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Antibiotic prescribing trends and determinants in a regional hospital in Ghana: An eight- year retrospective analysis with cross-sectional survey

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Research Article

Keywords: Antibiotic prescribing, Defined Daily Dose, Antimicrobial resistance, Rational drug use, Ghana

Posted Date: March 6th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-8949575/v1

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Additional Declarations: No competing interests reported.

Version of Record: A version of this preprint was published at BMC Infectious Diseases on September 4th, 2026. See the published version at https://doi.org/10.1186/s12879-026-14373-5.

Abstract

Background

Inappropriate antibiotic use is a key driver of antimicrobial resistance (AMR), a growing global public health threat. Monitoring prescribing patterns using standardised metrics such as World Health Organisation (WHO) prescribing indicators and Defined Daily Dose (DDD) supports antimicrobial stewardship. Evidence on outpatient antibiotic prescribing in parts of Ghana remains limited. This study assessed antibiotic prescribing trends and associated prescriber factors at a regional hospital in Ghana.

Methods

A hospital-based observational study was conducted at Bono Regional Hospital, Sunyani. Retrospective outpatient antibiotic prescription data (January 2014–December 2021) were extracted from the Hospital Administration Management Software. Antibiotic utilisation was quantified using DDD per 1,000 inhabitants per day. The study employed a cross-sectional survey of prescriber characteristics that influenced antibiotic prescribing practices. Descriptive statistics summarised prescribing patterns. Associations were examined using chi-square tests and binary logistic regression at $p < 0.05$.

Results

A total of 1,014,368 outpatient antibiotic prescriptions were analysed. Antibiotic consumption increased over time, reaching 11 DDD per 1,000 inhabitants per day in 2021. The study determined that amoxicillin/clavulanic acid (14.39%) served as the most commonly prescribed antibiotic, whereas erythromycin (11.44%), ciprofloxacin (11.36%), and amoxicillin (10.83%) followed. Five antibiotics accounted for more than half of total prescriptions. Among 35 prescribers (response rate: 64.8%), age and years of practice were associated with prescribing in bivariate analysis but were not significant in multivariable models. Delayed laboratory results were the most frequently reported barrier to rational prescribing.

Conclusions

Outpatient antibiotic prescribing increased over time with substantial reliance on broad-spectrum agents. There is a need for better management of healthcare resources and enhanced diagnostic facilities, which will help achieve proper antibiotic usage and control antimicrobial resistance.

Introduction

Antibiotics function as medications which treat bacterial infections through their ability to stop bacteria from growing or to eliminate bacterial organisms [1], [2]. The process of selecting antibiotics for patient treatment presents clinicians with challenges because they must make decisions during times when their medical diagnosis remains uncertain and other clinical obligations demand their attention [3], [4]. The rational use of medicines requires that patients receive their necessary medications through proper dosing and treatment length, which costs them and society the least amount of money [5]. According to this principle, prescribers must first confirm an infection exists before they can use diagnostic tools to assess infection status and base their treatment decisions on established clinical guidelines, which help reduce unnecessary antimicrobial contact [1], [3], [6].

Antimicrobial resistance (AMR) represents a significant global public health danger, which occurs through improper antimicrobial usage that includes both unnecessary drug prescriptions and wrong medication dosages and breaches of established treatment protocols [7], [8]. The overuse of antibiotics has resulted in diminished effectiveness with various antibacterial medications because of emerging resistant pathogens which spread throughout populations [5], [9], [10]. Antibacterial resistance creates multiple dangers, which include treatment failure and patient death and extended hospital

duration, and increased medical expenses thus raising worries about a future "post-antibiotic era" where ordinary infections turn into hard-to-treat conditions [11]. Pathogenic bacteria develop resistance through the selective pressure which arises from antibiotic misuse, thus demonstrating that healthcare facilities must restrict their antibiotic usage to essential and vital treatment needs [12], [13].

Outpatient evidence demonstrates that excessive antibiotic prescription practices continue to exist as a major problem. The consensus study conducted in India discovered that excessive prescription practices serve as a primary factor which leads to resistance development [14]. In the United States, the Centres for Disease Control and Prevention estimated that 30% of outpatient antibiotic prescriptions are unnecessary [15]. In many low- and middle-income settings, antibiotic exposure is even more extensive: antibiotics are prescribed for a large proportion of hospitalised patients and frequently inappropriately [16], and it has been projected that a sizeable share of medicines in Africa, including antibiotics, are used inappropriately [17]. Prescribing patterns also vary across countries and levels of care, reflecting differences in disease epidemiology, access to diagnostics, and implementation of clinical guidelines [18], [19], [20].

Ghana uses policy instruments which promote rational prescribing through its Essential Medicines List and Standard Treatment Guidelines [21]. Yet empirical evidence shows that medical professionals continue to prescribe antibiotics at high rates, which differ between different medical facilities [22], [23], [24], [25], [26]. The prescription practices at medical facilities result from various factors which include the prescribers' knowledge base and training level and practical experience as well as their access to drug guidelines and drug information and drug and therapeutics committees and their existing facility restrictions which include restricted diagnostic resources and slow laboratory analysis processing times [27], [28], [29], [30], [31], [32]. These influences can create two effects, which include rising empirical prescribing practices and healthcare providers who use only limited antibiotic options, which leads to faster development of resistance [33], [34]

Current research about antibiotic prescription in Ghana has increased, but there are still knowledge gaps that affect specific geographical areas and healthcare facilities. Existing research lacks sufficient organised studies that evaluate outpatient antibiotic prescription practices in the Bono Region through standardised assessment methods and World Health Organisation prescribing standards. The [35] states that organisations need to conduct regular assessments of their prescribing practices so they can discover specific medication usage issues, which will help them develop effective antibiotic management programs and make policy decisions. The Defined Daily Dose (DDD) metric enables researchers to measure antibiotic consumption, but it does not reflect how much doctors prescribe to their patients because DDD represents the typical daily dose for the primary medical usage of a medication [36], [37]. The development of specific evidence for each facility throughout multiple years, together with its connection to prescriber-reported factors, will create practical solutions that help organisations achieve better antibiotic usage. Accordingly, this study assessed outpatient antibiotic prescribing/consumption patterns at the Bono Regional Hospital, Sunyani, over an eight-year period, and examined prescriber-related factors associated with antibiotic prescribing practices using WHO rational drug-use prescribing indicators [35].

Study aim

To assess antibiotic prescribing patterns at the Bono Regional Hospital, Sunyani.

Specific objectives

1. To determine the defined daily doses (DDD) of outpatient antibiotic use/prescriptions at the Bono Regional Hospital.
2. To identify the most commonly prescribed antibiotics at the hospital.
3. To examine factors associated with clinicians’ antibiotic prescribing practices.

Methods

Study design

We conducted an observational study which included two distinct components. The first component involved a retrospective examination of outpatient antibiotic dispensing and prescribing records, which were maintained in an electronic hospital system throughout eight years from January 2014 until December 2021. The second component involved a facility-based cross-sectional survey, which evaluated prescriber characteristics that affected their antibiotic prescribing behaviour between February and July 2021. The World Health Organization WHO [35] rational drug-use prescribing indicators framework was used to evaluate antibiotic prescribing patterns.

Study setting

The study was undertaken at the Bono Regional Hospital, Sunyani, located in the Bono Region of Ghana. Sunyani is the regional capital, and the hospital provides outpatient and inpatient services to residents within the metropolis and surrounding districts [38].

Study Population

Secondary (electronic) data

The electronic dataset comprised outpatient records for patients aged ≥ 18 years who received an antibiotic prescription/dispensing episode at the hospital outpatient department (OPD) within January 2014–December 2021. Adults were selected because WHO-defined daily dose (DDD) metrics are primarily standardised for adult use and are not routinely determined for children [36].

Primary (prescriber survey) data

The survey population comprised prescribers working in the hospital during the study period, including medical doctors and physician assistants. Prescriber characteristics were collected to examine associations with antibiotic prescribing practices.

Eligibility criteria

Inclusion criteria

For the electronic records, OPD encounters for patients aged ≥ 18 years with an antibiotic dispensed/prescribed for a new episode of illness between January 2014 and December 2021 were eligible. For each patient, the first eligible visit with an antibiotic record within the period was selected, where applicable.

For the prescriber survey, clinicians/physician assistants present during data collection who consented to participate were eligible.

Exclusion criteria

Electronic records were excluded if they represented review visits, originated from other departments outside the OPD but were dispensed in the OPD pharmacy, had missing medication information in the system, or did not meet eligibility criteria. Prescribers who were absent during the survey period or declined consent were excluded.

Sample size

For the electronic component, no sample size calculation was performed because the study extracted all eligible antibiotic dispensing/prescribing records within the specified period from the hospital electronic system.

For the prescriber survey, the hospital's human resource directorate listed 54 prescribers (doctors and physician assistants). A census approach (complete enumeration) was intended; 35 prescribers participated (response rate: 64.8%).

Data sources and measurement

Electronic prescribing/dispensing data (2014–2021)

The Hospital Administration Management Software (HAMS) provided data about antibiotic usage. The researchers created a data extraction checklist (see Supplementary File 2_Data Extraction Tool) that used WHO prescribing indicators from 1993 and national and international prescribing assessment methods for its structure [21], [22], [39]. The researchers extracted multiple variables, which included the date of prescribing and dispensing the antibiotic, together with its name and category and the required dosage information needed for DDD calculations, the route of administration, the diagnosis, laboratory test results, and the total number of medications prescribed during each patient visit and the available drug prices.

The researchers used DDD methodology from the World Health Organization 2020) to summarise antibiotic consumption, which they reported as DDD per 1 000 inhabitants per day. This method establishes a standard usage metric which enables both benchmarking and trend analysis [37].

Prescriber survey (February – July 2021)

The research team created their questionnaire (see Supplementary File 1_Prescriber Survey), which they distributed through Google Forms. The study collected data about socio-demographic factors and professional characteristics through items that included age, sex, profession, years of practice, patient load, and enabling/facility factors, which supported rational use of medicines by documenting the existence of both a drug information unit and a drug and therapeutics committee [20], [29]. Prescribers reported their constraints, which impacted their ability to follow the rational use of medicines standards.

Data quality assurance

The researchers tested the data extraction checklist through its application on the HAMS system at Ahafo Regional Hospital, which they used to examine whether all needed data points could be collected. The team confirmed that all extracted information met requirements for completeness, consistency and accuracy before proceeding with the analysis. The researchers examined the prescriber questionnaire to improve its clarity through a design that would reduce the chances of respondents leaving questions unanswered.

Variables and operational definitions

1. **Antibiotic utilisation (DDD metrics)**: computed per WHO DDD definitions and summarised as DDD/1,000 inhabitants/day [36], [37].
2. **Common antibiotics prescribed**: frequency and percentage distribution of antibiotic types over 2014–2021.
3. **Prescribing practice outcome (survey)**: binary indicator reflecting whether the prescriber reported antibiotic prescribing in the assessed context (Yes/No), used for association testing with prescriber and facility factors.
4. **Explanatory variables (survey)**: age group, sex, profession, years of practice, patient load, consultation duration, and reported presence of DIU/DTC, and client demand.

Bias and how it was addressed

The researchers decreased selection bias from the electronic dataset by extracting all OPD antibiotic records which met the research criteria during the designated time period. Information bias was minimised through the use of a standardised extraction checklist based on WHO indicators [35]. The researchers tried to eliminate bias from non-response in the survey by conducting a complete assessment of all prescribers and providing a short electronic tool which would increase participation.

Statistical analysis

The researchers used Microsoft Excel to export data and conducted their analysis with STATA version 17. The researchers calculated descriptive statistics, which they presented through categorical variables as frequencies and percentages and through continuous variables as means and standard deviations. The prescriber survey component used chi-square tests to

examine bivariate relationships between prescriber and facility characteristics and their antibiotic prescribing patterns. The study used binary logistic regression to examine variables that showed significant relationships and all major theoretical predictors by calculating crude odds ratios and adjusted odds ratios with 95% confidence intervals. The researchers established statistical significance at $p < 0.05$.

Ethics approval and consent to participate

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board of Kwame Nkrumah University of Science and Technology (CHRPE/AP/098/21). Institutional permission was obtained from the Bono Regional Hospital administration and the regional directorate of health services. For the electronic records, patient identifiers were not extracted; confidentiality was maintained through the use of anonymised identifiers and secure storage. For the prescriber survey, informed consent was obtained electronically, and participation was voluntary. All data were used strictly for academic purposes and stored in password-protected electronic formats with access limited to the research team.

Results

Overview

A total of 1,014,368 outpatient antibiotic prescription records from January 2014 to December 2021 were extracted from the Hospital Administration Management Software (HAMS). In addition, 35 out of 54 eligible prescribers participated in the survey (response rate: 64.8%). Results are presented in four sections: (i) prescriber characteristics, (ii) antibiotic consumption measured using DDD, (iii) commonly prescribed antibiotics and trends, and (iv) factors associated with antibiotic prescribing practices.

Prescriber characteristics

Among the 35 prescribers (see Table 1), the majority were male and medical doctors. The mean age was 30.11 years (SD ± 6.63), and the mean years of practice was 5.17 years (SD ± 4.79). Most prescribers had fewer than six years of practice and reported seeing ≤20 patients per day. A large proportion reported the availability of a Drug Information Unit (DIU) and a Drug and Therapeutic Committee (DTC) within the facility. Approximately half indicated that clients demand antibiotics during consultations.

Table 1: Socio-demographic Characteristics of Prescribers at Bono Regional Hospital, 2021

Characteristics	Frequency (n=35)	Percentage
Age in years		
Mean (SD)	30.11 ± 6.63	
20-25	12	34.29
26-30	10	28.57
31-35	5	14.29
≥36	8	22.86
Sex		
Female	11	31.43
Male	24	68.57
Profession		
Doctor	25	71.43
Physician Assistant	10	28.57
Years of practice		
Mean (SD)	5.17 ± 4.79	
<6	23	65.71
≥6	12	34.29
Number of patients seen during a day		
Mean (SD)	27.26 ± 33.21	
≤20	18	51.43
21-30	10	28.57
≥31	7	20.00
Average duration to attend to a patient (minutes)		
Mean (SD)	15.51 ± 19.48	
≤10	18	51.43
11-20	12	34.29
≥21	5	14.29
Availability of DIU in the facility		
No	9	25.71
Yes	26	74.29
Availability of DTC in the facility		
No	8	22.86
Yes	27	77.14
Clients demand antibiotics		
No	17	48.57

Yes	18	51.43
DIU: Drug Information Unit; DTC: Drug and Therapeutic Committee; SD: Standard Deviation		

Antibiotic consumption (Defined Daily Dose – DDD)

Overall trend in antibiotic consumption

Antibiotic consumption expressed as DDD per 1,000 inhabitants per day demonstrated fluctuations across the eight-year period (see Figure 1). A progressive increase was observed from 2014, with a temporary decline in 2020, followed by a marked rise in 2021. In 2021, antibiotic consumption was equivalent to 11 DDD per 1,000 inhabitants per day.

Antibiotic-specific DDD trends

Across the study period, antibiotic-specific consumption varied considerably. Amoxicillin, doxycycline, and cefuroxime showed substantial increases during peak years. In 2021, doxycycline, amoxicillin, erythromycin, ciprofloxacin, cefuroxime, azithromycin, and clindamycin contributed significantly to overall DDD values (see Table 2).

Table 2: Antibiotic Consumption (DDD per 1,000 Inhabitants per Day) by Antibiotic Type, 2014–2021

Antibiotics	2014	2015	2016	2017	2018	2019	2020	2021
Cefuroxime	3.00	56.00	68.00	77.00	100.00	130.00	130.00	83.00
Amoxicillin	54.00	82.00	42.00	174.00	156.00	196.00	270.00	214.00
Ciprofloxacin	12.00	32.00	43.00	52.00	48.00	70.00	73.00	65.00
Flucloxacillin	13.00	12.00	5.00	10.00	26.00	23.00	32.00	33.00
Erythromycin	13.00	32.00	10.00	64.00	50.00	90.00	0.00	116.00
Doxycycline	66.00	270.00	186.00	186.00	274.00	500.00	170.00	42.00
Clarithromycin	7.00	24.00	10.00	32.00	20.00	66.00	16.00	21.00
Azithromycin	7.00	36.00	21.00	76.00	62.00	59.00	60.00	81.00
Clindamycin	12.00	13.00	30.00	43.00	56.00	60.00	56.00	90.00

Commonly prescribed antibiotics

Across the eight-year period (see Table 3), Amoxicillin/clavulanic acid was the most frequently prescribed antibiotic, followed by erythromycin, ciprofloxacin, and amoxicillin. A relatively small number of antibiotics accounted for a substantial proportion of total prescriptions.

Table 3: Most Commonly Prescribed Antibiotics at Bono Regional Hospital, 2014-2021

Antibiotics	Frequency	Percentage
Amoxicillin + clavulanic acid	146924	14.39
Erythromycin	116816	11.44
Ciprofloxacin	116003	11.36
Amoxicillin	110527	10.83
Cefuroxime	94136	9.22
Clindamycin	92772	9.09
Flucloxacillin	92332	9.04
Amoxicillin	91203	8.93
Doxycycline	62366	6.11
Azithromycin	35195	3.45
Clindamycin	33534	3.28
Clarithromycin	29120	2.85

Trend in total antibiotic prescriptions

The total number of antibiotic prescriptions increased steadily from 2014 to 2019, declined in 2020, and rose again in 2021, reaching the highest level observed during the study period (see Figure 2).

Yearly distribution of antibiotics

The most frequently prescribed antibiotic varied by year. Flucloxacillin predominated in 2014; ciprofloxacin was most frequent in 2015 and 2016; Amoxicillin/clavulanic acid dominated in 2017 and 2018; while erythromycin and amoxicillin were prominent in later years (see Table 4).

Table 4: Distribution of Antibiotics Prescribed by Year at Bono Regional Hospital, 2014–2021

Antibiotics Prescribed	Year							
	2014	2015	2016	2017	2018	2019	2020	2021
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Cefuroxime	728 (1.23)	10140 (10.54)	10296 (16.74)	10556 (8.41)	14664 (10.47)	18512 (10.14)	17108 (10.77)	11492 (6.04)
Amoxicillin + clavulanic acid	14560 (24.56)	20696 (21.51)	1456 (2.37)	18200 (14.50)	18200 (12.99)	24960 (13.67)	20696 (13.03)	26936 (14.15)
Amoxicillin	4368 (7.37)	2184 (2.27)	6552 (10.65)	13104 (10.44)	14196 (10.13)	6552 (3.59)	21840 (13.75)	21840 (11.48)
Amoxicillin	4888 (8.25)	6916 (7.19)	4732 (7.69)	16380 (13.05)	13364 (9.54)	24336 (13.32)	28704 (18.08)	10556 (5.55)
Ciprofloxacin	5096 (8.60)	11752 (12.22)	12896 (20.96)	14248 (11.35)	13936 (9.95)	20020 (10.96)	19240 (12.12)	18096 (9.51)
Flucloxacillin	11648 (19.65)	8736 (9.08)	2912 (4.73)	5512 (4.39)	15184 (10.84	13104 (7.17)	16640 (10.48)	18096 (9.51)
Erythromycin	5824 (9.82)	11648 (12.11)	2912 (4.73)	17472 (13.92)	14560 (10.39)	26208 (14.35)	5824 (3.67)	32032 (16.83)
Doxycycline	2912 (4.91)	9984 (10.38)	5616 (9.13)	5096 (4.06)	8008 (5.72)	14224 (7.79)	4472 (2.82)	11648 (6.12)
Clarithromycin	1456 (2.46)	4368 (4.54)	1456 (2.37)	4368 (3.48)	2912 (2.08)	9360 (5.12)	2080 (1.31)	2912 (1.53)
Azithromycin	936 (1.58)	3952 (4.11)	1872 (3.04)	6292 (5.01)	5408 (3.86)	4992 (2.73)	4680 (2.95)	6760 (3.55)
Clindamycin	3952 (6.67)	2912 (3.03)	5824 (9.47)	4472 (3.56)	2184 (1.56)	4368 (2.39)	2940 (1.85)	6656 (3.50)
Clindamycin	2912 (4.91)	2912 (3.03)	4992 (8.11)	9828 (7.83)	17472 (12.47)	16016 (8.77)	14560 (9.17)	23296 (12.24)
Total	**59280 (100)**	**96200 (100)**	**61516 (100)**	**125528 (100)**	**140088 (100)**	**182652 (100)**	**158784 (100)**	**190320 (100)**

N: Total number of antibiotics prescribed; %: Percentage of antibiotics prescribed

Reasons for non-adherence to rational use of medicines (RUM) standards

The most commonly reported reason for not fully adhering to RUM standards was delayed laboratory results (see Figure 3). Other contributing factors were reported less frequently.

Factors associated with antibiotic prescribing practices

Bivariate analysis (see Table 5) demonstrated statistically significant associations between antibiotic prescribing and prescribers' age, years of practice, and availability of a Drug and Therapeutic Committee. No significant association was observed with sex, patient load, consultation duration, or availability of a Drug Information Unit.

Table 5: Bivariate Analysis of Factors Associated with Antibiotic Prescribing Practices at Bono Regional Hospital, 2021

	Antibiotics prescribed		P-value
Variables	**No**	**Yes**	
	n (%)	**n (%)**	
Age in years			0.005*
20-25	9 (47.37)	3 (18.75)	
26-30	8 (42.11)	2 (12.50)	
31-35	1 (5.26)	4 (25.00)	
36+	1 (5.26)	7 (43.75)	
Sex			0.983
Female	6 (31.58)	5 (31.25)	
Male	13 (68.42)	11 (68.75)	
Years of practice			0.003*
<6	17 (89.47)	6 (37.50)	
6+	2 (10.53)	10 (62.50)	
Number of patients seen during a day			0.905
20	9 (47.37)	9 (56.25)	
21-30	6 (31.58)	4 (25.00)	
31+	4 (21.05)	3 (18.75)	
Average duration to attend to a patient (minutes)			0.806
≤10	10 (52.63)	8 (50.00)	
11-20	7 (36.84)	5 (31.25)	
≥21	2 (10.53)	3 (18.75)	
Availability of DIU in the facility			0.460
No	6 (31.58)	3 (18.75)	
Yes	13 ()68.42	13 (81.25)	
Availability of DTC in the facility			0.047*
No	7 (36.84)	1 (6.25)	
Yes	12 (63.16)	15 (93.75)	
Clients Demand Antibiotics			0.877
No	9 (47.37)	8 (50.00)	
Yes	10 (52.63)	8 (50.00)	
DIU: Drug Information Unit; DTC: Drug and Therapeutic Committee			

Logistic regression analysis

In crude (bivariate) logistic regression (see Table 6), prescribers aged ≥36 years and those with ≥6 years of practice experience had significantly higher odds of prescribing antibiotics compared to their reference groups. However, in the adjusted model, none of the independent variables remained statistically significant after controlling for confounders.

Table 6: Bivariate and Multivariable Logistic Regression of Factors Associated with Antibiotic Prescribing Practices, 2021

Variables	Bivariate Logistic Regression			Multiple Logistic Regression		
	COR	**(95% CI)**	**p-value**	**AOR**	**(95% CI)**	**p-value**
Age in years						
20-25	1 (Ref.)			1 (Ref.)		
26-30	0.75	0.10 – 5.69	0.781	1.10	0.11 – 10.59	0.933
31-35	12.00	0.94 – 15.89	0.056	6.78	0.33 – 13.39	0.214
36+	21.00	1.78 – 48.10	0.016 *	13.40	0.21 – 87.69	0.223
Sex						
Female	1 (Ref.)					
Male	1.02	0.24 – 4.26	0.983			
Years of practice						
<6	1 (Ref.)			1 (Ref.)		
6+	14.17	2.39 – 84.07	0.004 *	1.96	0.09 – 44.31	0.672
Availability of DTC in the facility						
No	1 (Ref.)			1 (Ref.)		
Yes	8.75	0.94 – 81.26	0.056	7.17	0.42 – 12.83	0.173

** Statistically significant at p<0.05; DTC: Drug and Therapeutic Committee; Ref: Base Reference; COR: Crude Odds Ratio; AOR: Adjusted Odds Ratio; CI: Confidence Interval*

Discussions

The research examined outpatient antibiotic prescribing patterns at a regional hospital in Ghana over an eight-year period while investigating factors that influenced prescribers' antibiotic prescribing behaviour. Three principal findings emerged. First, outpatient antibiotic consumption, expressed as DDD per 1,000 inhabitants per day, increased over time with a marked rise in 2021. Second, a relatively small group of antibiotics, particularly amoxicillin/clavulanic acid, erythromycin, ciprofloxacin, and amoxicillin, accounted for a substantial proportion of prescriptions. The bivariate analysis showed that prescriber age and years of experience affected antibiotic prescribing, but the statistical significance of these relationships disappeared after adjustment.

The total drug consumption of DDD in 2021 reached a value of 11 DDD per 1000 inhabitants per day. DDD serves as a standardised measurement unit which does not show the actual daily medication requirements for individual patients [36] but functions as a benchmarking tool that helps track changes in antibiotic use patterns [37]. The upward trajectory that researchers observed throughout the research period indicates that hospital facilities experienced higher rates of antibiotic treatment for patients who visited outpatient services.

The healthcare system experienced a temporary decline in 2020, but medical services showed to have recovered by 2021. The study however, did not intend to determine what specific factors brought about these changes. DDD values require careful

interpretation because they fail to include clinical severity assessment and case-mix analysis together with pharmacokinetic data from individual patients [36].

The study period saw amoxicillin/clavulanic acid become the most common antibiotic prescription, which was followed by erythromycin and ciprofloxacin and amoxicillin. The pattern demonstrates similarity with research results from different locations, which show that penicillins and fluoroquinolones represent the main antibiotics used in outpatient settings [25], [33], [40], [41]. Ghanaian hospitals have reported similar patterns, which researchers have documented [25], [26].

The concentration of prescribing within a limited number of antibiotic classes raises stewardship concerns. The persistent administration of a limited selection of broad-spectrum medications will result in more frequent development of antimicrobial resistance because microbiological testing occurs at rare intervals within these settings [8], [34]. The research results from Ghana show that ampicillin and cotrimoxazole, which are standard antibiotics, face increasing resistance rates that demonstrate the necessity for continuous monitoring and responsible use programs [42], [43], [44].

The study found two prescriber factors, which included their age together with their total years of practice, that influenced their decision to prescribe antibiotics. The study showed that older prescribers, together with those who possessed six or more years of experience, had a higher probability of prescribing antibiotics than their younger counterparts who had less work experience. The practice of prescribing in medical contexts shows similar patterns which emerge as doctors gain more clinical experience together with their professional development [45], [46].

The multivariable model revealed no significant relationships because the survey sample size restricted statistical analysis power, while potential confounding factors remained present. The adjusted analysis produced broad confidence intervals, which indicated measurement uncertainty and demanded careful assessment.

The primary reason for medical professionals to fail to follow the rational use of medicines standards involved late laboratory results. Diagnostic confirmation delays lead to increased empirical antibiotic prescribing, which researchers have found to exist in other low-resource environments [31], [32]. The practice of empirical prescribing without conducting antimicrobial susceptibility testing results in two negative outcomes, which include improper antibiotic usage and development of resistance selection pressure [8].

Policy and stewardship implications

The institutional stewardship mechanisms which include active Drug and Therapeutic Committees [29], [30] and better execution of national Standard Treatment Guidelines [21] demonstrate their institutional value. The World Health Organization [35] recommends routine monitoring of prescribing indicators which together with periodic antibiotic utilisation audits will enable better antibiotic usage. The implementation of faster laboratory test results will help decrease the need for empirical antibiotic treatment, which leads to unnecessary antibiotic use.

Strengths and limitations

The research benefits from its extensive eight-year retrospective dataset, which enables researchers to track outpatient antibiotic usage patterns at the regional referral hospital. The combination of DDD usage data with prescriber survey information creates a comprehensive view.

The study includes multiple limitations which require examination. The DDD system fails to measure actual patient dosing practices and appropriate clinical use (World Health Organization, 2020). The prescriber survey produced moderate response rates yet generated insufficient data to achieve reliable statistical outcomes. The study conducted its research at one regional hospital, which restricted its findings to that specific location. The research created no link between antibiotic resistance data and prescribing records, which stopped researchers from analysing the connection between antibiotic use and resistance development.

Conclusion

Outpatient antibiotic prescribing at Bono Regional Hospital increased over the eight-year study period, with amoxicillin/clavulanic acid and other broad-spectrum agents accounting for a substantial share of prescriptions. Although prescriber age and experience were associated with antibiotic prescribing in unadjusted analyses, these associations did not persist after adjustment. Delayed laboratory results were frequently reported as a barrier to rational prescribing. The implementation of enhanced antimicrobial stewardship programs, together with regular prescription audits and better diagnostic capabilities, will result in more effective antibiotic management, which will help reduce the spread of antimicrobial resistance.

Declarations

Consent for Publication

Not applicable.

Availability of Data and Materials

The datasets generated and/or analysed during the current study are not publicly available due to institutional data protection policies but are available from the corresponding author on reasonable request and with permission from Bono Regional Hospital.

Conflict of Interest / Competing Interests

The authors declare no competing interests concerning the work presented in this manuscript.

Funding

The authors declare that no funding was received for this manuscript's research, authorship, or publication.

Author Contributions

PG conceived the study, coordinated data collection, and contributed to manuscript drafting. YMB performed the statistical analyses and contributed to the interpretation of results. JL contributed to data acquisition and assisted with data validation. MBU conceptualised and supervised the study, provided methodological oversight, contributed to data analysis and interpretation, and critically revised the manuscript for important intellectual content. GOT contributed to the literature review, data interpretation, and manuscript revision. YGF and WKA supported data collection and contributed to manuscript editing. All authors read and approved the final manuscript.

Acknowledgements

The authors thank the management and staff of Bono Regional Hospital for granting permission to access prescription records. We also acknowledge the prescribers who participated in the survey.

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Figures

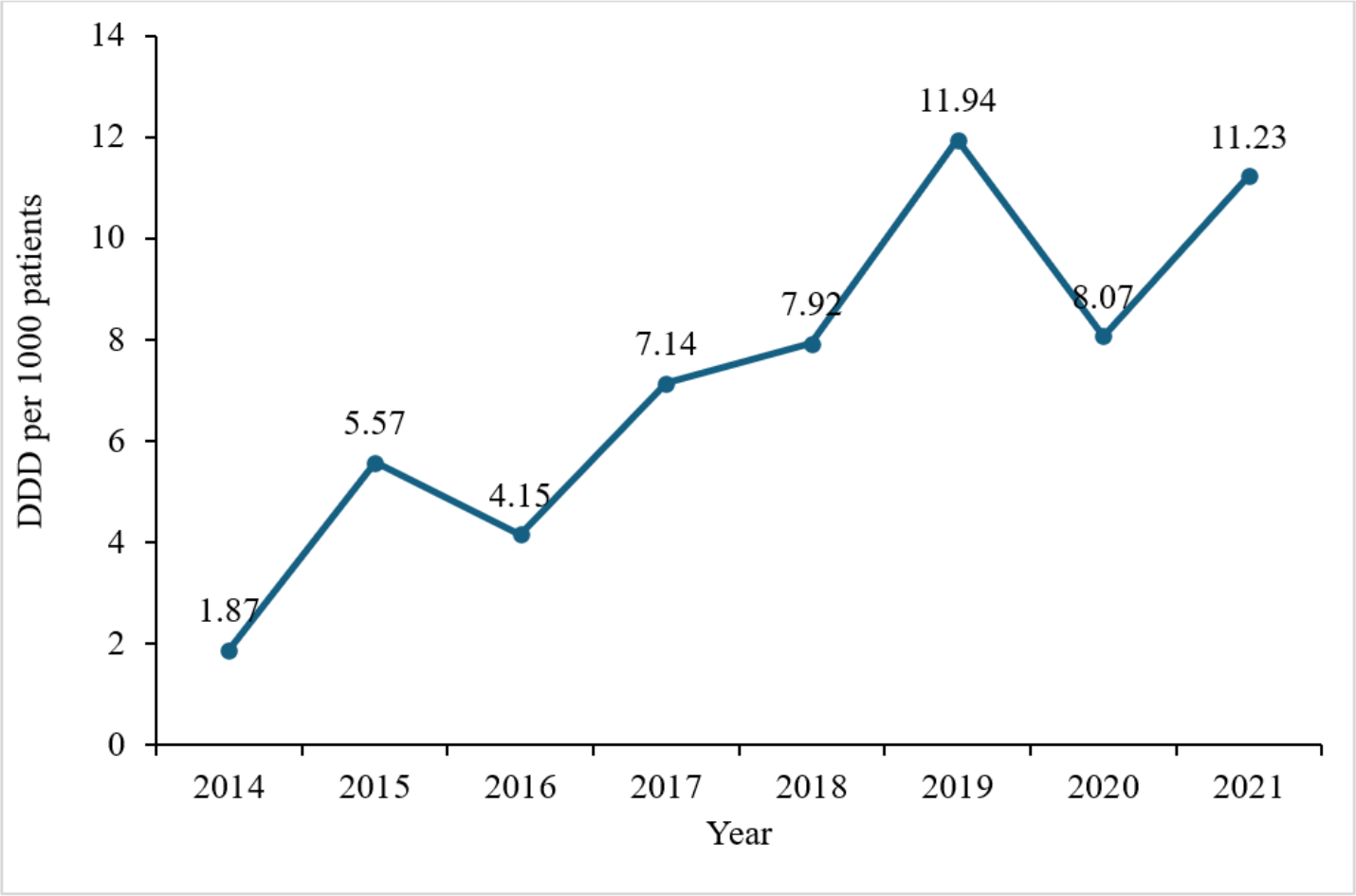

Figure 1

Antibiotic Consumption Rate at Bono Regional Hospital OPD (2014–2021) Expressed as DDD per 1,000 Inhabitants per Day

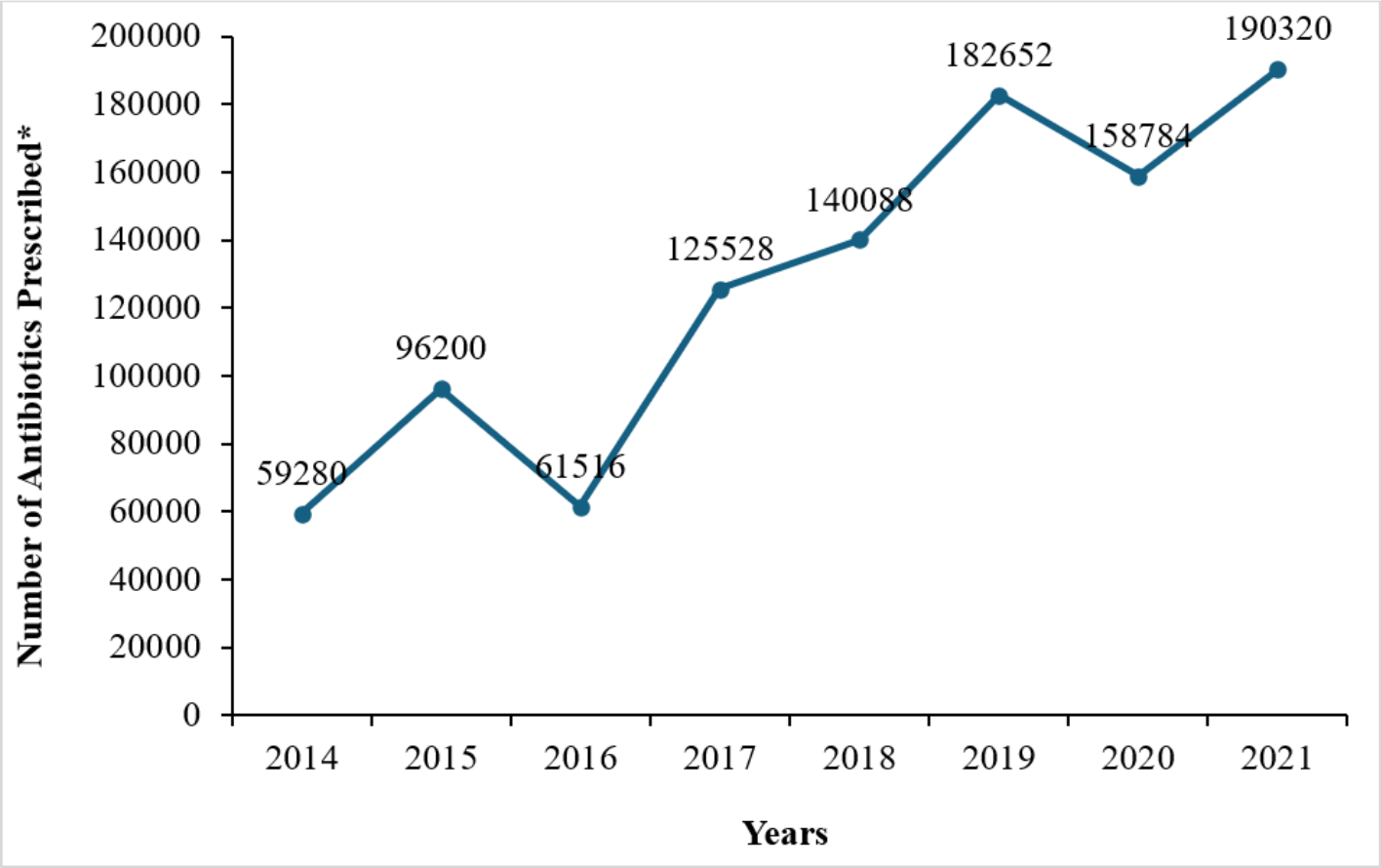

Figure 2

Secular Trend in Total Number of Antibiotic Prescriptions at Bono Regional Hospital, 2014–2021

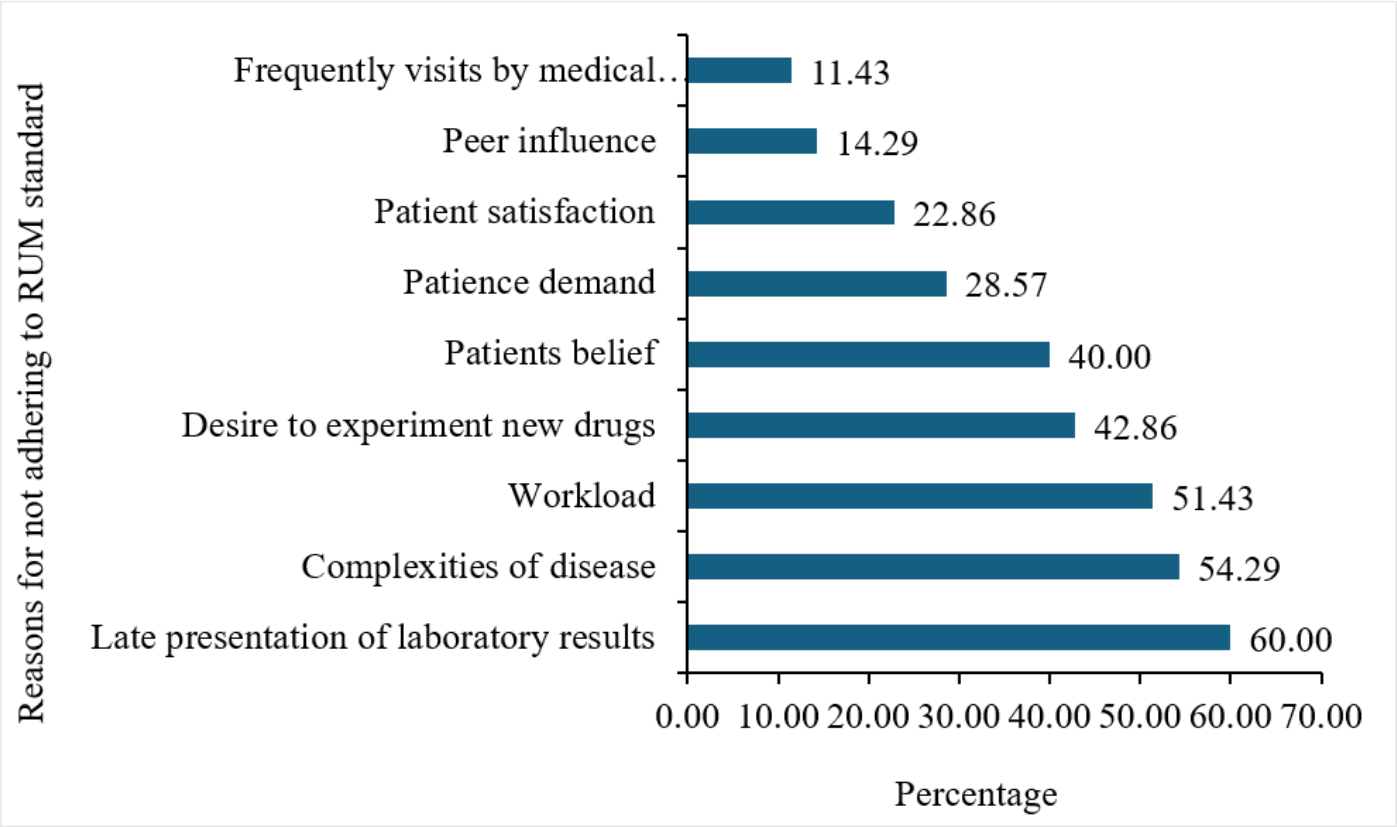

Figure 3

Reported Reasons for Non-Adherence to Rational Use of Medicines Standards among Prescribers, 2021

Supplementary Files

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- SupplementaryFile2DataExtractionTool.pdf