most frequently used. In the Watch group, ciprofloxacin (57.4%) and azithromycin (42.6%) predominated.

Table 4
Categorization of antibiotics according to AWaRe classification by the WHO

Antibiotics	ATC code	Access	Watch	Unclassified	Overall
		(N = 373)	(N = 54)	(N = 8)	(N = 435)
Amoxicillin	J01CA04	88 (23.6)	0 (0.0)	0 (0.0)	88 (20.2)
Azithromycin	J01FA10	0 (0.0)	23 (42.6)	0 (0.0)	23 (5.3)
Benzathine Penicillin	J01CE08	3 (0.8)	0 (0.0)	0 (0.0)	3 (0.7)
Ciprofloxacin	J01MA02	0 (0.0)	31 (57.4)	0 (0.0)	31 (7.1)
Cotrimoxazole	J01EE01	186 (49.9)	0 (0.0)	0 (0.0)	186 (42.8)
Erythromycin	J01FA01	31 (8.3)	0 (0.0)	0 (0.0)	31 (7.1)
Griseofulvin	D01BA01	0 (0.0)	0 (0.0)	5 (62.5)	5 (1.1)
Metronidazole	P01AB01	49 (13.1)	0 (0.0)	0 (0.0)	49 (11.3)
Nystatin	A07AA01	0 (0.0)	0 (0.0)	3 (37.5)	3 (0.7)
Phenoxymethylpenicillin	J01CE02	14 (3.8)	0 (0.0)	0 (0.0)	14 (3.2)
Tetracycline	J01A A01	2 (0.5)	0 (0.0)	0 (0.0)	2 (0.5)

WHO/INRUD Standard Prescribing Indicators

According to Table 5, all antibiotics were prescribed by their generic names (100%), fully meeting the WHO-recommended standard. Likewise, all prescribed antibiotics were listed in the Essential Medicines List (100%), in complete alignment with established guidelines. Only 0.5% of patients received antibiotics in injectable form.

Table 5
WHO/INRUD Standard Prescribing Indicators

Drug use indicators	N (%)	WHO optimal values (%) [26]
Average number of antibiotics per prescription	1.12 (SD: 0.426)	
Antibiotics prescribed by generic name	435 (100)	100
Antibiotics prescribed from the essential medicines list	435 (100)	100
Antibiotics prescribed in injectable form	2 (0.5)	13.4–24.1

Discussion

This study represents one of the first analyses conducted in Mozambique to evaluate outpatient antibiotic prescribing patterns using the WHO AWaRe classification, focusing on health facilities in the provinces of Tete and Sofala. A higher proportion of prescriptions was observed among children and adolescents, which may reflect the increased burden of infectious diseases in these age groups and their frequent use of outpatient services.

Amoxicillin and cotrimoxazole were the most commonly prescribed antibiotics, a pattern consistent with findings from other studies conducted in SSA [14–17], where these agents form the backbone of primary healthcare treatment. In settings characterized by a high burden of infectious diseases and limited access to diagnostic tools, empirical prescribing is common practice [1]. This likely explains the high proportion of clinically diagnosed cases observed in this study. Although these antibiotics predominated, other studies have reported different prescribing patterns, in which antibiotics such as ciprofloxacin ranked among the most frequently used after amoxicillin [15, 18]. This variation may reflect differences in local prescribing practices, availability of medicines, and adherence to treatment guidelines across settings.

The predominance of general medical technicians in issuing most prescriptions may reflect the structure of the Mozambican health system, where these professionals play a central role in primary healthcare delivery. In this context, investing in continuous professional training on rational prescribing, along with the adoption of tools that support appropriate antibiotic use [19], such as the AWaRe classification, may contribute to strengthening efforts to combat antimicrobial resistance.

Regarding the AWaRe classification, the findings of this study demonstrate a predominance of antibiotics from the Access group (85.7%), aligning with the WHO recommendation that at least 60% of total antibiotic consumption should come from this category [6]. The proportion of prescriptions from the Watch group was 12.4%. Although this proportion is relatively lower compared with findings from other studies [16, 20], antibiotics in this group are recommended only for specific indications and require careful monitoring due to their higher potential to drive AMR [6]. Their use should ideally be guided by laboratory diagnostics; however, in settings with limited diagnostic capacity, prescribing may occur empirically. Such practices can compromise the quality of care and contribute to the emergence and spread of AMR.

Regarding the WHO/INRUD prescribing indicators, all evaluated prescriptions were consistent with recommended standards. The average number of antibiotics per prescription was within acceptable limits, all antibiotics were prescribed by their generic names, were included in the essential medicines list, and were administered predominantly via the appropriate route, with limited use of injectable formulations [21]. These findings suggest good adherence to key prescribing principles and reflect rational practices in terms of medicine selection and prescription writing. Prescribing by generic name and adherence to the essential medicines list are particularly important in resource-limited settings, as they promote cost-effectiveness and improve access to treatment.

In terms of antibiotic consumption, this study identified a total of 121.91 DDD per 1,000 inhabitants per day, indicating a high level of use in the outpatient setting, likely associated with a substantial burden of infectious diseases and the frequent reliance on empirical prescribing. When compared with findings from other settings, these values are considerably higher than those reported in Ethiopia (5.31 DDD per 100 outpatient visits per day) [22], Tanzania (39.05 DDD per 1,000 inhabitants per day) [23], and Slovenia (59.8 DDD per 1,000 inhabitants per day) [24], where antibiotics such as penicillins, ciprofloxacin, and doxycycline were among the most commonly used. In the present study, amoxicillin showed the highest utilization rate, followed by ciprofloxacin and cotrimoxazole, suggesting that these agents form the core of treatment in the study setting. This pattern is partly expected, as amoxicillin belongs to the Access group and is widely recommended as a first-line treatment for common infections. However, the substantial use of ciprofloxacin, a Watch group antibiotic, warrants attention due to its higher potential to drive antimicrobial resistance. The differences observed across studies may be explained by several factors, including the relatively short data collection period in the present study, potential seasonal variations in infection patterns, and differences in prevention and control strategies [22].

In the context of the growing threat of antimicrobial resistance, strengthening antimicrobial stewardship strategies within healthcare facilities is essential. The systematic integration of the AWaRe classification into local treatment protocols, the implementation of regular prescription audits, and investment in laboratory infrastructure to support diagnostic confirmation are key measures [1]. In addition, targeted educational interventions for prescribers may help reduce inappropriate practices related to antibiotic selection, dosing, and treatment intervals.

This study has some limitations. As a cross-sectional study based on clinical records and prescription data, it is subject to potential omissions or inconsistencies in documentation. The inclusion of only two healthcare facilities limits the generalizability of the findings to other regions or settings within the country. Furthermore, the lack of microbiological data precluded the assessment of treatment appropriateness based on etiological confirmation. Despite these limitations, the study provides relevant insights into outpatient prescribing patterns and serves as an important foundation for future, more comprehensive research in Mozambique, while also contributing to efforts aimed at promoting the rational use of antibiotics.

Conclusion

Antibiotic prescribing in this outpatient setting was generally consistent with WHO recommendations, as reflected by the universal use of generic names and full adherence to the Essential Medicines List. Most prescriptions involved antibiotics from the Access group, aligning with global efforts to promote rational antibiotic use. Despite these positive findings, the results highlight the need to strengthen diagnostic capacity and reinforce antimicrobial stewardship strategies to further optimize prescribing practices and reduce the risk of AMR. Additionally, these findings emphasize the importance of conducting more comprehensive future studies to better understand prescribing patterns and inform evidence-based interventions.

Declarations

Acknowledgements

The authors would like to thank the Scientific Committee of Zambeze University, Faculty of Health Sciences, for approving this research project. They also express their gratitude to the health facilities where the data were collected for their support and collaboration.

Ethical Consideration and consent to participate

Prior to data collection, scientific approval to conduct the study was obtained from the Faculty of Health Sciences at Zambeze University in Tete, as well as from the participating health facilities. The study was conducted under official authorization (TF – VNo2/2025CCAP) and in accordance with the ethical principles outlined in the Declaration of Helsinki [25].

Clinical trial number

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that there are no competing interests.

Funding

This research did not receive any specific funding from public, commercial, or non-profit organizations.

Authors' contributions

All authors contributed to the study conception and critically reviewed the manuscript prior to submission. NDC performed the data analysis, and SPX validated the results. SPX, MMPI, ACRA, SSS, DAV, RLX, and NDC contributed to data interpretation and manuscript development. MMPI, ACRA, and SSS were responsible for data collection and data entry. All authors read and approved the final version of the manuscript.

References

1. Xavier SP. An urgent call to combat antimicrobial resistance in Sub-Saharan Africa through integrated and innovative solutions. Discov Public Heal. 2025;22:673.
2. Singh B, Bhat A, Ravi K. Antibiotics misuse and antimicrobial resistance development in agriculture: a global challenge. Environ Heal. 2024;2:618–22.
3. Nammi J, Pasala R, Andhe N, Vasam R, Poruri AD, Sherikar RR, Nammi JY. (2025) Antibiotic misuse: an in-depth examination of its global consequences and public health challenges. Cureus 17.
4. Murray CJL, Ikuta KS, Sharara F, Swetschinski L, Aguilar GR, Gray A, Han C, Bisignano C, Rao P, Wool E. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. Lancet. 2022;399:629–55.
5. Moja L, Zanichelli V, Mertz D, Gandra S, Cappello B, Cooke GS, Chuki P, Harbarth S, Pulcini C, Mendelson M. WHO's essential medicines and AWaRe: recommendations on first-and second-choice antibiotics for empiric treatment of clinical infections. Clin Microbiol Infect. 2024;30:S1–51.
6. Klein EY, Milkowska-Shibata M, Tseng KK, Sharland M, Gandra S, Pulcini C, Laxminarayan R. Assessment of WHO antibiotic consumption and access targets in 76 countries, 2000–15: an analysis of pharmaceutical sales data. Lancet Infect Dis. 2021;21:107–15.
7. Browne AJ, Chipeta MG, Haines-Woodhouse G, Kumaran EPA, Hamadani BHK, Zaraa S, Henry NJ, Deshpande A, Reiner RC, Day NPJ. Global antibiotic consumption and usage in humans, 2000–18: a spatial modelling study. Lancet Planet Heal. 2021;5:e893–904.
8. Laxminarayan R, Duse A, Wattal C, et al. Antibiotic resistance-the need for global solutions. Lancet Infect Dis. 2013;13:1057–98.
9. Salência-Ferrão J, Chissaque A, Manhique-Coutinho L, Kenga AN, Cassocera M, de Deus N. Inappropriate use of antibiotics in the management of diarrhoea in children under five years admitted with acute diarrhoea in four provinces of Mozambique 2014–2019. BMC Infect Dis. 2025;25:209.
10. Xavier SP, Victor A, Cumaquela G, Vasco MD, Rodrigues OAS. Inappropriate use of antibiotics and its predictors in pediatric patients admitted at the Central Hospital of Nampula, Mozambique. Antimicrob Resist Infect Control. 2022;11:79.
11. Monteiro LGS, Chaúque A, Barros MP, Irá TR. Determinants of antibiotic prescription in paediatric patients: The case of two hospitals in Maputo. Mozambique. 2017;11:109–11.
12. Faiela C, Sevene E. Antibiotic prescription for HIV-positive patients in primary health care in Mozambique: A cross-sectional study. South Afr J Infect Dis. 2022;37:340.
13. Xavier SP, da Silva AMC, Victor A. Antibiotic prescribing patterns in pediatric patients using the WHO access, watch, reserve (AWaRe) classification at a quaternary hospital in Nampula. Mozambique Sci Rep. 2024;14:22719.
14. Igirikwayo ZK, Migisha R, Mukaga H, Kabakyenga J. Prescription patterns of antibiotics and associated factors among outpatients diagnosed with respiratory tract infections in Jinja city, Uganda, June 2022-May 2023. BMC Pulm Med. 2024;24:446.

15. Yimenu DK, Emam A, Elemineh E, Atalay W. Assessment of antibiotic prescribing patterns at outpatient pharmacy using world health organization prescribing indicators. J Prim Care Community Health. 2019;10:2150132719886942.
16. Hailesilase GG, Welegebrial BG, Weres MG, Gebrewahd SA. WHO/INRUD prescribing indicators with a focus on antibiotics utilization patterns at outpatient department of Adigrat general hospital, Tigrai, Ethiopia: a retrospective cross-sectional study. Antimicrob Resist Infect Control. 2024;13:133.
17. Zhang HL, Bodinayake C, Wijayaratne GB, Jayatissa P, Piyasiri DLB, Kurukulasooriya R, Sheng T, Nagahawatte A, Woods C, Tillekeratne LG. Point-prevalence survey of outpatient antibiotic prescription at a tertiary medical center in Sri Lanka: opportunities to improve prescribing practices for respiratory illnesses. BMC Infect Dis. 2021;21:97.
18. Summoro TS, Gidebo KD, Kanche ZZ, Woticha EW. (2015) Evaluation of trends of drug-prescribing patterns based on WHO prescribing indicators at outpatient departments of four hospitals in southern Ethiopia. Drug Des Devel Ther 4551–7.
19. Faiela C, Cambaco O, Boene H, Monnier AA, Wertheim HFL, Munguambe K, Sevene E. Knowledge and practices of healthcare professionals regarding antibiotic use in a district hospital, Southern Mozambique: a cross-sectional study. Sci Rep. 2025;15:14333.
20. Pauwels I, Versporten A, Drapier N, Vlieghe E, Goossens H. Hospital antibiotic prescribing patterns in adult patients according to the WHO Access, Watch and Reserve classification (AWaRe): Results from a worldwide point prevalence survey in 69 countries. J Antimicrob Chemother. 2021;76:1614–24.
21. Kilipamwambu A, Bwire GM, Myemba DT, Njiro BJ, Majigo MV. WHO/INRUD core prescribing indicators and antibiotic utilization patterns among primary health care facilities in Ilala district, Tanzania. JAC-Antimicrobial Resist. 2021;3:dlab049.
22. Melaku T, Gashaw M, Chelkeba L, Berhane M, Bekele S, Lemi G, Wakjira T, Tesfaw G, Mekonnen Z, Ali S. (2021) Evaluation of adult outpatient antibiotics use at Jimma Medical Center (With defined daily doses for usage metrics). Infect Drug Resist 1649–58.
23. Šahman-Zaimović M, Vukmirović S, Tomić N, Stilinović N, Horvat O, Tomić L. Relationship between outpatient antibiotic use and the prevalence of bacterial infections in Montenegro. Vojnosanit Pregl. 2017;74:46–50.
24. Čižman M. Nationwide hospital antibiotic consumption in Slovenia. J Antimicrob Chemother. 2011;66:2189–91.
25. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA. 2013;310:2191–4.
26. Atif M, Azeem M, Sarwar MR, Shahid S, Javaid S, Ikram H, Baig U, Scahill S. (2016) WHO/INRUD prescribing indicators and prescribing trends of antibiotics in the Accident and Emergency Department of Bahawal Victoria Hospital, Pakistan. Springerplus 5:1928.

Figures

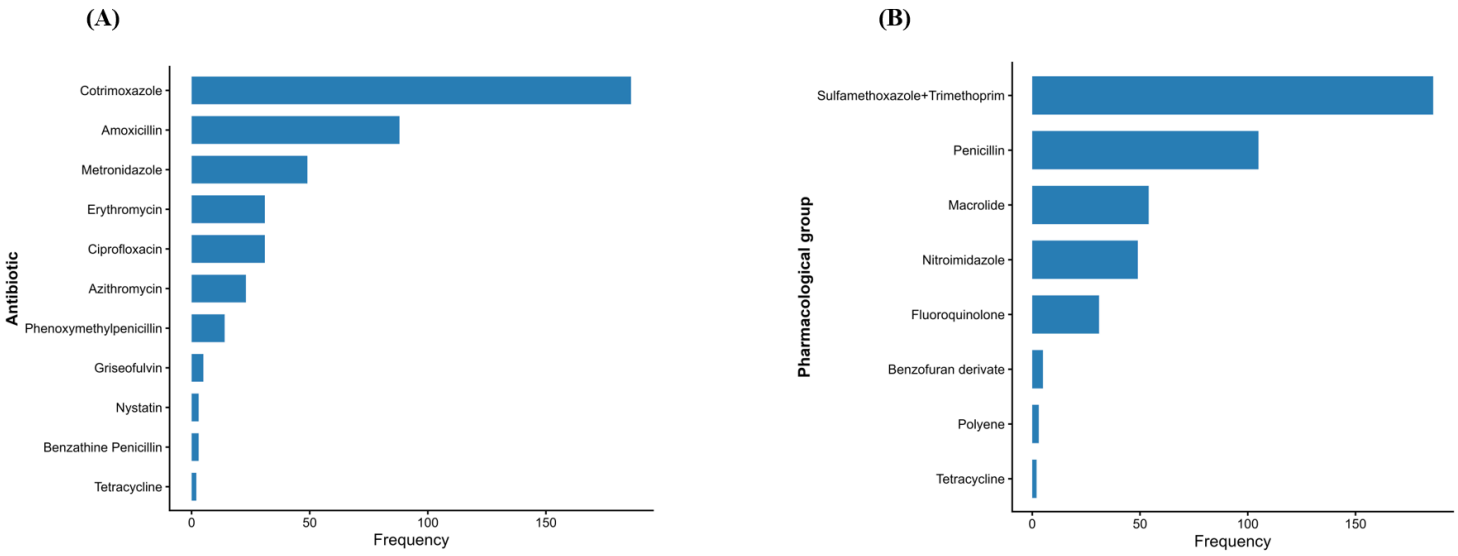


Figure 1

Distribution of prescribed antibiotics by individual agent (A) and by pharmacological group (B).

Supplementary Files

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- SupplementaryMaterial.docx