

# Evaluation of Antibiotics Use and its Predictors at Pediatrics Ward of Jimma Medical Center: Hospital Based Prospective Cross-sectional Study

Aster Wakjira Garedow<sup>1</sup>, Gorfineh Teshome Tesfaye<sup>2</sup>

<sup>1</sup>Jimma University, School of Pharmacy, Jimma, Ethiopia; <sup>2</sup>Jimma University Medical Center, Jimma, Ethiopia

Correspondence: Aster Wakjira Garedow, Email [asterwakjira@gmail.com](mailto:asterwakjira@gmail.com); [aster.garedow@ju.edu.et](mailto:aster.garedow@ju.edu.et)

**Background:** One of the biggest emerging public health issues is the alarming increase in the prevalence of antibiotic resistance across the globe, which is linked to significant morbidity and mortality and demands special attention. The most significant risk factor for antimicrobial resistance (AMR), which is increasing considerably in Ethiopia and is responsible for increased adverse effects, treatment failure, and rising health-care costs, is inappropriate antibiotic usage. The purpose of this study was to assess the use of antibiotics in inpatient settings at an Ethiopian teaching hospital providing tertiary care.

**Methods:** The hospital-based prospective cross-sectional study was undertaken at JMC in southwest Ethiopia. Data were collected by using structured checklist which contains patient's sociodemographic characteristics and pattern of antimicrobial use. All cards of patients which fulfill the inclusion criteria were selected by using a systematic random sampling technique. Bivariate analysis was done to know the association between independent variable and the outcome variable.

**Results:** The medical records of 402 pediatric patients who had taken at least one systemic antibiotic were examined. The most frequently prescribed combination antibiotics were ampicillin+gentamycin (43.33%) followed by ceftriaxone+gentamycin (15.23%). Gentamycin 116 (24.11%) was the most frequently used antimicrobial. Overall 19.29% of antibiotic use was improper. A higher percentage of participants 149 (22.41%) experienced inappropriate antibiotic usage as a result of inappropriate frequency. Pediatric patients stay in hospital  $\geq 7$  days (AOR; 2.45, 95%CI: 2.32–5.34), prescribed antibiotics  $\geq 3$  (AOR: 3.12, 95%CI: 6.32–13.37) and prescribed empirical treatment types (AOR; 2.65, 95%CI: 4.23–8.87) were independent predictors of inappropriate antibiotics use.

**Conclusion:** Antibiotics were generally used inappropriately at high rates. Gentamycin and crystalline penicillin were the most prescribed antibiotics. Longer hospital stay, antibiotics prescription  $\geq 2$ , and empirical treatments were the independent predictors of inappropriate antibiotic use.

**Keywords:** antibiotics, pediatrics, evaluation, Jimma university

## Background

Antimicrobials are medications used to treat diseases caused by microbes (bacteria, viruses, fungi, and parasites).<sup>1</sup> Antimicrobial resistance (AMR) occurs when microbes change gradually and become unresponsive to the drugs designed to kill them.<sup>1,2</sup> AMR is one of the most serious and urgent global public health problems since it affects the health care, veterinary, and agriculture industries.<sup>1–3</sup> AMR is associated with high mortality, frequent health-care visits, prolonged hospital stay, and a huge economic burden on health care.<sup>3</sup> For instance, each year in the USA, at least 2.8 million people are infected with antimicrobial-resistant microbes and about 35,000 people die as a result with an overall cost of up to \$55 billion annually.<sup>2,4</sup> The World Bank indicated that AMR would upraise the rate of poverty and disproportionately affect low-income countries compared to the rest of the world.<sup>5</sup>

The main driver of AMR is the misuse of antimicrobials both in animal and human medicine globally and antimicrobial misuse is disproportionately higher in low and middle-income countries (LMIC).<sup>2,6,7</sup> Worldwide up to 50% of antimicrobials used in the hospital were inappropriate.<sup>8,18</sup> Similarly, almost half (49%) of antimicrobials used in

Ethiopian hospitals were inappropriate.<sup>9,20,21</sup> In addition, the pooled prevalence of multidrug resistant (MDR) strains was about 60% and the majority of bacterial isolates have shown significant resistance to commonly used antibiotics in Ethiopia.<sup>10</sup> To increase the appropriate prescription and utilization of antimicrobials the Federal Ministry of Health (FMOH)<sup>11</sup> and Ethiopian Food and Drug Administration (EFDA)<sup>12</sup> have developed and implemented an antimicrobial stewardship (AMS) program which is crucial for treatment success and prevention of AMR on a broader scale. However, this essential program is not fully implemented in most health care institutions.<sup>13,14</sup>

In order to prevent multiple drug resistance, treatment failure, nonadherence, adverse medication reactions, drug-drug reactions, and a rise in treatment costs, rational antibiotic prescription is crucial, especially for pediatric patients.<sup>15–17</sup> There is now ample global evidence that there is continued irrational use of medications in poorer nations. Fewer than 40% of patients in the public sector and fewer than 30% in the private sector are treated in accordance with existing recommendations, and the situation is not improving in either developing or transitional nations.<sup>19</sup> The prevalence of infections caused by resistant bacteria has increased, and certain pathogens are now resistant to several different kinds of antibiotics.<sup>20–22</sup>

One of the primary causes of the high incidence of antimicrobial resistance is thought to be the frequent use of antibiotics. Antimicrobials are used more frequently in infants and children than in adults due to the higher frequency of infection;<sup>23</sup> in developed countries, these medications are used to treat about 30% of hospitalized patients.<sup>24</sup> The effectiveness of many antibiotics may be lost due to their widespread availability and improper usage by patients and health-care professionals in the treatment of diseases with high prevalence.<sup>25</sup> The evaluation of medication use among pediatrics is crucial for clinical, educational, and financial reasons.<sup>26,28</sup> There is still a lack of information on the usage patterns of antibiotics in the Jimma Medical Center's (JMC's) pediatric wards. This study's goal is to close these knowledge gaps by identifying the hospital's pattern of antibiotic use.

## Methods and Participants

### Study Design and Settings

Hospital-based cross-sectional study was conducted from November 1, 2021 to April 30, 2021 at Jimma Medical Centre (JMC). JMC is the only teaching and referral hospital in the southwest of Ethiopia with a bed capacity of 660 and a catchment population of over 20 million. Jimma Medical Center (JMC) is one of the oldest public hospitals in the country. Geographically, it is located about 350 km southwest of Addis Ababa, the capital. It provides services for approximately 15,000 inpatient, 11,000 emergency cases and 4500 deliveries per year. The overall catchment population for the outpatients reaches 160,000 attendants including the pediatrics and those patients on ambulatory follow-up for chronic diseases, human immunodeficiency virus (HIV) and tuberculosis per year. The hospital gives services both for patients from the community presenting directly to the outpatient department and those referred after attending some other health-care facility or primary hospitals. However, as the hospital is the tertiary teaching hospital in the country, more than 75% of inpatient attendants are referred to hospital from lower-level health institution. JMC pediatric ward has 163 beds and around 3670 children are admitted per year.

### Study Population

Pediatric patients (aged  $\leq 18$  years) who were treated at the inpatient pediatric ward of JMC department were included in the study. The inclusion criteria were patients who were prescribed with at least one systemic antibiotic for suspected or confirmed infections during the study period. Patients who were prescribed with topical antimicrobial, antifungal, antiviral, anthelmintic and antiprotozoal and antituberculosis were excluded. A total of pediatric 610 patients visited the inpatient clinics of the hospital during the study period; from these 402 patients received systemic antibiotics and were included in the study. Dependent variable was patterns of antibiotic Utilization; independent variables include sociodemographic and clinical characteristics (weight, medical condition, mediations, duration of hospital stay, diagnosis, laboratory parameter). World Health Organization Guideline for Pediatric Illness<sup>36</sup> and Ethiopia Standard Treatment Guideline for General Hospitals<sup>37</sup> were used to assess the rational use and prescribing pattern of antibiotics. Appropriateness was measured according to a recommendation of use in terms of indication, dose, frequency, and duration. Core drug prescribing indicators such as percentage of generic prescription, injection use, and prescription from

the National Essential Drug List were assessed using WHO, Food, Medicine, and Healthcare Administration and Control Authority (FMHACA) standards.<sup>33,35</sup>

## Sample Size Determination and Sampling Technique

The required sample size was calculated using simple population proportion formula by considering  $P=0.499$  ( $P$ -of study done in other setting<sup>33</sup>) and  $d$  (sampling error) = 5% and using 95% confidence level, the final sample sizes was 402. All cards of patients which fulfill the inclusion criteria were selected by using systematic random sampling technique until the required sampling size was obtained.

## Data Collection Procedure

Pharmacists and general practitioners were trained to collect data following predesigned and pretested data collection formats. Antibiotics which were classified as J01 category (antibiotics for systemic use) under the Anatomical Therapeutic Chemical classification (ATC) classification system were included in this study. Medical record of the patient was used to extract data on the antibiotics' dosage regimen, age of patients, number of antibiotics prescribed per prescription, duration of antibiotics use, and prescriber's information, the primary diagnosis and comorbid conditions. Data collection was supervised by the investigators frequently in order to monitor the process and to assist in case of queries.

## Data Processing and Analysis

The collected data was checked for completeness and consistency, coded, cleaned compiled, and entered into EpiData 4.6, and exported to the SPSS version 21.0 for analysis. Sociodemographic characteristics of patients, clinical characteristics, and treatment-related information were described in terms of frequency and proportions using descriptive statistics. Univariate and multivariate logistic regression analyses were employed to come up with factors associated with inappropriate use of antibiotics. Bivariate analysis was done to know the association between independent variable and the outcome variable. The multivariate logistic regression model was used to identify the independent determinants of appropriateness of antibiotic prescribing after selecting variables that meet crude odds ratio significance value, ie,  $P < 0.25$  in bivariate analysis. Finally, based on adjusted odds ratios at 95% confidence interval and  $P$ -value  $< 0.05$ , the variables with significant predictors were identified.

## Data Quality Control and Assurance

The questionnaires were prepared in English and translated into Amharic and local language Afan Oromo, and back-translated into English by an independent person to assure its consistency. A pretest was conducted on 8 (5%) study participants by randomly selected patients before the actual data collection to check the consistency and validity of the structured data collection format. Data were compiled, cleared, coded, and checked for consistency. All steps in data collection and recording were closely monitored by the supervisor and any gaps identified were immediately communicated with the data collectors.

## Ethical Consideration

The study was conducted in accordance with the principles of the Declaration of Helsinki and the International Council on Harmonization Guidelines for Good Clinical Practice. The Jimma University Institution Review Board (IRB) granted ethical clearance and approval, and the JMC clinical director office was given a letter of authorization. The pediatric unit received a letter from the JUMC clinical director office. By employing identification numbers rather than patient names, confidentiality was guaranteed. A patient's parent or legal guardian gave their consent.

## Operational Definitions and Definitions of Terms

### Antibiotics

Are substances produced by microorganisms and used to treat bacterial infections by killing or inhibiting their growth.

## Drug Use Evaluation

Is a performance improvement method that focuses on evaluating and improving drug use processes to achieve optimal patient outcomes.

## Rational Use of Drugs

Is the process of prescribing right drug for right patient at right time, frequency and for right duration of time as well as correct dispensing and correct use of the drug by the patient.

## Empirical Treatment

Is an administration of drugs without an identification of causative agent.

## Prophylactic Treatment

Administration of drugs to prevent possible infection before its occurrence.

## Neonate

New born especially less than one month of age.

## Pediatrics

The branch of medicine concerned with the care and development of children and with the prevention and treatment of children's diseases.

## Antibiotics Utilization

Is using of the antimicrobial for treatment of bacterial infections.

# Results

## Baseline and Clinical Characteristics of Study Participants

From a total of 6100 pediatric patients visited the pediatric ward of JUM during study period, 402 patients received systemic antibiotics and included to the final analysis. The average antibiotics prescribed per patient was  $1.62 \pm 0.45$ . Most 132 (32.83%) of them were in the age range of 1–5 years. Most (72.33%) of patients' were prescribed with monotherapy antibiotics. Majority 285 (70.89%) of patients stays in hospital for greater than seven days, 288 (71.64%) patients were from rural areas. In more than two thirds of the cases, antibiotic prescriptions were ordered by medical interns (Table 1).

## Primary Infectious Condition and Comorbidities

From a total of 485 primary infectious conditions for which an antibiotic were prescribed, 162 (33.4%) accounted for meningitis and 137 (28.24%) for lower respiratory tract infection. About 3.3% of study participants used antibiotics for unknown infections (Table 2).

## Antibiotics Consumption

Among all pediatrics medical records containing antimicrobials, gentamycin 116 (24.11%), was the most commonly used antimicrobial followed by pencillin G 87 (18.1%), ampicillin 82 (17%), ceftriaxone 73 (15.17%) (Table 3). From the 184 combination antibiotic prescriptions, ampicillin with gentamicin 66 (43.3%) and ceftriaxone with gentamycin 33 (17.93%) was more widely prescribed antibiotics, while ceftriaxone with ampicillin 3 (1.63%) and ceftriaxone with gentamycin with cloxacillin 3 (1.63%) was the least commonly used antibiotics combination in the study area (Table 4).

Considering the route of drug administration, out of the 665 total number of antimicrobial drugs, the parenteral route contributed the highest, 523 (78.65%) followed by oral (PO) 142 (21.35%) (Table 5). A higher proportion of participants 149 (22.41%) encountered inappropriate use of antibiotics due to inappropriate frequency followed by inappropriate dose 130 (19.55%) and indication 129 (19.4%). The overall inappropriate use of antibiotics was 19.29% (Table 6).

**Table 1** Study Participants' Baseline Characteristics and Other Related Information at the JUMC Pediatric Ward from November 1, 2021 to April 30, 2021

Variables		Frequency	Percentage
Age	<1 month	91	22.63
	1 month–1 year (infant)	109	27.11
	1–5 years	132	32.83
	6–18 years	70	17.41
Duration of hospital stay (days)	≤7 days	107	26.62
	>7 days	285	70.89
Sex	Male	222	55.22
	Female	180	44.78
Antibiotic treatment days	≤7 days	175	43.53
	>7 days	227	56.47
Number of antibiotics prescribed	Monotherapy	481	72.33
	Dual antibiotics	115	17.3
	Three antibiotics	69	10.37
Prescriber	Medical intern	340	51.13
	Senior	64	9.6
	Resident	261	39.27
Treatment type	Empirical treatment	351	60.41
	Kinetic/definitive treatment	135	23.23
	Prophylactic treatment	95	16.35
Residence	Urban	114	28.36
	Rural	288	71.64
Weight (kg)	<4.9	63	15.67
	5–9.9	156	38.8
	10–14.9	71	17.66
	15–19.9	48	11.94
	>20	64	15.92

## Predictors of Inappropriate Use of Antibiotics

In crude analysis using binary logistic regression: duration of hospital stay >7 days, antibiotic treatment duration >7 days, number of antibiotics prescribed  $\geq 2$ , empirical treatment and prophylactic treatment types were found to predispose a pediatric for inappropriate antibiotic use with statistically significant association. Independent predictors for encountered inappropriate use of antibiotics were identified using multivariate logistic regression, Duration of hospital stay (day) >7 days (AOR; 2.45, 95%CI: 2.32–5.34,  $P=0.03$ ), antibiotic treatment duration >7 days (AOR; 2.54, 95%CI: 4.34–6.54,  $P=0.02$ ), number of antibiotics prescribed  $\geq 2$  (AOR: 3.12, 95%CI: 6.32–13.37,  $P=0.01$ ), empirical treatment types (AOR; 2.65, 95%CI: 4.23–8.87,  $P=0.02$ ) were found to be independent predictors of inappropriate antibiotic use.

**Table 2** Primary Infectious Conditions for which Antibiotics were Prescribed at Pediatric Ward of JUMC from November 1, 2021 to April 30, 2021 (N=485)

Disease/Disorder Type	Frequency	Percentage
Meningitis	162	33.4
Lower respiratory tract infection	137	28.24
Severe pneumonia	81	16.7
Severe acute malnutrition	77	15.86
Late onset neonatal sepsis	42	8.66
Early onset neonatal sepsis	29	5.97
Skin and soft tissue infection	22	4.53
Unknown	16	3.3
Total	485	100

**Table 3** Most Commonly Prescribed Individual Antibiotics at the Pediatric Ward of JUMC from November 1, 2021 to April 30, 2021 (N=481)

Antimicrobial Agents	Frequency	Percentage
Gentamycin	116	24.11
Penicillin G	87	18.1
Ampicillin	82	17
Ceftriaxone	73	15.17
Cloxacillin	58	12.06
Chloramphenicol	53	11.02
Metronidazole	39	8.1
Amoxicillin	29	6.02
Ceftazidime	24	4.98
Azithromycin	10	2.01
Total	481	100

According to our finding pediatric patients who stay in hospital >7 days are 2.45 (AOR; 2.45, 95%CI: 2.32–5.34) times at risk for inappropriate antibiotic use than those stay in hospital <7 days, pediatric patients prescribed antibiotics  $\geq 2$  are 3.12 (AOR: 3.12, 95%CI: 6.32–13.37) times likely to encounter inappropriate antibiotic use than those with monotherapy. Pediatric patients prescribed empirical treatment types were 2.65 (AOR; 2.65, 95%CI: 4.23–8.87,  $P=0.02$ ) times likely to encounter inappropriate antibiotic use than those prescribed kinetic/definitive treatment (Table 7).

**Table 4** Most Commonly Prescribed Combination Antibiotics at the Pediatric Ward of JUMC from November 1, 2021 to April 30, 2021 (N=184)

Antimicrobial Combinations	Frequency	Percentage
Ampicillin+gentamycin	66	43.33
Ceftriaxone+gentamycin	33	17.93
C.pencillin G+chloramphenicol	25	13.9
Ampicillin+gentamycin+metronidazole	23	12.5
Ceftriaxone+metronidazole	18	9.7
Ampicillin+gentamycin+metronidazole	13	2.85
Ceftriaxone+ampicillin	3	1.63
Ceftriaxone+gentamycin+cloxacillin	3	1.63
Total	184	100

**Table 5** Route of Drug Administration Among Pediatric Patient of JUMC Pediatric Ward from November 1, 2021 to April 30, 2021 (N=665)

Route	Frequency	Percentage
Parenteral (IV, IM)	523	78.65
PO	142	21.35
Total	665	100

**Table 6** Appropriateness of Dosage Regimen of Overall Antibiotics Prescribed at the Pediatric Ward of JUMC from November 1, 2021 to April 30, 2021 (N=665)

Parameters	Antibiotic Regimen	Number	Percentage
Dose	Appropriate	535	80.45
	Inappropriate	130	19.55
Frequency	Appropriate	516	77.59
	Inappropriate	149	22.41
Duration	Appropriate	540	81.2
	Inappropriate	125	18.8
Treatment	Appropriate	536	80.6
	Unnecessary antibiotic	129	19.4

**Table 7** Factors Associated with Inappropriate Use of Antibiotics Using Binary Logistic Regression at the Pediatric Ward of JUMC from November 1, 2021 to April 30, 2021

Variables		Appropriateness		COR (95%CI)	P-value	AOR (95%CI)	P-value
		Yes	No				
Age	<1 month	51	49	1	0.55		
	1 month–1 year (infant)	61	46	0.34 (1.23–2.45)	0.76		
	1–5 years	98	34	0.65 (2.43–5.23)	0.75		
	6–18 years	50	20	0.54 (3.21–6.23)	0.45		
Duration of hospital stay (days)	≤7 days	72	45	1	0.24	1	0.03
	>7 days	217	68	2.45 (2.32–5.34)	0.05	2.21 (2.32–7.64)	
Sex	Male	153	69	0.12 (2.56–4.87)	0.78		
	Female	132	48	1			
Antibiotic treatment days	≤7 days	127	48	1	0.23	1	0.02
	>7 days	130	97	2.23 (3.34–5.54)	0.03	2.54 (4.34–6.54)	
Number of antibiotics prescribed	1	332	149	1	0.084	1	0.01
	≥2	115	69	2.37 (5.32–12.65)	0.02	3.12 (6.32–13.37)	
Prescriber	Medical intern	288	52	1	0.26		
	Senior	44	20	0.84 (2.65–5.63)	0.45		
	Resident	188	73	1.32 (4.32–7.82)	0.74	1	
Treatment type	Kinetic/definitive treatment	88	47	1	0.24	1	0.34
	Empirical treatment	299	52	2.21 (3.42–6.84)	0.02	2.65 (4.23–8.87)	0.04
	Prophylactic treatment	55	40	0.91 (4.62–7.74)	0.17	3.12 (6.32–10.23)	0.08
Residence	Urban	74	40	1	0.64		
	Rural	231	57	0.45 (2.32–6.73)	0.72		
Weight (kg)	<4.9	42	21	1	0.84		
	5–9.9	108	48	1.23 (2.76–5.63)	0.52		
	10–14.9	40	31	0.93 (3.21–5.65)	0.63		
	15–19.9	25	23	0.32 (2.73–6.74)	0.74		
	>20	38	26	0.84 (1.74–4.54)	0.73		

## Discussion

Monitoring antibiotic usage is crucial for enhancing the efficacy of antibiotic use. It is crucial in establishing the justification for using antibiotics. The highest incidences of AMR are found in nations with the highest per capita antibiotic use.<sup>31</sup> Drug consumption studies have always been helpful in highlighting the issue and the risks of frequently prescription antimicrobial drugs. This problem is prevalent throughout the world. To better understand the connection between the use of antibacterial medications and the emergence of bacterial resistance, numerous groups have urged that antibacterial drug use at the institutional and governmental levels be tracked.<sup>32</sup>

Antibiotics are strong and effective medicines which are used to treat most different bacterial infections and are among the most commonly prescribed drugs in the pediatric department. According to this study, the average antibiotics prescribed per patient was  $1.62 \pm 0.45$ , which is nearly approachable with a study done in Saudi Arabia, which showed 2.12 antibiotics prescribed per patient,<sup>27</sup> lower than that reported from Nigeria where antibiotics prescribed per patient were  $4.54 \pm 1.71$ ,<sup>18</sup> but higher than a report from Turkey (1.54).<sup>21</sup> This difference might be due to study setting, study design, the sample size, type, and geographical location of the hospital, different infection prevention strategy, and antibiotic use policy between our country and the aforementioned countries.

In our study, the common reasons for antibiotic prescription were, meningitis followed by lower respiratory tract infection, and severe pneumonia which were in line with studies done in northern and North East Ethiopia where the most common diagnosis was pneumonia and severe pneumonia, respectively.<sup>6,30</sup> This is in contrast to a study from Saudi Arabia which explored that gastroenteritis was the most common reason for antibiotic prescriptions.<sup>27</sup> This discrepancy might be due to the difference in the study design, study area, and time period during which these studies were conducted.

The most frequently prescribed individual antimicrobial agents were gentamycin followed by crystalline penicillin and ampicillin which is similar to a study done in northern Ethiopia.<sup>38</sup> This was different from a study done in Indonesia,<sup>23</sup> which showed that cefotaxime, amoxicillin, and ampicillin were the most frequently prescribed antibiotics, and a study in India<sup>20</sup> indicated that the most frequently prescribed individual antimicrobial drugs were cefotaxim, ceftriaxone, cefpodoxime, cefaclor. This difference might be due to availability of that drug in the facility, the difference in the indications, differences in the types of infections that are prevalent, antibiotics selection based on the sensitivity of the responsible pathogens unlike our case in which most of them were selected empirically.

The most frequently prescribed combined antimicrobials were ampicillin+gentamycin followed by ceftriaxone+gentamycin, which is similar with study done in another part of Ethiopia, which explored that the most commonly prescribed multiple drugs were ampicillin+gentamicin followed by ceftriaxone+gentamicin.<sup>29</sup> This was different from Study done in Indonesia which indicated that the most frequently prescribed multiple antimicrobials were ampicillin+chloramphenicol followed by cefotaxime+amikacin and cefotaxime+cotrimoxazole.<sup>24</sup> This difference might be due to the availability of drug within study area. The majority of antimicrobials were prescribed by parenteral 523 (78.65%). This was similar with study done in northern Ethiopia which showed most of (71.8%) the drugs were administered through parenteral route.<sup>38</sup> This result was higher than WHO standards (13.4–24.1).<sup>33</sup> A report from the University of Gondar indicated that the proportion of drugs given by injections was 6.3%.<sup>34</sup> The discrepancy could be due to a focus of the study to outpatient pharmacy, while the result of our study represents inpatient pediatric wards.

The overall inappropriate use of antibiotics was 19.29%. A higher proportion of participants 149 (22.41%) encountered inappropriate use of antibiotics due to inappropriate frequency, followed by inappropriate dose 130 (19.55%), and indication 129 (19.4%). This was in line with study done in Nekemte which showed inappropriate dose, frequency, and duration was the commonly observed inappropriate antibiotic use.<sup>16</sup> In contrast to this, a study done in Turkey showed that the rate of inappropriate antibiotic use was 33.8%, Unnecessary antibiotic prescription was the most common cause for inappropriate antibiotic use (51.9%), followed by unnecessary multiple antibiotic use (29.6%), inaccurate dosing (11.1%), use of broader spectrum than required (7.4%), and use of antibiotics with narrower spectrum than needed (3.7%).<sup>30</sup> This difference might be due to the professional knowledge, skills, integrity to their works, and also unavailability of first-line drugs.

According to our finding pediatric patients stay in hospital >7 days are 2.45 (AOR; 2.45, 95%CI: 2.32–5.34) times at risk for Inappropriate antibiotics use than those stay in hospital <7 days. Pediatric patients prescribed antibiotics  $\geq 2$  are 3.12 (AOR: 3.12, 95%CI: 6.32–13.37) times likely to encounter Inappropriate antibiotics use than those with monotherapy. It is in line with earlier findings done in Nigeria.<sup>18</sup> This study also revealed that Pediatric patients prescribed empirical treatment types were 2.65 (AOR; 2.65, 95%CI: 4.23–8.87,  $P=0.02$ ) times likely to encounter inappropriate antibiotics use than those prescribed definitive treatment. This finding was different from study done in North Ethiopia, which showed that advanced age was the independent predictors of inappropriate drug use.

## Conclusion

Inappropriateness of antibiotics use was high in our setting. Longer hospital stay, antibiotics prescription  $\geq 2$ , empirical treatment types was the independent determinant of inappropriate drug use.

## Abbreviations

ADRs, adverse drug reactions; AGE, acute gastroenteritis; AMA, antimicrobial agent; EDL, essential drug list; JUMC, Jimma University Medical Center; SPSS, Statistical Packages for Social Sciences.

## Data Sharing Statement

Readers who require data and materials of the current study can communicate and get from the corresponding author with a reasonable request.

## Acknowledgments

Jimma University is greatly acknowledged for the financial support of the study. The authors are grateful to the study participants for taking their time to provide information. Data collectors are also appreciated for their immense contributions.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

## Funding

This research was funded by Jimma University Institute of Health. The funding body had no role in the design of the study, data collection, and analysis, interpretation of data and in writing the manuscript.

## Disclosure

The authors report no conflicts of interest in this work.

---

## References

1. World health organization (WHO). Fact sheets, antimicrobial resistance; 2020. Available from: <https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance>. Accessed October 5, 2021.
2. CDC. Antibiotic/antimicrobial resistance (AR/AMR); 2020. Available from: <https://www.cdc.gov/drugresistance/about.html>. Accessed March 5, 2021.
3. Michael CA, Dominey-Howes D, Labbate M. The antimicrobial resistance crisis: causes, consequences, and management. *Front Public Heal.* 2014;2:1–8. doi:10.3389/fpubh.2014.00145
4. Dadgostar P. Antimicrobial resistance: implications and costs. *Infect Drug Resist.* 2019;12:3903–3910. doi:10.2147/IDR.S234610
5. Wang W, Arshad MI, Khurshid M, et al. Antibiotic resistance: a rundown of a global crisis. *Infect Drug Resist.* 2018;11:1645–1658. doi:10.2147/IDR.S173867
6. Klein EY, Van Boeckel TP, Martinez EM, et al. Global increase and geographic convergence in antibiotic consumption between 2000 and 2015. *Proc Natl Acad Sci U S A.* 2018;115(15):E3463–E3470. doi:10.1073/pnas.1717295115
7. Pokharel S, Raut S, Adhikari B. Tackling antimicrobial resistance in low-income and middle-income countries. *BMJ Glob Heal.* 2019;4(6):4–6. doi:10.1136/bmjgh-2019-002104
8. CDC. *Antibiotic Resistance Threats in the United States, 2019*. Washington, DC: US Department of Health and Human Services; 2019.
9. Muhie OA. Antibiotic use and resistance pattern in Ethiopia: systematic review and meta-analysis. *Int J Microbiol.* 2019;2019. doi:10.1155/2019/2489063
10. Tsegaye A, Mulubrahan A, Enkosilassie M, Mengistu H. The burden of antimicrobial resistance at tertiary care hospital, southern Ethiopia: a three years' retrospective study. *BMC Infect Dis.* 2019;1:6–13.
11. Ethiopia. Strategy for the prevention and containment of antimicrobial resistance for Ethiopia. World Health Organization (WHO). <https://www.who.int/publications/m/item/ethiopia>. Accessed March 2, 2021.
12. Gerba H. Ethiopian food, medicine and healthcare administration and control authority; 2018. Available from: [http://www.nifds.go.kr/brd/m\\_95/down.do?brd\\_id=board\\_mfds\\_411&seq=30934&data\\_tp=A&file\\_seq=4](http://www.nifds.go.kr/brd/m_95/down.do?brd_id=board_mfds_411&seq=30934&data_tp=A&file_seq=4). Accessed August 23, 2022.
13. FMHACA. A practical guide to antimicrobial stewardship program in Ethiopian hospitals; 2018. Available from: <https://www.ghsupplychain.org/sites/default/files/2019-03>. Accessed August 23, 2022.
14. Gebretekle GB, Mariam DH, Abebe W, et al. Opportunities and barriers to implementing antibiotic stewardship in low and middle-income countries: lessons from a mixed-methods study in a tertiary care hospital in Ethiopia. *PLoS One.* 2018;13(12):1–15. doi:10.1371/journal.pone.0208447
15. Narayan DS, Mangesh MMA. Study of prescription pattern of antibiotics in paediatric in patients at a tertiary care hospital in central India. *Int J Pharmacol Res.* 2016;6(8):2277–3312.

16. Asefa L, Bayissa G, Abera Z. Antibiotics use evaluation for pediatrics at nekemte referral hospital East Wollega Zone, Oromia Region, West Ethiopia. *World J Med Sci.* 2016;13(1):17–26.
17. Choudhury DK, Bezbaruah BK. Antibiotic prescriptions pattern in pediatrics in-patient department Gauhati medical college and hospital, Guwahati. *J Appl Pharm Sci.* 2013;3(8):144–148.
18. Shivaleela J, Revankar S, Vedavathi H, et al. A study of prescription pattern of antibiotics in pediatric in-patients of mc-gann teaching hospital Shivamogga Institute of Medical Sciences (SIMS), Shivamogga, Karnataka. *Age.* 2014;4(1):32–33.
19. Bonniface M, Nambatya W, Rajab K. An evaluation of antibiotic prescribing practices in a rural refugee settlement district in Uganda. *Antibiotics.* 2021;10(2):172. doi:10.3390/antibiotics10020172
20. Shamshy K, Mufida Begum I, Perumal P. Drug utilization of antimicrobial drug in pediatrics population in a tertiary care hospital in Erode, Tamilnadu, India. *Int J Pharmtech Res.* 2011;3(3):1530–1536.
21. Anong DN, Akoachere J-FK. Prescribing patterns and associated factors of antibiotic prescription in primary health care facilities of Kumbo East and Kumbo West Health Districts, North West Cameroon. *PLoS One.* 2018;13:e0196861.
22. Frieden T. Antibiotic resistance threats in the United States. *Centers Dis Control Prev.* 2013;12(1):136–141.
23. Amin H, Abdoerrachman H, Akib A. Antibiotic profile in pediatric wards, department of child health, ciptomangunkusumo hospital. *PaediatricIndonesiana.* 2014;44:3–4.
24. Nebyu Daniel A, Berhe YH, Kaushik A. Assessment of inpatient antibiotic use in halibet national referral hospital using WHO indicators: a retrospective study. *BMC Res Notes.* 2018;11:904. doi:10.1186/s13104-018-4000-7
25. Mezgebe HB, Tadesse B, Legesse B. Antibiotics prescribing pattern in pediatric unit of Ayder referral hospital Tigray Region, Northern Ethiopia. *J Sci Innov Res.* 2015;4(2):57–60. doi:10.31254/jsir.2015.4202
26. Venkateswaramurthy N, Murali R, Sampathkumar R. the study of drug utilization pattern in pediatric patients. *Int J Pharm Pharm Sci.* 2012;5(3):140–144.
27. Alakhali K, Shaik Mohammad A. Prescribing pattern of antibiotics in pediatric patients in the Jazan Region, Kingdom of Saudi Arabia. *RGUHS J Pharm Sci.* 2014;4(3):120–124. doi:10.5530/tjps.2014.3.6
28. Chaitanya Kumar T, Pappachan B, John A, et al. study on prescribing pattern and utilization of antibiotics in inpatients of the medicine department of a tertiary care teaching hospital, davangere, Karnataka, Indo. *Am J Pharmacol Res.* 2015;5:12.
29. Alemnew G, Asared S. assessment of the pattern of antibiotics use in pediatrics ward of dessie referral hospital, north east Ethiopia. *Int J Med Medical Sci.* 2015;7(11):1–7. doi:10.5897/IJMMS2014.1101
30. Ergül B, Gökçek İ, Çelik T, Altuner Torun Y. Assessment of inappropriate antibiotic use in pediatric patients: point-prevalence study. *Turk Pediatri Ars.* 2018;53:17–23. doi:10.5152/TurkPediatriArs.2018.5644
31. Patel S, Shah A, Shah R, et al. Evaluation of drug utilization pattern of antimicrobials using ATC/DDD system in intensive care unit of a tertiary-care teaching hospital. *Int J Med Sci Public Health.* 2016;5(1):2–6. doi:10.5455/ijmsph.2016.08112015189
32. Azizi H, Kabir K, Farrokhi B, et al. Pattern and determinants of antibiotic mal-prescribing among family physicians in the primary health care facilities in Iran; 2019.
33. World Health Organization. How to investigate drug use in health facilities: selected drug use indicators. World Health Organization; 1993, [https://apps.who.int/iris/bitstream/handle/10665/60519/WHO\\_DAP\\_93.1.pdf](https://apps.who.int/iris/bitstream/handle/10665/60519/WHO_DAP_93.1.pdf). Accessed October 12, 2021.
34. Gebretsadiq Z, Gebrehans M, Getnet D, Gebrie D, Alema T, Belay YB. Assessment of drug-drug interaction in ayder comprehensive specialized hospital, Mekelle, Northern Ethiopia: a retrospective study. *Biomed Res Int.* 2017;2017:6. doi:10.1155/2017/9792363
35. World Health Organization. Food, medicine and healthcare administration and control authority of Ethiopia, national essential medicine list fifth edition. [https://www.who.int/selection\\_medicines/country\\_lists/EML\\_5th\\_edition\\_2015.pdf?ua](https://www.who.int/selection_medicines/country_lists/EML_5th_edition_2015.pdf?ua). Accessed November 13, 2018.
36. World Health Organization. Pocket book of hospital care for children; guidelines for the management of common childhood illness- 2nd ed. [https://www.who.int/maternal\\_child\\_adolescent/documents/child\\_hospital\\_care/en/](https://www.who.int/maternal_child_adolescent/documents/child_hospital_care/en/). Accessed November 25, 2021.
37. Standard treatment guideline for general hospitals in Ethiopia-4th edition. <http://www.fmhaca.gov.et/wp-content/uploads/2014/03/STGGeneral-Hospital.pdf>. Accessed November 26, 2021.
38. Adane Y, Chernet T, Abere TB, Desalegn GD. Appropriateness and pattern of antibiotic prescription in pediatric patients at Adigart General Hospital, Tigray, Ethiopia. *Biomed Res Int.* 2021;6640892:7. doi:10.1155/2021/6640892

## Infection and Drug Resistance

Dovepress

### Publish your work in this journal

Infection and Drug Resistance is an international, peer-reviewed open-access journal that focuses on the optimal treatment of infection (bacterial, fungal and viral) and the development and institution of preventive strategies to minimize the development and spread of resistance. The journal is specifically concerned with the epidemiology of antibiotic resistance and the mechanisms of resistance development and diffusion in both hospitals and the community. The manuscript management system is completely online and includes a very quick and fair peer-review system, which is all easy to use. Visit <http://www.dovepress.com/testimonials.php> to read real quotes from published authors.

Submit your manuscript here: <https://www.dovepress.com/infection-and-drug-resistance-journal>