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Knowledge and practices of healthcare professionals regarding antibiotic use in a district hospital, Southern Mozambique: a cross-sectional study

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Tackling the worldwide problem of antibiotic resistance requires addressing the lack of knowledge about antibiotics and understanding the impact of resistance. This study aimed to assess healthcare professionals' (HCP) knowledge about antibiotics and antibiotic resistance and the antibiotic prescription practices for outpatients at the Manhiça District Hospital in Mozambique. This cross-sectional study assessed the knowledge and practices of 20 HCPs about antibiotic use and resistance and evaluated quality indicators of antibiotic use of 200 prescriptions. We observed that 20% of the participants incorrectly placed amoxicillin in the cephalosporin group, and 10% considered antibiotic resistance a rejection reaction by the patient's body. However, the HCPs showed Knowledge level A. Antibiotics featured in 88% of prescriptions, with an average of one antibiotic per prescription. Cotrimoxazole (30.77%) and amoxicillin (26.15%) were the most frequently prescribed antibiotics. Cotrimoxazole was more prescribed for adults (21.54%) and amoxicillin for children (17.95%). Seasonal variation was observed with an increased winter consumption of cotrimoxazole and phenoxymethylpenicillin in summer. The results revealed a high level of knowledge of HCPs about how to use and identify antibiotics. A higher frequency of broad-spectrum antibiotic prescriptions was observed with cotrimoxazole and amoxicillin being the most prescribed.

Keywords Antibiotic prescription, Antibiotic resistance, Knowledge, Prescribing practices, Mozambique

Abbreviations

ABACUS	AntiBiotic ACcess and USe
AWaRe	Access, watch, and reserve antibiotic groups
CISM	Centro de Investigação em Saúde de Manhiça
HCPs	Healthcare professionals
HICs	High-income countries
HIV	Human immunodeficiency virus
LICs	Low-income countries
MDH	Manhiça District Hospital
NPA	National action plan
RTIs	Respiratory tract infections
WHO	World Health Organization

Global health is threatened by the rise of antibiotic resistance. For over three decades, the World Health Organization (WHO) has been warning of this situation's gravity[1]. Resistance is a naturally occurring event but is exacerbated by human practices such as overuse and misuse of antibiotics and limited infection control[2].

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Therapeutic failure due to resistance causes increased mortality and more extended hospital stays with a consequent increase in resource consumption[3]. Important drivers of antibiotic overuse include using antibiotics for viral infections[3], such as flu and the common cold, inadequate prescription due to the pressure of patient demand[4], and lack of knowledge about antibiotic treatment protocols[5]. This is exacerbated in low-income countries, where the global burden of infectious diseases is the highest in sub-Saharan Africa in particular, where the relative number of deaths attributed to antimicrobial resistance is higher than in other parts of the world[6]. In this region, legislation on the use and distribution of antibiotics is often absent, and where laws exist, they are poorly enforced[2]. Access to healthcare is often challenging, and public awareness of the risks of overuse and misuse of antibiotics is limited[7]. Furthermore, access to diagnostics that help decide whether to give an antibiotic is lacking in low-resource settings[8].

A global survey on antibiotic knowledge indicated that the misuse of antibiotics by the community due to a lack of knowledge was the same between high- and low-income countries, with marked differences when comparing urban and rural areas. This led, the WHO to establish a priority goal of improving global public awareness and understanding of antibiotic resistance[9]. Reducing misuse is essential to reduce antibiotic resistance and adverse reactions[10]. Besides the community, prescribers' awareness and understanding should also be considered, as appropriate prescribing is an essential strategy to reduce the misuse and overuse of antibiotics[10].

Mozambique is a low-income country (LIC) with a high burden of infectious diseases, especially in children under five years of age, with a significant impact on life expectancy[10]. It has a national action plan (NAP) against antimicrobial resistance developed under the "One Health" approach. This plan attests to the country's commitment to promote and facilitate actions to contain antimicrobial resistance and ensure the availability of effective antibiotics. The pillars of the Mozambique NAP, published in 2019, include increasing public awareness of antimicrobial resistance, rational use, and prescription of antibiotics through effective communication, education, and training among HCPs[11].

Since the launch of the NAP, some studies have assessed knowledge, attitudes, antibiotic prescribing practices, and antibiotic resistance patterns in Mozambique. Some studies documented cases of poor knowledge of antibiotics and resistance and a broad understanding of the importance of medication compliance among respondents[7,12]. In addition, there is evidence of a high frequency of prescription of antibiotics for the treatment of respiratory and gastrointestinal tract infections in pediatric patients and HIV-infected patients of all ages, with penicillin, sulfonamides, and aminoglycosides among the most commonly prescribed groups of antibiotics[13,14]. Increased prevalence of antimicrobial resistance genes to first-line drugs for multiple infections has also been reported[15]. This calls for the need to periodically assess antibiotic prescription patterns to inform and guide prescription improvement strategies and impact on antibiotic resistance. This study assessed HCPs' knowledge and practices regarding outpatient antibiotic prescriptions at the Manhiça District Hospital (MDH), a health facility that provides secondary healthcare.

Methods

Study design

A cross-sectional study was carried out in two phases at the MDH. First, structured interviews with HCPs about their knowledge of antibiotics and antimicrobial resistance were conducted. Then, outpatient antibiotic prescriptions (children and adults) were assessed.

Study site and population

The study was conducted in the district of Manhiça, specifically at the MDH. The district of Manhiça is located in the south of Mozambique, around 80 km north of Maputo city. The area has two distinct seasons: summer, the wet season (November to April), and winter, the dry season (May to October). The weather is warm throughout the year, with two to three months (May to July) of mild to moderately cool days[16]. The district has 2380 km^2, with a population of 212,626 inhabitants. Since 1996, this population has been under demographic surveillance by the Manhiça Health Research Center (CISM), which records vital events (including pregnancy, death, births, and migrations) and morbidity in patients under 15 years of age through a combination of home, community and health facility visits every six months. CISM entity collaborates directly with the public health service. The public healthcare network in the district consists of two hospitals (the MDH and Xinavane Rural Hospital) and 17 primary healthcare facilities. The primary healthcare services offer family planning, maternal and child health, youth and adolescent care, health counseling and screening, outpatient care for all ages, and an immunization program. Inpatient health care is provided only in hospitals[16].

Healthcare professionals (HCPs) who regularly prescribe or dispense antibiotics, including nurses, medical technicians (i.e., non-doctor HCPs with training in the clinical area and public health and primarily assigned to primary and secondary level health facilities), and pharmacists, were interviewed to assess their level of knowledge. Twenty HCPs were randomly selected from 30 designated at the MDH upon giving consent to participate in the study. The interviews were performed in the summer of 2017 (February to April 2017). Prescriptions from outpatients, which were stored in the pharmacy at the MDH, were also randomly selected. Prescriptions were collected retrospectively, accounting for two distinct seasons: winter (May to August 2017) and summer (January to April 2018).

Data collection

Knowledge of healthcare professionals (HCPs)

To assess the knowledge of HCPs about antibiotics and antimicrobial resistance, a questionnaire with 13 questions was developed. The first section was composed of close-ended questions, each with four options, of which only one was correct. The questions were about knowledge of antibiotic use and antimicrobial resistance. In the second section, the researcher showed pictures of three images of frequently used medications to the HCP:

analgesic (“Paracetamol”—a round white tablet with a slot), non-steroidal anti-inflammatory (“Ibuprofen”—a round red tablet), and antibiotic (“Amoxicillin”—red and yellow capsule). The HCP had to identify the antibiotic. Afterward, pictures of five more images were shown, each belonging to a different antibiotic group: Amoxicillin (red and yellow capsule and a suspension bottle), Metronidazole (a round yellow tablet with a scoring), Co-trimoxazole (a round white tablet with a scoring), Erythromycin (an oval white tablet) and Azithromycin (an oval white tablet). All the pictures showed the dosage strength, the dosage form (capsule or tablet), and the commercial and generic names. The HCP should have identified all of them as antibiotics. If the HCP got two or more correct answers in the multiple-choice questions and identified an antibiotic in the two questions in the second section, their knowledge was classified as level A (high). If the result was less than two correct answers, but they identified the antibiotic in the first batch of images, their knowledge was classified as level B (moderate). If the participant did not identify the antibiotic in the first batch of images, their knowledge was classified as level C (low). The questionnaire was designed in the ABACUS 1[12] consortium to apply to dispensers at the community level, and it was adapted for prescribers and dispensers at the healthcare facility. Before implementation, the questionnaire was pre-tested with a group of healthcare professionals not assigned to the MDH to ascertain its reliability and validity using the content-related method. An overview of the questionnaire is shown in Supplementary Material/Appendix 1.

Assessment of antibiotic prescriptions

The MDH has two pharmacies, one for outpatients and one for inpatients. A questionnaire was used to collect data to assess the prescriptions. The questionnaire consisted of close-ended questions focused on practices of antibiotic prescriptions. According to the World Health Organization (WHO), a statistically feasible analysis of antibiotic prescribing patterns requires a minimum of 100 prescriptions[17]. Thus, 200 prescriptions for outpatients were randomly chosen, half of which were from children (100) and the other half from adults (100). We assessed antibiotic prescription compliance with the core WHO quality indicators: average number of medicines per prescription, antibiotic prescription rate, prescriptions with generic names, and medicines prescribed from the National Drug Formulary[18]. Additional quality indicators were assessed, including the average number of antibiotics per prescription, prescriptions with legible handwriting, prescriptions with an indication of the patient’s name, the date, the clinical indication, the dosage, and the duration of treatment. We considered good compliance if the indicator was within the WHO reference range or a rate over 90%. The questionnaire for the assessment of prescriptions is shown in Supplementary Material/Appendix 2.

Data management and statistical analysis

The questionnaires were designed in REDCap, a secure electronic data capture tool that offers a range of functions to collect, store, and analyze simple data. The information was exported to SPSS (Statistical Package for Social Sciences) version 25 for statistical analysis. The data analysis used descriptive and analytical statistics. Descriptive statistics was performed for univariate data by drawing relative frequency tables and graphs for categorical variables. Averages and variability of the values were also calculated for numerical variables. Analytical statistics was performed for bivariate data, and a Pearson’s chi-square test was used with a 95% confidence interval to test the existence or not of significant differences in the pattern of antibiotic prescription between the two groups of population (children and adults), and the two distinct seasons (summer and winter).

Results

Participants’ demographic characteristics

A total of 20 HCPs were interviewed: the majority were female (12/20, 60.0%) and had an age range of 26–35 years, with a mean age of 29 years (SD = 4). Most (13/20, 65%) were nurses (Table 1).

Knowledge of health care professionals (HCPs)

According to the established assessment criteria, all participants achieved knowledge level A (all recognized the antibiotic visually and answered at least two multiple-choice questions correctly). Among the most frequent errors, 7/20 (35%) of the participants defined an antibiotic as a medicine used for infections without being specific

Variable	*N* (20)	% (100)
Sex		
Male	8	40.0
Female	12	60.0
Age		
[18–25 years]	4	20.0
[26–35 years]	14	70.0
[36–49 years]	2	10.0
Professional category		
Nurse	13	65.0
Clinical technician	6	30.0
Pharmacist	1	5.0

Table 1. Characteristics of HCPs interviewed.

Knowledge variables	Yes	No
Multiple choice questions		
1. Does the HCP know what antibiotics are?	13 (65%)	7 (35%)
2. Does the HCP know what antibiotics are for?	19 (95%)	1 (5%)
3. Does the HCP know with which body parameter the dose of antibiotic is defined?	20 (100%)	0
4. Does HCP know the test that is used to assess sensitivity?	20 (100%)	0
5. Does the HCP know if the hospital has recently received antibiotics?	19 (95%)	1 (5%)
6. Did the HCP recently prescribe an antibiotic?	19 (95%)	1 (5%)
7. Has the HCP heard about antibiotic resistance?	20 (100%)	0
8. Does the HCP know what antibiotic resistance is?	17 (85%)	3 (15%)
9. Does the HCP know why antibiotic resistance occurs?	17 (85%)	3 (15%)
Recognition questions		
10. Does the HCP recognize under what circumstances antibiotics should be taken?	20 (100%)	0
11. Does the HCP recognize the antibiotic group of amoxicillin?	16 (80%)	4 (20%) ((20%)
12. Does the HCP visually distinguish an antibiotic among 3 different classes of drugs?	20 (100%)	0
13. Does the HCP visually recognize different groups of antibiotics?	20 (100%)	0

Table 2. Knowledge of healthcare professionals (HCPs) interviewed.

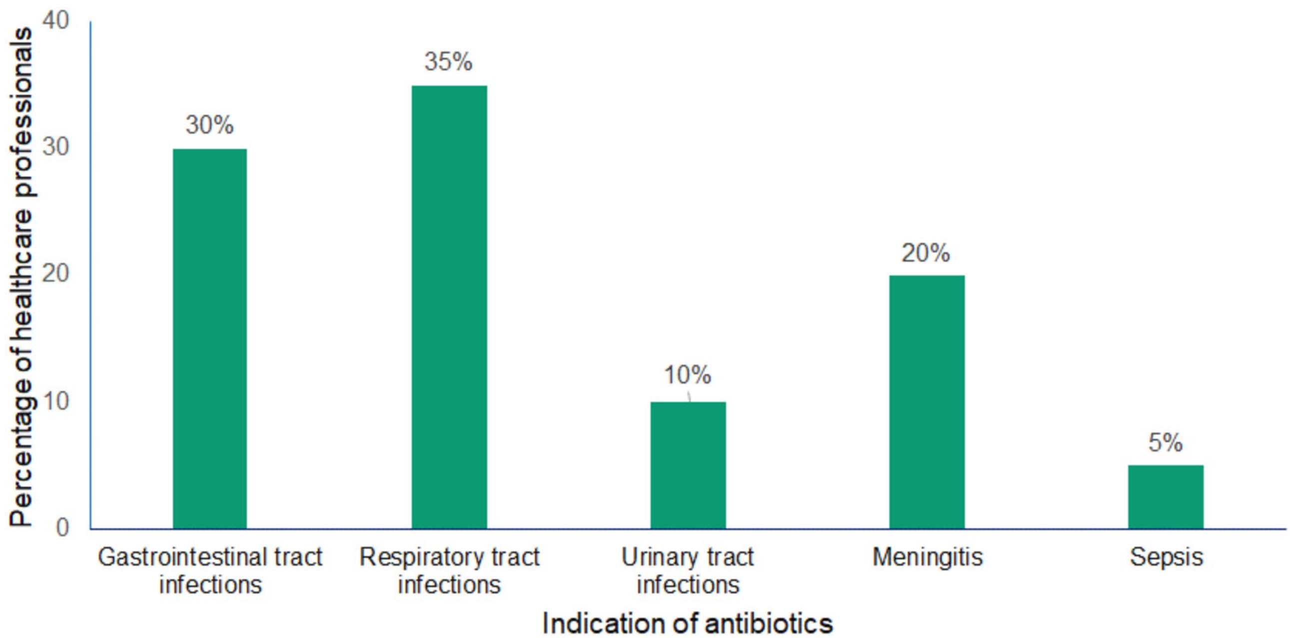

Fig. 1. Indications of last antibiotics prescribed by HCPs interviewed.

for bacteria (question 1, Table 2). Some HCPs (4/20, 20%) incorrectly placed amoxicillin in the cephalosporin group (question 11). Additionally, 3/20 (15%) incorrectly considered antibiotic resistance (question 8, Table 2) a rejection reaction of the patient's body.

Figure 1 shows the percentage of HCPs interviewed who documented the clinical indication of the last prescribed antibiotics. Over a third of HCPs stated that the last antibiotics they prescribed were indicated to treat suspected respiratory tract infections (7/20, 35%). Just about the same proportion reported having prescribed antibiotics for treating suspected gastrointestinal tract infections (6/20, 30%) and suspected meningitis (4/20, 20%). Some HCPs declared the prescription of antibiotics for treating suspected urinary tract infections (2/20, 10%) and septicemia (1/20, 5%). In all situations, antibiotics were empirically prescribed without a confirmation of the diagnosis.

Prescription quality indicators

Out of the 200 prescriptions analyzed (100 from children and the other half from adults), we found a high frequency of antibiotic prescriptions (176/200, 88%). This means that, on average, 88 prescriptions out of 100 had at least one prescribed antibiotic (Table 3). There was no statistical difference between the frequency of

Prescription quality indicators	WHO reference [18]	Overall ($n = 200$)	Children ($n = 100$)	Adults ($n = 100$)	p-value
WHO core quality indicators					
Average number of medicines per prescription	1.6–1.8	2.0	2.1	1.9	–
Antibiotic prescription rate	20–26.8%	176 (88.0%)	90 (90.0%)	86 (86.0%)	0.384
Prescriptions with an injectable antibiotic	13.4–24.1%	62 (31.0%)	32 (32.0%)	–	–
Prescriptions with medicines prescribed by generic name	100%	192 (96.0%)	97 (97.0%)	95 (95.0%)	0.470
Prescriptions with medicines prescribed from the National Medicines Formulary	100%	200 (100%)	100 (100%)	100 (100%)	–
Additional quality indicators					
Average number of antibiotics per prescription	–	1.00	0.96	1.05	0.065
Prescriptions with legible handwriting	–	194 (97.0%)	99 (99.0%)	95 (95.0%)	0.097
Prescriptions with documented patient's name	–	197 (98.5%)	99 (99.0%)	98 (98.0%)	0.561
Prescriptions with documentation of the prescriber's name	–	144 (72.0%)	74 (74.0%)	70 (70.0%)	0.095
Prescriptions with a documented clinical indication	–	177 (88.5%)	93 (93.0%)	84 (84.0%)	**0.046**
Prescriptions with documentation of the date	–	196 (98.0%)	98 (98.0%)	98 (98.0%)	1.000
Prescriptions with documentation of dosage	–	174 (87.0%)	89 (89.0%)	85 (85.0%)	0.400
Prescriptions with documentation of the duration of treatment	–	165 (82.5%)	82 (82.0%)	83 (83.0%)	0.852

Table 3. Prescription quality indicators by group of population. Significant values are in [bold].

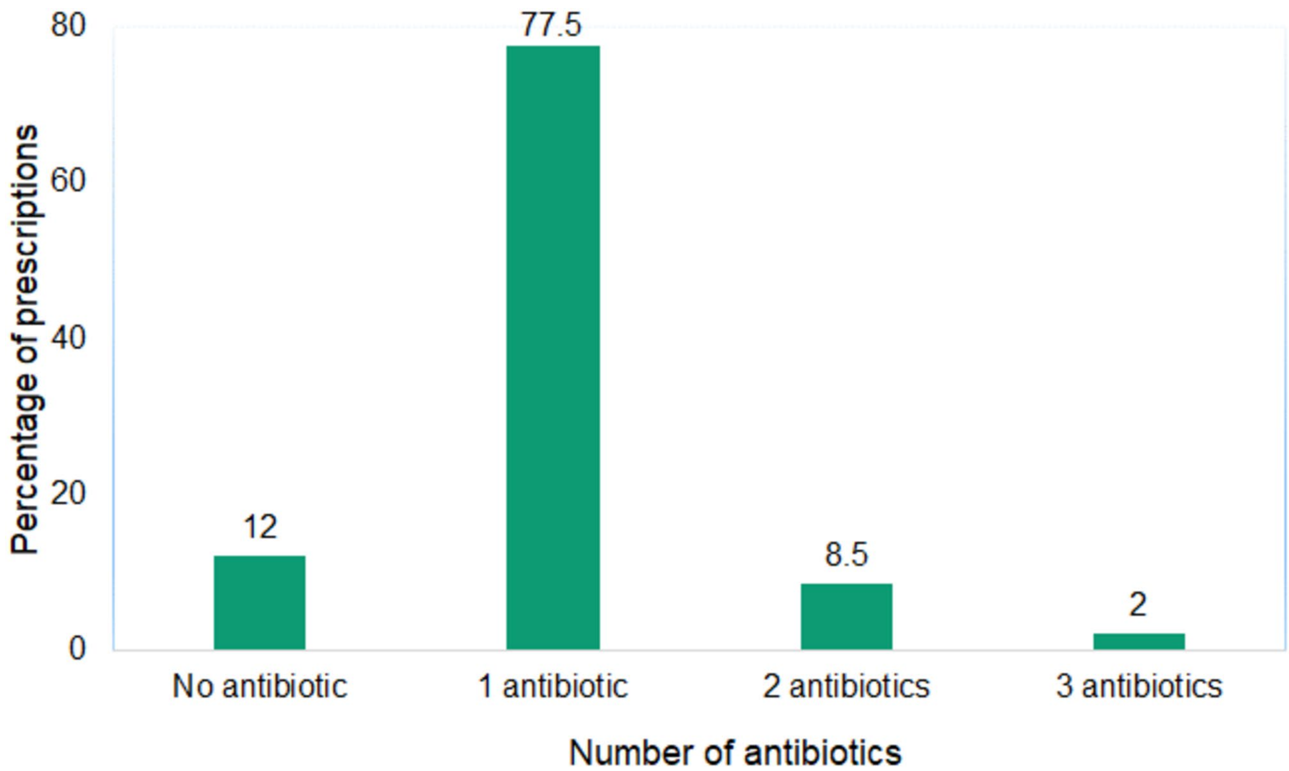

Fig. 2. Number of antibiotics per prescription.

antibiotic prescriptions in children (90/100, 90%) and adults (86/100, 86%). The majority (155/200, 77.5%) contained one antibiotic, and 17/200 (8.5%) had two antibiotics (Fig. 2).

Good compliance with WHO core quality indicators was observed for two indicators. Overall, 192/200 (96%) prescriptions had medicines prescribed by generic name, and 200/200 (100%) prescriptions had medicines prescribed from the National Medicines Formulary (100%). The other WHO core indicators were out of the reference range. The average number of medicines per prescription (2.0) was slightly higher than the reference range (1.6–1.8). Sixty-two out of two hundred (31%) prescriptions had an injectable antibiotic, which was relatively higher than the reference range (13.4–24.1%).

Good compliance with additional quality indicators was observed in three indicators. Overall, 194/200 (97%) of the prescriptions contained legible handwriting, 197/200 (98.5%) indicated the patient's name, and 196/200 (98%) indicated the date. The other complementary indicators had rates below 90%. Hundred-forty-four out of

Class	Antibiotic	Spectrum	Overall n (%)	Children n (%)	Adults n (%)	p -value	Summer n (%)	Winter n (%)	p -value
Penicillin			95 (48.72)	66 (33.85)	29 (14.87)	**0.001**	57 (29.23)	38 (19.49)	**0.016**
	Amoxicillin[a]	Broad	51 (26.15)	35 (17.95)	16 (8.21)	**0.002**	29 (14.87)	22 (11.28)	0.256
	Fenoximetil penicillin[a]	Narrow	32 (16.41)	19 (9.74)	13 (6.67)	0.247	22 (11.28)	10 (5.13)	**0.021**
	Amoxicillin + clavulanic acid[a]	Broad	12 (6.15)	12 (6.15)	0	**0.001**	6 (3.08)	6 (3.08)	1.000
Sulphonamide	Cotrimoxazole[a]	Broad	60 (30.77)	18 (9.23)	42 (21.54)	**0.001**	19 (9.74)	41 (21.03)	**0.001**
Quinolone			11 (5.64)	3 (1.54)	8 (4.10)	0.121	5 (2.56)	6 (3.08)	0.756
	Ciprofloxacin[w]	Broad	8 (4.10)	1 (0.51)	7 (3.59)	0.065	4 (2.05)	4 (2.05)	1.000
	Nalidixic acid[w]	Narrow	3 (1.54)	2 (1.03)	1 (0.51)	1.000	1 (0.51)	2 (1.03)	1.000
Macrolide			11 (5.64)	4 (2.05)	7 (3.59)	0.352	5 (2.56)	6 (3.08)	0.756
	Erythromycin[w]	Broad	6 (3.08)	4 (2.05)	2 (1.03)	0.680	3 (1.54)	3 (1.54)	1.000
	Azithromycin[w]	Broad	5 (2.56)	0	5 (2.56)	**0.024**	2 (1.03)	3 (1.54)	0.651
Metronidazole	Metronidazole[a]	Broad	18 (9.23)	8 (4.10)	10 (5.13)	0.621	12 (6.15)	6 (3.08)	0.663

Table 4. Antibiotic category and prescription rates. Considering the WHO AWaRe classification of antibiotics, the most prescribed antibiotics are classified as Access (a) and the less prescribed as Watch (w)[32]. Significant values are in [bold].

two hundred (72%) had the name of the prescriber, 177/200 (88.5%) provided the clinical indication, 174/200 (87%) the dosage, and 165/200 (82.5%) the duration of treatment. Significant differences were only observed for prescriptions with a documented clinical indication. Children 105/200 (52.5%) had slightly more prescriptions with a documented clinical indication than adults 95/200 (47.5%).

Antibiotic prescribing pattern

Nine different types of antibiotics were prescribed, seven broad-spectrum and two narrow-spectrum. Almost all antibiotics were broad-spectrum, except phenoxymethylpenicillin and nalidixic acid. Cotrimoxazole was the most prescribed antibiotic 60/195 (30.77%), followed by amoxicillin 51/195 (26.15%). There was a difference in the age group in the use of amoxicillin and amoxicillin-clavulanic acid, the latter being more frequent in children and cotrimoxazole and azithromycin in adults. There was also a significant difference in the season in the use of phenoxymethylpenicillin, commonly prescribed in summer, and cotrimoxazole in winter (Table 4).

Five different classes of antibiotics were prescribed in this study. Penicillin family 95/195 (48.72%) and sulfonamides 60/195 (30.77%) were the most prescribed groups of antibiotics, with a significant difference between children and adults and between summer and winter. Penicillins were the most frequently prescribed in children and in summer, and sulfonamides in adults and in winter.

Discussion

The HCPs interviewed showed a high level of knowledge about identifying, differentiating from other drugs, and using antibiotics. However, a tenth of the HCPs showed limited knowledge of antibiotic resistance, and classification of the main pharmacological groups of antibiotics was observed. Some HCPs could not explain the meaning of “antibiotic” and “antibiotic resistance”. With specific training of HCPs, this situation can be improved, therefore contributing to the control of antibiotic resistance. Behavior change interventions based on education strategies, either as stand-alone interventions or as part of multifaceted interventions, positively impact antibiotic use[5]. The high level of knowledge observed in this study may be partially explained by the fact that the HCPs interviewed were from a district hospital (i.e., a secondary reference level health facility). A high prescriber’s knowledge, associated with compliance in the use of antibiotics, is a good starting point for appropriate antibiotic prescription and indeed contributes to the fight against antibiotic resistance[2].

Some studies elsewhere reported that respiratory tract infections (RTIs) are the most common indications for prescribing antibiotics[19]. Prognostic uncertainty and the complexity of diagnosing RTIs have been reported as factors that influence antibiotic prescribing decisions. In this study, it was observed that almost one-third of the respondents (35%) stated that the last prescribed antibiotics were indicated for RTIs. This finding is concerning, as there is evidence of inappropriate use of antibiotics to treat RTIs, especially upper respiratory tract infections, such as the common cold[20]. Most upper RTIs are of viral etiology, and therefore the use of antibiotics is not indicated[21]. It is restricted to patients with a confirmed diagnosis of a bacterial infection or when prophylaxis is strongly recommended because of a higher risk for a bacterial infection.

In addition to RTIs, gastrointestinal tract infections are also common and more susceptible to the empirical use of antibiotics, especially in LICs such as Mozambique, where access to diagnostic tests is scarce[14]. Xavier et al.[10] and Monteiro et al.[13] showed that antibiotics were mostly prescribed for pediatric patients with gastroenteritis, thus agreeing with the results of the present study. In this study, 30% of the respondents reported having been prescribed the last antibiotics for gastroenteritis.

The study found considerable use of antibiotics, in the order of 88% of all prescriptions, with at least one antibiotic per prescription. This frequency is high compared to the WHO reference of 20–26.8% [18]. Compared with studies carried out in Mozambique, this frequency (88%) is lower than the 97.6% reported by Monteiro et al. and 97.5% by Xavier et al. in pediatric patients and higher than the 65.9% reported by Faiela & Sevene in HIV-infected patients[10,13,14]. The frequency is also higher compared to 37.7% reported in South Africa and 46.7% in Kenya[22,23]. Other regional studies also reported high frequencies, such as 84.9% in Tanzania, 80.6% in Nigeria, and 70.6% in Botswana[24,25,26]. These differences may reflect the use of antibiotics in different contexts such as urban or rural, as well as a different pattern of behavior among prescribers. In addition, considering that the study was conducted in a secondary-level hospital, it is likely that some of the patients might have been referred from a primary healthcare facility with more severe infections that would require an antibiotic. The high frequency of antibiotic prescriptions observed in this study may indicate excessive use.

Most drugs were prescribed by generic name (96%), showing the trend of compliance with Mozambican medicines legislation that requires prescription by generic name. This frequency is lower than the 100% recommended by the WHO for prescriptions by generic name[18]. Our results are similar to 98.4% reported in Cameroon and 97% in Ethiopia[27,28]. Prescribing by generic name reduces the chances of drug duplication, as patients unknowingly buy and use the same drug from different prescribers when a prescriber uses a brand name and another generic name or when both use different brand names[27]. However, the prescription by generic name observed in this study may also show a high availability of drugs as generics. In Mozambique, generic drugs are more available in the public sector, while branded drugs are mainly found in the private sector.

All prescriptions had medicines listed in the National Medicines Formulary showing good compliance with the WHO reference rate of 100%. In contrast, the rate of prescriptions with an injectable antibiotic was relatively higher compared to the WHO reference range. The relatively higher rate may be linked to the healthcare being the local reference hospital, and it might have received patients referred to it for severe bacterial infections requiring an injectable antibiotic. Additionally, all injectable antibiotics were observed in children, and probably some could not take oral antibiotics.

Documentation of the antibiotic plan (or detailed antibiotic treatment) is a basic requirement for further antibiotic stewardship efforts. Although we have found good performance in the documenting of the prescriptions, some areas need improvement. We assume that the documentation of the prescribers' names, clinical indications, dosage, and duration of the treatment, with a frequency of less than 90%, needs to be improved.

However, greater attention is needed regarding the key aspect of documenting the clinical indication (specifically in adults), the prescriber's name, and the duration of the treatment. The prescriber's name was not indicated in one-third of the prescriptions. The lack of the prescriber's name may hinder the communication between the prescriber and pharmacist in the case of unclear prescriptions. The lack of duration of the treatment may contribute to the inappropriate use of antibiotics by favoring patients to take medicines for a period that is not recommended.

A total of nine different types of antibiotics, seven broad-spectrum and two narrow-spectrum were prescribed at the study site. Increased prescription of broad-spectrum antibiotics is a common phenomenon reported in other studies conducted in different contexts[27]. When the use of broad-spectrum antibiotics is indicated, there is a greater risk of resistance due to the selection of resistant strains, making them ineffective in controlling infections. Unfortunately, prescribers tend to use broad-spectrum antibiotics to treat suspected cases of gram-positive and gram-negative bacterial infections[27]. They are sometimes, prescribed for conditions that do not require antibiotic treatment, such as the common cold and flu, which are viral infections[14].

Five different classes of antibiotics were prescribed in this study, with penicillins and sulfonamides being the most prescribed groups. Penicillins were more prescribed for children, while sulfonamides were for adults. This finding aligns with a study carried out in HIV-infected patients in southern Mozambique, which reported a higher frequency of prescription of antibiotics from the penicillin and sulfonamide groups[14]. The literature also shows that the antibiotics penicillin families are consumed more in hospitals and primary healthcare facilities[27,29].

Cotrimoxazole was the most commonly prescribed antibiotic in adults and amoxicillin in children (Table 4). This finding may substantiate the knowledge of health professionals who are familiar with cotrimoxazole and amoxicillin[12]. The prevalence of HIV in Mozambique and the risk of opportunistic infections that require antibiotics for treatment or prevention could probably be responsible for the high frequency of cotrimoxazole prescription in this study. In addition, RTIs are more frequent in children and are mainly treated with amoxicillin, which probably justifies being the most prescribed antibiotic in children in this study[30]. The higher frequency of amoxicillin prescription in pediatric patients observed in this study is consistent with the literature. Studies in different contexts found amoxicillin to be the most prescribed antibiotic for pediatric patients in hospitals in Ghana and India[20,31]. In addition, we assume that prescribers tend to prescribe cotrimoxazole and amoxicillin more frequently because they are more accessible and belong to the group of antibiotics with a good safety profile regarding side effects, according to WHO AWaRe classification[32].

The seasonal pattern of infections characterizes the demand for antibiotics. Most antibiotics are prescribed in winter, when an increase in bacterial and viral infections, such as rhinosinusitis and the common cold, is expected[33]. However, in this study, we observed a different trend of increased cotrimoxazole prescriptions in winter and phenoxymethylpenicillin in summer. In contrast, using a different approach, Caucci et al. found no seasonal trend for the prescription of cotrimoxazole and penicillin in a European context[33].

Strengths and limitations

Our study was able to identify targets for improvement and stewardship efforts. The high frequency of antibiotic prescribing reveals a need to develop strategies to de-implement unnecessary and wasteful antibiotic prescriptions. We have addressed several points that reinforce our results, including the knowledge chain, antibiotic access through inventory, and prescription rates by age group and seasonality. We have identified some areas for improvement. These targets for improvement should inform and guide future training and development of guidelines to enhance the performance of the HCPs. With these findings, community and hospital-based awareness was performed.

Multiple-choice questions may not measure respondents' accurate knowledge level because they could choose any alternative when they do not know the correct answer. However, tendencies were clear and unlikely of random responses. We assume that this limitation did not significantly impact our results, and it was a way to gather clear, concise quantitative data that could be easily parsed and shared. The relatively small sample size of healthcare professionals does not allow us to generalize the findings. Prescription data were collected retrospectively from copies kept at the pharmacy, so there may have been information bias. To minimize information bias, we have compared prescriptions kept at the pharmacy with other medical records. We did not measure antibiotic use or audit prescriptions to determine whether or not antibiotics were used appropriately, but we have identified areas for improvement. Despite these limitations, the study provides a good insight into the knowledge and antibiotic prescribing practices of HCPs from the MDH.

Conclusions

Prescribers showed a high level of knowledge about identifying and using antibiotics. However, limited knowledge of antibiotic resistance and classification of the main pharmacological groups of antibiotics was observed. A higher frequency of prescription of broad-spectrum antibiotics was observed, with cotrimoxazole and amoxicillin being the most prescribed for adults and children, respectively. These findings revealed adherence to AWaRe recommendations as cotrimoxazole and amoxicillin belong to access group antibiotics. Continuing medical education and antibiotic stewardship programs are recommended to improve antibiotic knowledge and prescribing practices in inpatient and outpatient settings.

Data availability

All the data and materials used to analyze and interpret the results of the study are available from the corresponding author at reasonable request.

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Author contributions
ES and KM contributed to the study design, and conceptualization, and oversaw study implementation and data analysis. CF contributed to data analysis and wrote the manuscript. OC contributed to the study implementation in the field. OC, HB, AM, HW, KM, and ES interpreted the results and revised the manuscript. All authors have read and approved the manuscript.

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Declarations

Competing interests
The authors declare no competing interests.

Ethical approval and consent to participate
The study protocol was approved by the institutional ethics committee of the Manhiça Health Research Centre with reference CIBS-CISM 099/2016. Ethical aspects were guided by the ethical norms of the Declaration of Helsinki. Our study was conducted following the relevant guidelines and regulations. All the participants had given their voluntary informed consent.

Additional information
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