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Drug Utilization Review of Antibiotics in Geriatric Outpatients at Cilacap Regional General Hospital During the COVID-19 Pandemic

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ABSTRAK

Penyakit infeksi merupakan tantangan bagi geriatri karena risiko infeksi yang lebih tinggi dan gejala yang tidak khas, yang menyebabkan ketidakpastian diagnosis. Penelitian ini bertujuan untuk mengevaluasi pola penggunaan antibiotik pada pasien rawat jalan geriatri di Rumah Sakit Umum Daerah Cilacap, Indonesia, selama pandemi COVID-19. Studi retrospektif dilakukan dengan menganalisis rekam medis elektronik pasien rawat jalan geriatri yang menerima antibiotik dari Januari-Desember 2021. Data yang dikumpulkan meliputi karakteristik demografis, jenis antibiotik berdasarkan klasifikasi AWaRe, rute pemberian, kode ICD-10, dan pola penggunaan antibiotik. Hasil penelitian menunjukkan bahwa kelompok usia 65–69 tahun merupakan pengguna antibiotik terbanyak, dengan bentuk sediaan yang paling umum adalah sediaan oral padat. Sebagian besar antibiotik yang diresepkan termasuk dalam kategori Watch, seperti sefiksim dan levofloksasin, dengan diagnosis terbanyak berdasarkan kode ICD-10 adalah Z098. Hasil tersebut menunjukkan adanya kecenderungan penggunaan antibiotik spektrum luas yang berisiko meningkatkan resistensi antibiotik. Oleh karena itu, diperlukan intervensi berupa pengawasan penggunaan antibiotik yang lebih ketat serta edukasi berkelanjutan untuk meningkatkan rasionalitas penggunaan antibiotik pada populasi geriatri.

Kata kunci: *antibiotik; COVID-19; penggunaan obat; geriatri; Indonesia*

ABSTRACT

Infectious diseases are challenging for the geriatric due to higher infection risk and atypical symptoms, leading to more diagnostic uncertainty. This study aimed to evaluate antibiotic use patterns among geriatric outpatients at Cilacap Regional General Hospital in Indonesia during the COVID-19 pandemic. A retrospective study analyzed electronic medical records of geriatric outpatients who received antibiotics from January to December 2021. Data collected included demographic characteristics, types of antibiotics based on the AWaRe classification, route of administration, ICD-10 codes, and antibiotic use. The results showed that the age group of 65–69 years was the most frequent user of antibiotics, with solid oral formulations being the most commonly prescribed. Most antibiotics prescribed belonged to the Watch category, such as cefixime and levofloxacin. The most common diagnosis based on ICD-10 codes was Z098. These findings indicate a tendency toward the use of broad-spectrum antibiotics, which poses a risk of increasing antibiotic resistance. Therefore, stricter antibiotic stewardship interventions and continuous education are necessary to improve the rational use of antibiotics in the geriatric population.

Keywords : *antibiotic; COVID-19; drug utilization; geriatrics; Indonesia*

INTRODUCTION

Antibiotic resistance presents a pervasive global crisis, contributing to an estimated 1.27 million fatalities worldwide in 2019 (Ranjbar & Alam, 2024). The Centers for Disease Control and Prevention (CDC) reports that the United States experiences two million cases of antibiotic-resistant bacterial infections each year, leading to over 35,000 deaths (Centers for Disease Control and Prevention, 2019). In Indonesia, antibiotic utilization demonstrates markedly high prevalence across various regions, with approximately 700,000 deaths attributed to antibiotic resistance (Kementerian Kesehatan Republik Indonesia, 2018).

The aging population's heightened risk of infectious diseases is caused by a compromised immune system, chronic comorbidities, and declining organ function (Farheen et al., 2021). This age group is particularly susceptible to various infections due to immunosenescence, the gradual decline in immune system function (Feehan et al., 2021). Both innate and adaptive immune responses are impacted by Immunosenescence (Feehan et al., 2021). Moreover, infections in older adults often present with atypical symptoms, increasing diagnostic uncertainty (Struyf et al., 2021).

Although Indonesia's geriatric population is increasing, there is limited research on antibiotic use among outpatients in this age group. In 2020, the global geriatric population numbered 727 million, and by 2050, it is projected to double to 1.5 billion (United Nations of Economic and Social Affairs Department, 2020). In Indonesia, the percentage of geriatric individuals has risen from 4.5% in 1971 to approximately 10.7 % in 2020, with projections indicating a further increase to 19.9% by 2045 (Badan Pusat Statistik Indonesia, 2021). Research data on antibiotic use in geriatrics are limited, with available data only from a few countries, such as the United States (Kabbani et al., 2018), India (Kotwani & Holloway, 2011), Arab Emirates (Menon et al., 2024), and Canada (Tan et al., 2017). However, studies about patterns and trends of antibiotic use in Indonesia are still a limited recent study only focus on outpatients but not specifically on geriatric. Furthermore, antibiotic use in the geriatric has only been reported in specific diseases, such as urinary tract infections (UTIs) (Kurniawati & Auliyanah, 2021), diabetes mellitus complications (Nurjanah et al., 2023), and pneumonia (Sitompul et al., 2022). The purpose of this study is to evaluate the antibiotic use patterns of geriatric outpatients at Cilacap Regional General Hospital in Indonesia during the COVID-19 pandemic. This study also seeks to identify potential areas for improving antibiotic stewardship and reducing the risk of antibiotic resistance in this vulnerable population.

METODE PENELITIAN

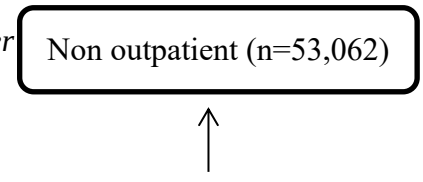
Study Design and Setting

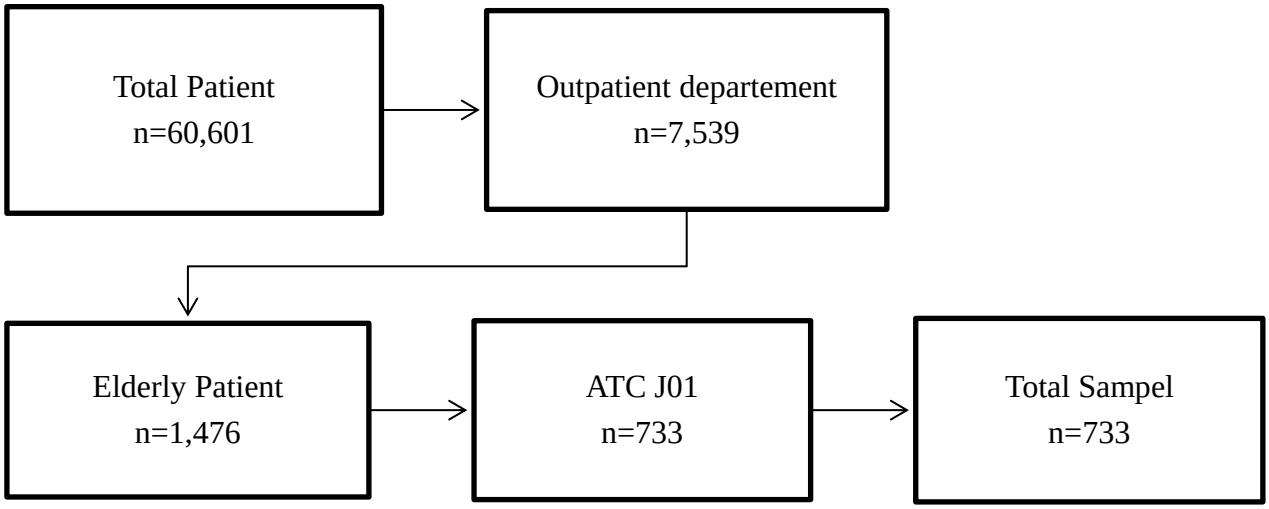
This retrospective observational study was conducted in the outpatient department of Cilacap Regional General Hospital in Cilacap Regency, Central Java, Indonesia, during the Covid 19 outbreak, from January 1st to December 31st, 2021. Cilacap Regional General Hospital is one of the biggest hospitals in Central Java, with 700-bed healthcare, serving as the primary healthcare provider for approximately 2 million people in the most populous district of Central Java. In 2021, nearly 60,000 patients received antibiotics at Cilacap Regional General Hospital, with a total of 7,539 entries from the outpatient department.

Data Sources

The data were sourced from the electronic medical records (e-MR) at Cilacap Regional General Hospital in Indonesia. Data extraction was carried out manually by pharmacy personnel. Information such as patient age, sex, entry date, department entry, and diagnostic information classified by ICD-10 (International Classification of Diseases 10th) code, as well as antibiotic details (name, dose, formulation, and route of administration), were collected. The study encompassed all patients aged 65 years who were prescribed antibiotics categorized by anatomical therapeutic chemical (ATC: J01) codes and entered the outpatient department between January 2021 to December 2021. Patients lacking complete electronic medical records were excluded from the analysis. The focus was on geriatric patients aged 65 years and older, with specific age subgroups, who were prescribed systemic antibiotics (WHO ATC: J01) treatment and had a recorded ICD Code **(Figure 1**).

Figure 1. Flowchart of the study participant





ATC= Anatomical Therapeutic Chemical; J01= Antibacterials for Systemic Use

Study Variables

The study variables comprise the total number of prescriptions issued, the type of antibiotic prescribed based on ICD-10, patients' age, sex, route of administration, antibiotic AWaRe classification, and seasonality by month of administrations. Antibiotic prescribing was categorized by age subgroup (65-69, 70-74, 75-79, and 80+), sex (male or female), route of administration (parenteral, liquid oral, and solid oral), and AWaRe classification ("Access, Watch, and Reserve"). Accepted antibiotics are perfect for common diseases because they have a restricted spectrum of activity, fewer side effects, less selection against antibiotic resistance, and lower prices. On the other hand, watch antibiotics have a higher risk of resistance and are usually used in hospital settings for serious diseases. Reserve antibiotics are a final choice for serious infections brought on by bacteria resistant to most drugs (WHO, 2024). Data were also categorized using the ICD-10 medical classification system, developed by WHO, and the ATC code J01 for systemic antibacterial, which is a therapeutic subgroup within the anatomical therapeutic chemical classification system (WHO, 2019).

Statistical Analysis

Descriptive statistical analysis was conducted using Microsoft Excel 2021. Data were presented in tables to illustrate distributions by age group, sex, diagnosis (ICD-10), formulation type, and AWaRe classification. A bar chart was used to visualize the top 10 most frequent diagnoses (ICD-10 codes) associated with antibiotic prescriptions. In addition, a separate table summarized the top 10 most frequently prescribed antibiotics. A line graph was also included to demonstrate seasonal variations in antibiotic use, capturing peak usage periods for different geriatric subgroups over the 12-month study period.

These visualizations were used to explore general prescribing trends. No inferential statistical tests (e.g., chi-square or logistic regression) were performed due to the descriptive nature of the study and

limitations in the available data, which restrict the ability to draw causal or statistically significant associations.

Methodological Limitations and Potential Bias

As a retrospective study, the analysis is limited by potential selection and information biases, due to reliance solely on existing EMR data. Clinical details such as treatment indication, comorbidities, or appropriateness of antibiotic use were not assessed. Furthermore, diagnoses were not clinically validated by treating physicians, introducing potential misclassification bias. The absence of inferential analysis also restricts the depth of statistical interpretation.

Ethical Considerations

The ethical approval was granted by the Health Research Ethics Committee of Universitas Harapan Bangsa No. B.LPPM-UHB/608/06/2014. The respondents provided written informed consent for participation in the survey. This research was conducted ethically in accordance with the World Medical Association Declaration of Helsinki.

RESULT AND DISCUSSION

The study encompassed 7,539 patients sourced from outpatient departments. The final study population of 733 patients exposed to systemic antibiotics is shown in the flowchart (**Figure 1**). The characteristics of antibiotic use among different age subgroups in the study population revealed several key findings in **Table 1.** The majority of patients receiving antibiotics were in the 65-69 age group, comprising 48.8% of the total, while the 80+ age group had the fewest patients, accounting for 8.6% of the total. Across all age groups, there was a higher proportion of male patients (58.4%) receiving antibiotics. Oral administration was the most common route, with 99.4% of antibiotic prescriptions being administered orally, and solid oral formulations were more commonly used than liquid oral formulations. According to AWaRe classification, the majority of prescribed antibiotics fell into the Watch Group (80.1%), indicating a higher potency and risk of resistance compared to Access Group antibiotics. Analysis of ICD-10 subgroups revealed that the most prevalent disease category was "Chapter XXI Factors influencing health status and contact with health services (Z00-Z99)" encompassing 72% of cases.

In contrast to previous studies, which primarily focused on inpatients or specific infectious diseases such as urinary tract infections (Kurniawati & Auliyanah, 2021) or pneumonia (Sitompul et al., 2022), this research uniquely explores overall antibiotic prescribing patterns among geriatric outpatients, independent of specific clinical diagnoses. Furthermore, this study incorporates the WHO AWaRe classification and examines seasonal variations in antibiotic use across different geriatric age subgroups, providing a more comprehensive perspective on antibiotic utilization in primary care settings.

Table 1. Characteristics Of Antibiotic Use

		Age subgroup				Total
		65-69 years	**70-74 years**	**75-79 years**	**80+ years**	
	N	**358(100%)**	**198(100%)**	**114(100%)**	**63(100%)**	**733(100%)**
Sex	Female	159(44.4%)	75 (37.9%)	39(34.2%)	32(50.8%)	305(41.6%)
	Male	199(55.6%)	123(62.1%)	75(65.8%)	31(49.2%)	428(58.4%)
Administration	Oral	356(99.4%)	195(98.5%)	112(98.2%)	63 (100%)	726 (99%)
	• Liq Oral	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

	• Solid Oral	356(99.4%)	195(98.5%)	112(98.2%)	63 (100%)	726 (99%)
	Parenteral	2 (0.6%)	3 (1.5%)	2 (1.8%)	0 (0%)	7 (1%)
Antibiotic AWaRe	Access	58 (16.2%)	35 (17.7%)	16 (14%)	9 (14.3%)	118(16.1%)
	Watch	286(79.9%)	155(78.3%)	94(82.5%)	52(82.5%)	587(80.1%)
	Reserved	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Not Listed	14 (3.9%)	8 (4%)	4 (3.5%)	2 (3.2%)	28 (3.8%)
ICD-10 Subgroups	Chapter I Certain infectious and parasitic diseases (A00-B99)	2 (0.6%)	1 (0.5%)	2 (1.8%)	2 (3.2%)	7 (1%)
	Chapter II Neoplasms (C00-D48)	3 (0.8%)	1 (0.5%)	0 (0%)	0 (0%)	4 (0.5%)
	Chapter IV Endocrine, nutritional and metabolic diseases (E00-E90)	4 (1.1%)	0 (0%)	0 (0%)	0 (0%)	4 (0.5%)
	Chapter IX Diseases of the circulatory system (I00-I99)	7 (2%)	2 (1%)	1 (0.9%)	0 (0%)	10 (1.4%)
	Chapter VII Diseases of the eye and adnexa (H00-H59)	36 (10.1%)	15 (7.6%)	14 (12.3%)	3 (4.8%)	68 (9.3%)
	Chapter VIII Diseases of the ear and mastoid process (H60-H95)	5 (1.4%)	6 (3%)	2 (1.8%)	1 (1.6%)	14 (1.9%)
	Chapter X Diseases of the respiratory system (J00-J99)	30 (8.4%)	18 (9.1%)	6 (5.3%)	6 (9.5%)	60 (8.2%)
	Chapter XI Diseases of the digestive system (K00-K93)	6 (1.7%)	3 (1.5%)	2 (1.8%)	1 (1.6%)	12 (1.6%)
	Chapter XII Diseases of the skin and subcutaneous tissue (L00-L99)	3 (0.8%)	0 (0%)	0 (0%)	4 (6.3%)	7 (1%)
	Chapter XIV Diseases of the genitourinary system (N00-N99)	4 (1.1%)	3 (1.5%)	0 (0%)	0 (0%)	7 (1%)
	Chapter XIX Injury, poisoning and certain other consequences of external causes (S00-T98)	2 (0.6%)	3 (1.5%)	0 (0%)	0 (0%)	5 (0.7%)

	Chapter XVIII Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (R00-R99)	3 (0.8%)	0 (0%)	0 (0%)	1 (1.6%)	4 (0.5%)
	Chapter XXI Factors influencing health status and contact with health services (Z00-Z99)	252(70.4%)	146(73.7%)	87 (76.3%)	43(68.3%)	528 (72%)
	Not Recorded	1 (0.3%)	0 (0%)	0 (0%)	2 (3.2%)	3 (0.4%)

In our study, the high utilization of antibiotics among geriatric patients, particularly those aged 65-69 years, is noteworthy in the context of life expectancy. Indonesia's geriatric population has a life expectancy of around 71.6 years (Badan Pusat Statistik Indonesia, 2021) with over 41% of the geriatric population in Indonesia experiencing health issues (Siahaan, 2024) and possibly being more susceptible to infections (Feehan et al., 2021). Our findings showed geriatric patients aged 65-69 tend to use more antibiotics due to various factors such as physiological changes, frequent hospital visits, and reduced immunity contributing to the higher antibiotic consumption observed. Physiological changes in this age group, such as alterations in drug absorption, distribution, metabolism, and excretion, impact antibiotic pharmacokinetics, potentially necessitating higher antibiotic consumption for efficacy (Butranova et al., 2023). Additionally, geriatrics often experience age-related physical decline, frequent hospital visits, and reduced immunity, making them more susceptible to infections and subsequent antibiotic treatments (Schramm et al., 2023). Previous research has indicated that geriatric individuals exhibit a per capita antibiotic consumption rate approximately 50% higher than that of younger adults, driven by factors including health status, polypharmacy, and hospitalization (Portero de la Cruz & Cebrino, 2020). Moreover, older patients encounter challenges in antibiotic treatment due to age-related alterations in pharmacokinetics and pharmacodynamics, complex polypharmacy regimens, and an increased susceptibility to adverse effects, necessitating meticulous consideration and monitoring of antibiotic usage (Green & Wright, 2020; Soraci et al., 2023). Previous studies have observed a high proportion of older patients (age ≥ 60 years) (Niu et al., 2020). In this study, most geriatric patients were under 75 years old, whereas research conducted in the Caribbean found that the majority of patients were over 75 years old (Ribeiro et al., 2022).

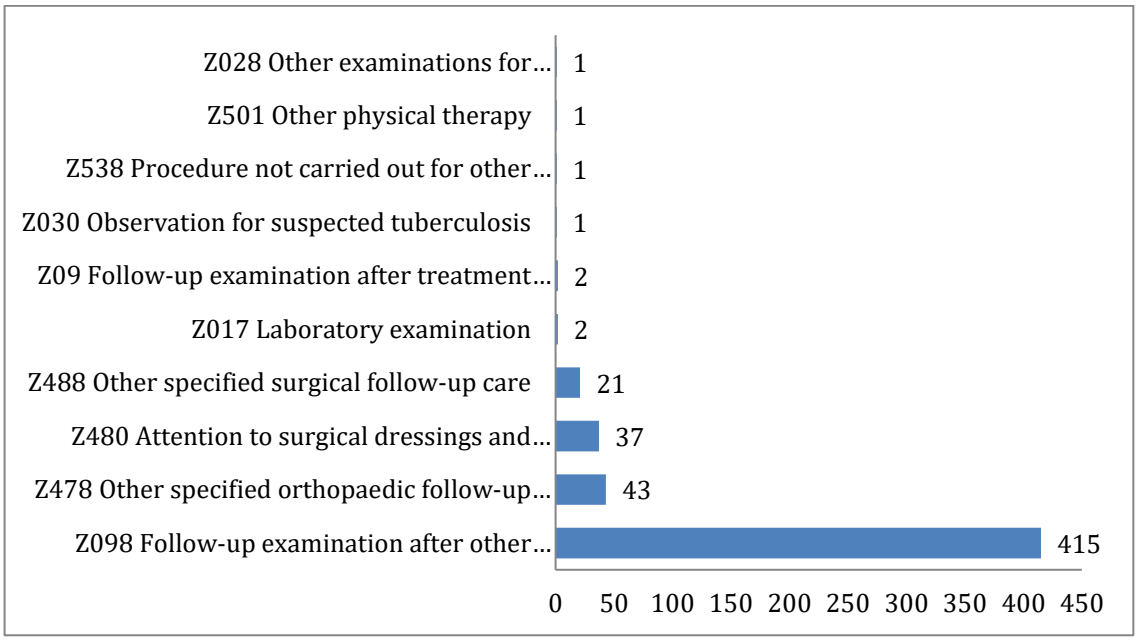
Males are the most frequently users antibiotics in geriatric patients in Indonesia. Men received more antibiotic prescriptions due to a higher prevalence of risk factors such as smoking (WHO, 2018). Smoking significantly contributes to high morbidity and mortality rates in Indonesia. A study conducted in 2015 revealed that 925,611 men (93.27%) and 66,719 women (6.93%) were hospitalized due to smoking-related illnesses, including hypertension (42.6%), chronic obstructive pulmonary disease (COPD) (40.2%), and stroke (12%), which accounted for 21.05% of all chronic diseases in the country (Kristina et al., 2018). Between 2007 and 2017, the mortality rates from smoking-related diseases like COPD rose by 29.2%, 29.0%, and 10.5%, respectively (Holipah et al., 2020). The proportion of Indonesian men smoking tobacco surged from 56.2% in 2000 to 76.2% in 2015 (Holipah et al., 2020). Moreover, Indonesia does not have comprehensive policies regarding the tobacco market and is one of the countries that have not signed the WHO Framework Convention on Tobacco Control (WHO FCTC) (WHO, 2017). In 2023, more than 21.7% of Indonesia's geriatric population continued to smoke daily, with over 2% having quit smoking. During the same year, over 41% of the senior

population in Indonesia encountered health issues (Siahaan, 2024). Taken together, these circumstances suggest that Indonesia significantly affects the worldwide occurrence of diseases linked to tobacco use, including an increased risk of infectious diseases.

Interestingly, our finding illustrates the predominant use of solid oral antibiotic formulations compared with liquid oral. This finding contrasts with the potential benefits of liquid formulations in facilitating improved adherence and suitability for patients with dysphagia or swallowing difficulties, which are common challenges in the geriatric population (Shariff et al., 2020). While liquid formulations can be easier for patients with swallowing difficulties to take, the high utilization of solid oral antibiotics in our study suggests that other factors may be influencing prescribing practices. Solid formulations are often more stable and have a longer shelf life compared to liquid formulations, making them easier to store and transport, which can be particularly important in outpatient settings. They are also generally easier to dose accurately, as they come in pre-measured tablets or capsules, reducing the risk of dosing errors. Moreover, solid formulations are often more cost-effective than liquid formulations, which can be particularly relevant for geriatric patients who may be on fixed incomes or have limited access to healthcare resources. Additionally, some patients may simply prefer the convenience and familiarity of swallowing a tablet or capsule over liquid formulations (Drumond & Stegemann, 2020).

Based on AWaRe classification, antibiotics in the "Watch" group were among the most commonly prescribed. These findings align with similar results reported in studies conducted across various countries (Adebisi et al., 2021; Tadesse et al., 2022), India (Mugada et al., 2021), Malaysia (Mohamad et al., 2022), Eastern Mediterranean countries (Jirjees et al., 2022), and Zambia (Kalungia et al., 2022; Mudenda et al., 2022). The rise in respiratory tract infections during the COVID-19 pandemic, many of which were initially suspected to be COVID-19, might explain these similarities (Andrews et al., 2021; Nguyen et al., 2022). Furthermore, the rise in the prescription of Watch group antibiotics (broad-spectrum antibiotics) can be attributed to concerns regarding the efficacy of Access group antibiotics, the availability of these medications, and patient demands and expectations (Gandra & Kotwani, 2019). Therefore, healthcare authorities should prioritize enhancing the accessibility of Access group antibiotics and decreasing the usage of Watch group antibiotics, which are linked to elevated rates of resistance (Bansal et al., 2022; Gandra & Kotwani, 2019; Yin et al., 2021).

Figure 2. Top 10 Diagnoses by ICD-10 Code for Patients Who Received Antibiotic



The top diagnoses for which patients received antibiotics in **Figure 2** indicate that these medications were commonly prescribed for post-treatment follow-up and care, particularly after orthopedic and surgical procedures. ICD code Z098 was the most frequent diagnosis, suggesting ongoing monitoring for various conditions. Other diagnoses, such as Z478 for orthopedic follow-up, possibly related to surgeries or injuries, and Z480 and Z488 for post-surgical care, were also relatively common, highlighting the role of antibiotics in post-surgical care.

The most common diagnosis category was "Chapter XXI Factors influencing health status and contact with health services (Z00-Z99)," primarily driven by follow-up examinations (ICD code Z098). This finding underscores the vulnerability of geriatric patients to infectious complications, necessitating frequent follow-up visits and antibiotic prescriptions (Cristina et al., 2021; Shrestha et al., 2023).

Table 2. Antibiotics Prescribed in Total Population

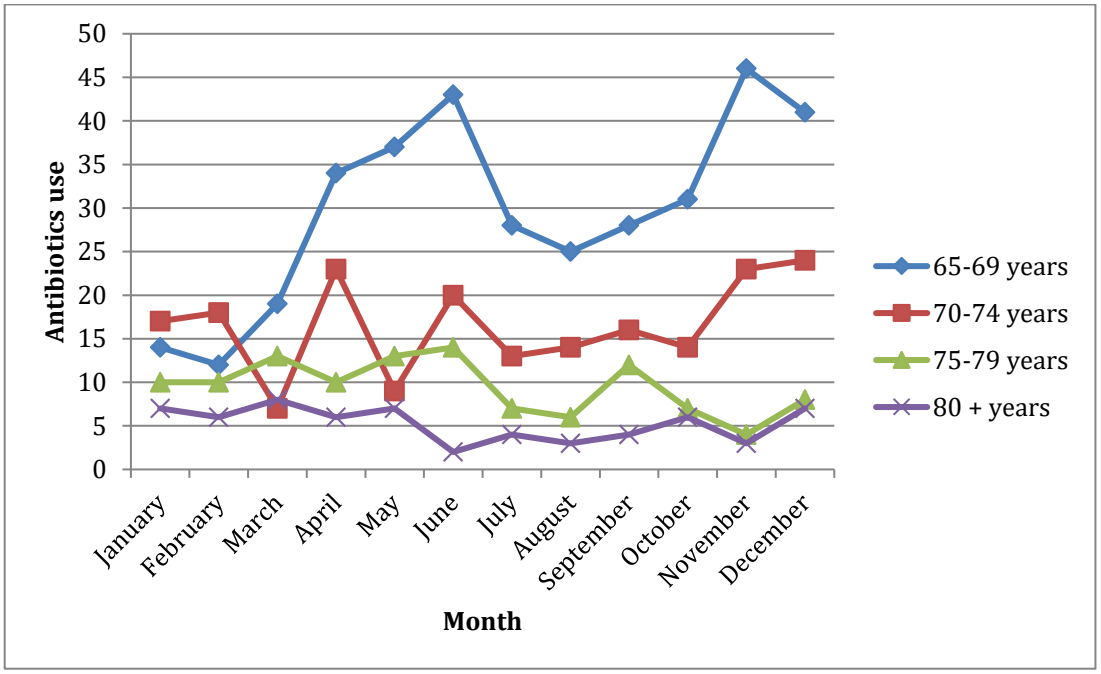
Antibiotic Subclass (ATC)	Age group				Total
	65-69 years	70-74 years	75-79 years	80+ years	
Cefixime (J01DD08)	121(33.8%)	59 (29.8	43(37.7%)	26(41.3%)	249 (34%)
Levofloxacin (J01MA12)	80 (22.3%)	42 (21.2%)	30(26.3%)	13(20.6%)	165(22.5%)
Azithromycin (J01FA10)	52 (14.5%)	37 (18.7%)	14(12.3%)	12 (19%)	115(15.7%)
Cefadroxil (J01DB05)	39 (10.9%)	17 (8.6%)	8 (7%)	6 (9.5%)	70 (9.5%)
Ciprofloxacin (J01MA02)	20 (5.6%)	7 (3.5%)	6 (5.3%)	0 (0%)	33 (4.5%)
Amoxicillin (J01CA04)	11 (3.1%)	7 (3.5%)	4 (3.5%)	2 (3.2%)	24 (3.3%)
Clindamycin (J01FF01)	8 (2.2%)	7 (3.5%)	7 (6.1%)	0 (0%)	22 (3%)
Ofloxacin (J01MA01)	9 (2.5%)	6 (3%)	0 (0%)	1 (1.6%)	16 (2.2%)
Sulfamethoxazole and trimethoprim (J01EE01)	7 (2%)	4 (2%)	0 (0%)	2 (3.2%)	13 (1.8%)
Amoxicillin and beta-lactamase inhibitor (J01CR02)	2 (0.6%)	6 (3%)	1 (0.9%)	1 (1.6%)	10 (1.4%)
Erythromycin (J01FA01)	2 (0.6%)	3 (1.5%)	1 (0.9%)	0 (0%)	6 (0.8%)
Doxycycline (J01AA02)	2 (0.6%)	1 (0.5%)	0 (0%)	0 (0%)	3 (0.4%)
Ceftriaxone (J01DD04)	2 (0.6%)	1 (0.5%)	0 (0%)	0 (0%)	3 (0.4%)
Phenoxymethylpenicillin (J01CE02)	2 (0.6%)	0 (0%)	0 (0%)	0 (0%)	2 (0.3%)
Tetracycline (J01AA07)	1 (0.3%)	1 (0.5%)	0 (0%)	0 (0%)	2 (0.3%)

The **Table 2** presents the distribution of antibiotic prescriptions across different age groups. Among the antibiotics prescribed, cefixime was the most frequently prescribed antibiotic in geriatric patient (34%) of all the antibiotics prescribed in 2021. The results also indicated that levofloxacin were the second most prescribed antibiotics (22.5%). Other antibiotics that were prescribed at much lower frequency were the tetracycline (0.3%) and phenoxymethylpenicillin (0.3%). The analysis of antibiotics prescribed in the total population reveals that a significant proportion of prescriptions are for broad-spectrum antibiotics. Cephalosporins such as cefixime, cefadroxil, and ceftriaxone, as well as fluoroquinolones including ofloxacin, ciprofloxacin, and levofloxacin, collectively account for more than half of all antibiotic prescriptions in 2021. The extensive range of bacteria that these antibiotics are known to target, including both gram-positive and gram-negative species, is attributed to their broad spectrum of activity.

Among all the antibiotics used, the most commonly used antibiotic was cefixime. Cefixime, a third-generation cephalosporin antibiotic, exhibits enhanced efficacy against Gram-negative bacteria compared to earlier generations of cephalosporins (Katzung, 2017). Cefixime is utilized for treating

respiratory infections and abdominal infections and is recommended as an alternative treatment for gonorrhea (Jensen & Unemo, 2024). Cefixime has been found to be safe in both adults and children, with a safety profile similar to other beta-lactam antibiotic agents (Shafi et al., 2024). Mild gastrointestinal disturbances, such as diarrhea, nausea, and vomiting, are often reported side effects (Karunarathna et al., 2024). In our study, levofloxacin was the second most common antibiotic used for the study population. Levofloxacin, a fluoroquinolone antibiotic, demonstrates broad-spectrum activity against both Gram-positive and Gram-negative bacteria (Alawkally et al., 2022; Owoade et al., 2018). Its efficacy extends to common respiratory pathogens, as demonstrated by its bactericidal action against clinical isolates such as *Escherichia coli, Klebsiella spp, Staphylococcus aureus,* and *Enterobacter spp* (She PengFei et al., 2019). Specifically in lower respiratory tract infections, the pharmacokinetics and pharmacodynamics of levofloxacin in lung tissues and bronchial mucosa support its clinical and microbiological efficacy, particularly against *Streptococcus pneumoniae* (Cao et al., 2020). The extensive use of fluoroquinolones can lead to various adverse effects. The U.S. Food and Drug Administration (FDA) has issued a boxed warning for fluoroquinolone antibiotics, cautioning that geriatric patients are at increased risk of severe side effects such as tendon rupture, delirium, peripheral neuropathy, blood sugar disturbances, and aortic dissection (U.S. Food and Drug Administration, 2018). Additionally, fluoroquinolones elevate the chance of contracting *Clostridioides difficile* infection (CDI) (Kabbani et al., 2018). Additionally, these antibiotics may extend the QT interval, which raises the possibility of arrhythmias of the torsades de pointes (TdP). type. Geriatric patients are especially susceptible to potentially fatal cardiac arrhythmias like TdP because they are more likely to have illnesses like heart failure and risk factors such uncorrected hypokalemia and hypomagnesemia (Stahlmann & Lode, 2010).

Figure 3. Seasonal Variations in Antibiotic Utilization Across Different Age Groups



The data presented in the **Figure 3** illustrates seasonal variations in antibiotic utilization across different age groups. Among individuals aged 65-69 years, the highest antibiotic use was observed in November, while the lowest use was observed in February. In the 70-74 age category, the highest peak of antibiotic use is December, with the lowest use in March. Geriatric patients 75-89 years showed the antibiotic use peaked in June and reached its nadir in November. Moreover, geriatric patients above 80 years demonstrated the highest antibiotic use in March, with the lowest use observed in June. These findings underscore different age-specific trends in antibiotic consumption throughout the year.

The observed seasonal variations in antibiotic prescription rates among different age groups of geriatric patients highlight the complex interplay of factors influencing antibiotic use during the COVID-19 pandemic. For patients aged 65-69, the peak in November (rainy season) may be attributed to the compounded effect of increased bacterial infections and healthcare-associated infections during the pandemic (Charave et al., 2020; Shuriqy, 2023). The peak in antibiotic prescriptions for patients aged 70-74 in December (rainy season) aligns with the emergence of the Omicron variant, suggesting that heightened COVID-19 cases may have led to increased empirical antibiotic use despite the lack of a proportional increase in mortality (Masrika et al., 2023). Patients aged 76-80 have a peak in June during the dry season, suggesting different pattern of infection dynamics, potentially related to higher bacterial infection rates necessitating empirical antibiotic treatment (Limato et al., 2022; Subagdja et al., 2022). March marks a peak in patients aged 80 and above during the rainy season, underscoring the enduring influence of the COVID-19 pandemic on bacterial infection rates and consequent antibiotic utilization (Subagdja et al., 2022; Suminar, 2022).

This study, while offering valuable insights into antibiotic use among geriatric outpatients during COVID-19, has some limitations. Firstly, its retrospective nature and reliance on electronic medical records introduce biases and may overlook incomplete data. Secondly, it was conducted in a single healthcare facility, limiting its generalizability. Thirdly, it only focuses on outpatient settings, overlooking inpatient data and transitions between care levels. Fourthly, it doesn't assess the appropriateness of antibiotic prescriptions or their clinical outcomes. Fifthly, it doesn't delve into factors influencing prescribing practices, like physician attitudes or patient preferences. Sixthly, it doesn't explicitly examine the impact of COVID-19 on antibiotic use. Lastly, it doesn't consider the economic implications of antibiotic prescribing. Despite these limitations, the study provides a foundational understanding of antibiotic use in geriatric outpatients during a critical period, paving the way for future research on improving antibiotic prescribing practices and patient outcomes in this vulnerable population.

CONCLUSION

This study described the prescribing patterns of systemic antibiotics in geriatric outpatients at Cilacap Regional General Hospital during the COVID-19 pandemic. The majority of prescriptions were given to patients aged 65–69 years, with a strong preference for solid oral dosage forms. Most antibiotics belonged to the Watch category, particularly cefixime and levofloxacin, indicating a reliance on broad-spectrum agents. Follow-up visits were the most common diagnosis associated with antibiotic use, and seasonal variations suggested peaks in prescribing during certain months across age subgroups.

These findings highlight potential overuse of high-resistance-risk antibiotics in elderly patients and underscore the need for improved prescribing practices in outpatient settings. Targeted antibiotic stewardship interventions, routine prescription monitoring, and prescriber education are recommended to promote more rational antibiotic use and reduce the risk of antibiotic resistance in this vulnerable population.

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