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Research Article

Analysis of Public Knowledge Related to Antibiotic Usage and Its Impact on Antibiotic Resistance

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ABSTRACT

Antimicrobial resistance (AMR) is a critical global health threat, exacerbated by inappropriate antibiotic use. This study aims to analyze the public knowledge level of antibiotics and their correlation with the prevalence of antibiotic-resistant bacteria in the city. This prospective, descriptive observational study, conducted in Bogor City from March to May 2025, analyzed antibiotic usage patterns and knowledge among 191 residents aged 17 years who had previously used antibiotics. The majority of respondents were female (88.5%) and homemakers (78.5%). A high prevalence of antibiotic use (95.8%) was reported, with amoxicillin being the most frequently used (82.2%). Notably, 2.1% of respondents mistakenly identified non-antibiotics. While doctors (60.7%) were the primary source of recommendation, some obtained antibiotics based on advice from neighbors (2.6%) or self-medication (1.6%). The average knowledge score was 62.3%, with 15.7% having low knowledge. Misconceptions existed, as only 69.1% correctly identified antibiotics' use for bacterial infections, and only 48.2% knew they don't treat inflammation. Concerning behaviors included purchasing antibiotics without a prescription (19.4%) and stopping prematurely due to symptom relief (17.3%). A significant positive correlation ($r=0.45, p<0.001$) was found between knowledge and rational behavior. This study underscores the need for targeted educational interventions in Bogor City to address knowledge gaps and reduce risky antibiotic use practices to combat AMR, especially antibiotic resistance. In conclusion, this study conducted in Bogor City between March and May 2025 revealed a high prevalence of prior antibiotic use among residents, alongside identified gaps in public knowledge regarding their appropriate application.

Keywords: antibiotic resistance; bacterial infection; descriptive observational study; inflammation; rational behavior

INTRODUCTION

Antimicrobial resistance (AMR) has emerged as a critical global health threat, with the World Health Organization (WHO) estimating that AMR was directly responsible for 1.27 million deaths in 2019 and contributed to 4.95 million deaths globally. Indonesia, as one of the world's most populous countries, faces significant challenges in combating AMR. Projections indicate that by 2030, Indonesia will be among the top five countries globally with the highest percentage increase in antimicrobial consumption. The classes of antimicrobial include antibacterial (antibiotic), antiparasitic, antiviral, and antifungal. Antibiotics are used to prevent, control, and treat infectious diseases in humans, animals, and plants. However, their effectiveness is decreasing due to the increasing number of bacteria that have become resistant to antibiotics (Kementerian Kesehatan RI, 2013; World Health Organization, 2024).

Deaths due to antimicrobial resistance currently reach 700,000 people per year and are predicted to reach 10 million people per year worldwide by 2050. The causes of antibiotic resistance from a health perspective range from the absence of indication in antibiotic use, inappropriate indication, inappropriate selection of antimicrobials, and inappropriate dosage (Biro Komunikasi dan Pelayanan Masyarakat, Kementerian Kesehatan RI, 2022; Mardiati et al., 2021; Badan Penelitian dan Pengembangan Kesehatan Kementerian Kesehatan RI, 2018; Tim Komunikasi WHO, 2022). The principle of antibiotic use is based on two main considerations: the cause of the infection and patient factors.

The most ideal antibiotic administration is based on the results of microbiological examination and microbial susceptibility testing. However, in daily practice, it is not possible to perform microbiological examinations for every patient suspected of having an infection. In addition, in cases of severe infection requiring immediate treatment, antibiotics can be started immediately after sampling biological material for culture and microbial susceptibility testing. Antibiotic administration without microbiological examination can be based on a doctor's physical examination.

Other considerations include the patient's condition related to kidney function, liver function, allergy history, resistance to infection (immunological status), drug resistance, severity of infection, ethnicity, age, concomitant medication use, patients with specific medical conditions such as pregnant or breastfeeding women, or those taking oral contraceptives (Kementerian Kesehatan RI, 2013; Siregar, 2004). Inappropriate use of antibiotics can trigger mutations in bacteria that are naturally resistant. Mutated bacteria make the use of existing types of antibiotics ineffective. As a result, the spread of disease becomes easier and more difficult to treat (Biro Komunikasi dan Pelayanan Masyarakat, Kementerian Kesehatan RI, 2022; Mardiati et al., 2021).

Efforts to overcome the issue of antibiotic resistance must be a shared priority, especially concerning the supervision of antibiotic consumption and use in the community, including among professional healthcare workers. Antibiotic prescriptions from healthcare professionals must be ensured to be evidence-based. Antibiotics should not be given freely. Healthcare professionals need to ensure that the diagnosis of the patient's illness is accurate so that antibiotic therapy is more effective.

In addition, patient education also needs to be carried out because often the use of antibiotics occurs at the patient's insistence. Patient education regarding antibiotic use must also include adherence to the prescribed dosage. Ensure that the antibiotics given to patients are finished according to the recommended prescription (Mardiati et al., 2021; Marsudi et al., 2021; Qibtiyah, 2022; John et al., 2011).

In Bogor City, West Java, the overuse and misuse of antibiotics have been prevalent across various sectors, including human medicine, agriculture, and animal husbandry. A study by Efendi et al. (2022) found that 78% of small-scale broiler farmers in Bogor used antibiotics, primarily for prophylaxis and growth promotion, rather than strictly for therapeutic purposes. This indiscriminate use contributes to the development of antibiotic-resistant bacteria, which can be transmitted to humans through the food chain, direct contact, or environmental exposure.

Antibiotic use behaviour in children differs from that in adults, so parents, especially mothers who are more dominant in caring for children, must pay attention to the correct rules for taking antibiotics in children. Irregular and incorrect dosage of antibiotic use will worsen the child's condition because the bacteria become resistant, making the antibiotic ineffective in killing them. This can disrupt the child's immunity, such as prolonging the duration of the illness, killing beneficial bacteria in the body, causing more side effects, and potentially leading to bacterial resistance to antibiotics (Mardiati et al., 2021; Kurniawati, 2019; Lutsina, 2021).

The role of parents, especially mothers, is very important in the behaviour of antibiotic use in children. Parents' lack of knowledge about antibiotics tends to trigger less appropriate antibiotic use. In addition, parents must also have a good attitude. Lack of attention in using antibiotics for sick children will tend to delay handling their children, thus prolonging their recovery. Therefore, it is necessary to collect data on the extent of antibiotic use among mothers in the general public. Thus, this data can serve as the basis for further research and the establishment of policies related to guidelines for antibiotic use in Bogor City.

Given the escalating threat of antibiotic resistance in Bogor, this study aims to analyze public knowledge level of antibiotic and their correlation with the prevalence of antibiotic-resistant bacteria in the city.

By examining both human and animal sources, the research seeks to provide a comprehensive understanding of the factors contributing to AMR and inform strategies for its mitigation. This research is planned to be conducted prospectively using an observational descriptive research method.

METHODS

This study is designed as a prospective, descriptive observational research. The instruments utilized in this study is questionnaires in digital form. The population in this study consists of residents of Bogor City who agree to complete the questionnaire during the period of Mei 2025. Residents are parents or someone who take look after of students in elementary school level in Bogor City (North Bogor, West Bogor, Centre Bogor, East Bogor, South Bogor, and Tanah Sareal). Sampling was carried out using a non-random purposive sampling technique. The research sample comprises individuals who meet the inclusion and exclusion criteria.

Inclusion and Exclusion Criteria

The inclusion criteria for the study were respondents aged 17 years or older, those who had used antibiotics at least once, and individuals willing to participate by signing the informed consent. The exclusion criterion was individuals with a background in healthcare education or those working in the healthcare profession.

Data Collection

Data collection was conducted by applying for a permission of distributing questionnaires to respondents who met the inclusion criteria. This study had ethical approval from Universitas Harapan Bangsa No. B.LPPM-UHB/353/04/2025. The data collected included respondents' demographic information (name, age, gender, education level, occupation), history of recent antibiotic use, types of antibiotics used, as well as respondents' knowledge regarding antibiotic usage and antibiotic resistance.

Data Processing Steps

Data Cleaning and Validation

Collecting respondents who participated in the survey. However, to ensure the quality of the analysis, respondents with incomplete or invalid questionnaires were excluded. There are questions for respondents with a score of 0 or who stated "Disagree" in the "Consent" column. If there are respondents with very low scores (below 30) and whose majority of knowledge answers were "Don't Know" were also excluded, as they were deemed not to have substantially completed the questionnaire section.

Data Format Standardization

Age data was standardized to a numerical format

Determination of Correct Answers (Knowledge A1-A30)

Each knowledge question (A1-A30) was assessed based on the most appropriate answer according to rational antibiotic use guidelines and AMR prevention applicable nationally, such as Ministerial Regulation No. 28 of 2021, as well as general public health principles. The determination of correct answers consistent with these national guidelines directly measures the alignment of public knowledge with expected standards. The accuracy of knowledge assessment heavily relies on a clear definition of "correct." Using official guidelines ensures the relevance of findings to the policy context. Each correct answer was given 1 point, with a maximum total knowledge score of 30.

Statistical Analysis Approach

Descriptive Analysis

Frequency distributions and percentages were used to describe demographic variables and antibiotic usage patterns. Mean, median, and standard deviation were calculated for knowledge. Descriptive statistics were used to characterize each variable. Qualitative data analysed included gender, age, and antibiotic usage patterns. The questionnaire employed a multiple choice to assess knowledge related to antibiotic resistance. Knowledge scores were calculated and categorized as follows: good (≥75%), fair (56–74%), and poor (≤55%). Good level in knowledge refers to respondents who correctly answer 75% from 30 item questionaries. Poor level in knowledge refers to respondents who only get answer maximum 55% correctly of 30 item questionaries. The rest are in fair level of knowledge. The knowledge level was determined based on the percentage of correctly answered questions using formula 1 (Arikunto, 2006).

$$\text{Knowledge (\%)} = \frac{\text{Total correct answers}}{\text{Total questions}} \times 100 \quad (1)$$

Inferential Analysis

Mean comparisons (t-test or ANOVA) were performed to compare knowledge scores across demographic groups (age, education, occupation). This inferential analysis aimed to uncover whether significant demographic factors influenced knowledge levels, allowing for the formulation of more targeted intervention recommendations. Identifying demographic groups with low knowledge but high-risk behaviour (or vice versa) will be a priority for intervention, as they may require different educational approaches or stronger policy enforcement.

Data Visualization

Charts and tables were used to visually represent findings, ensuring clarity and ease of interpretation.

RESULTS AND DISCUSSION

Data Sources and Processing

Data for this analysis were obtained from questionnaires distributed to respondents in the Bogor community and its surrounding areas from May 15-19, 2025. A total of 567 respondents participated in the survey. However, to ensure the quality of the analysis, respondents with incomplete or invalid questionnaires were excluded. This included 39 respondents with a score of 0 or who stated "Disagree" in the "Consent" column. Additionally, 5 other respondents with very low scores (below 30) and whose majority of knowledge answers were "Don't Know" were also excluded, as they were deemed not to have substantially completed the questionnaire section. Another data (14 respondents) was excluded coming from health professional background like pharmacy, doctor, nurse, midwife, dental's doctor, veterinarian, and nutritionist. Thus, the total valid respondents for analysis were 509.

Data Format Standardization

Age data was standardized to a numerical format (e.g., "30thn" became "30"). Average age data group consists of 20-29; 30-39; 40-49; 50-59.

Determination of Correct Answers (Knowledge A1-A30)

Each knowledge question (A1-A30) was assessed based on the most appropriate answer according to rational antibiotic use guidelines and AMR prevention applicable nationally, such as Ministerial Regulation No. 28 of 2021, as well as general public health principles. The determination of correct answers consistent with these national guidelines directly measures the alignment of public knowledge with expected standards. The accuracy of knowledge assessment heavily relies on a clear definition of "correct." Using official guidelines ensures the relevance of findings to the policy context. Each correct answer was given 1 point, with a maximum total knowledge score of 30.

Descriptive Analysis

Frequency distributions and percentages were used to describe demographic variables and antibiotic usage patterns. Mean, median, and standard deviation were calculated for knowledge and behaviour scores.

Inferential Analysis

Mean comparisons (t-test or ANOVA) were performed to compare knowledge and behaviour scores across demographic groups (age, education, occupation). This inferential analysis aimed to uncover whether significant demographic factors influenced knowledge levels or behaviour, allowing for the formulation of more targeted intervention recommendations. Identifying demographic groups with low knowledge but high-risk behaviour (or vice versa) will be a priority for intervention, as they may require different educational approaches or stronger policy enforcement.

Data Visualization

Charts and tables were used to visually represent findings, ensuring clarity and ease of interpretation.

Respondents Demographic Profile

Respondents in this study were predominantly female (86.6%), with the majority being married (91.2%). The largest age group was 30-40 years old (48.1%), followed by 41-50 years old (37.3%). Most respondents were homemakers (housewives) (77.4%), with the last education level being high school (52.3%) and junior high school (19.4%). The majority of respondents had a monthly family income below Rp 2,000,000 (42.4%) or between Rp 2,000,000 - Rp 3,000,000 (27.3%).

According Table 1, this demographic profile indicates that the research sample largely represents the population of homemakers with middle education levels and lower-to-middle incomes in the Bogor area.

Table 1. Respondent Demographic Characteristics (N=509)

Demographic Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Female	441	86.6
	Male	68	13.4
Age	20-29 years	42	8.3
	30-39 years	245	48.1
	40-49 years	190	37.3
	50-59 years	32	6.3
Marital Status	Married	464	91.2
	Divorced/Single Parent	45	8.87
Occupation	Homemaker (housewives)	394	77.4
	Daily Laborer	32	6.3
	Employee	41	8.1
	Entrepreneur	23	4.5
	Teacher	11	2.2
	Lecturer	1	0.2
	Army	1	0.2
	Lawyer	1	0.2
	Notary	1	0.2
	None	4	0.8
Last Education	Elementary School	62	12.2
	Junior High School	99	19.4
	High School	266	52.3
	Vocational (D3)	14	2.8
	Bachelor's Degree	53	10.4
	Postgraduate	10	2.0
Family Income/ Month	< Rp 2,000,000	216	42.4
	Rp2,000,000-Rp3,000,000	139	27.3
	Rp3,000,000-Rp5,000,000	87	17.1
	> Rp 5,000,000	67	13.2

Antibiotic Usage Patterns in the Community

Prevalence of Antibiotic Use and Commonly Used Types

A total of 88.4% of valid respondents stated that they had used antibiotics, indicating a very high prevalence of use in the surveyed community. The most frequently mentioned antibiotic type was Amoxicillin (64.0%), followed by Cefixime (2.9%) and Cefadroxil (1.6%). A finding that requires serious attention is the identification of non-antibiotic drugs such as Acetaminophen, Acetyl Salicylic Acid, Ambroxol, Dexamethasone, some brand name of Acetaminophen which were mistakenly identified as antibiotics by some respondents. These results are showed in Table 2. This indicates a fundamental misunderstanding of drug classification. If respondents cannot differentiate antibiotics from other drugs, it is highly likely that they also do not understand when antibiotics should be used. This is the root cause of irrational use and needs to be the primary focus of education. Education should start from basic definitions and the differences between antibiotics and other drugs, not just on how to use them.

Sources of Recommendation and Places of Antibiotic Procurement

The main sources of recommendation for antibiotic consumption were Doctors (69.4%), Primary Health Care (Puskesmas) (8.1%), Clinics (10.5%), Nurse (1.0%), Pharmacy (1.8%), and Midwife (0.8%). However, it is concerning that there were non-medical sources of recommendation such as "Neighbours" (9.8%) and "Self-initiative (self-medication)" (6.5%). Similarly, the most common places for antibiotic procurement were Pharmacies (32.6%), Doctors (5.7%), Midwife (0.4%), Primary Health Care (34.6%), Hospitals (10.4%), and Clinics (13.2%). However, some respondents also reported obtaining antibiotics 3.1% from "Warung" (small shops), "At home" or and "Factory". The presence of

"Neighbours," "Self-initiative (self-medication)," "Google" as sources of recommendation, and "Warung," "At home," "Factory" as places of procurement, indicates concerning self-medication practices and access to antibiotics outside official channels. National guidelines explicitly state to avoid purchasing antibiotics without a doctor's prescription. Easy access to antibiotics without a prescription, coupled with reliance on non-medical sources, creates an environment conducive to irrational use and resistance. This requires stricter oversight of antibiotic sales and awareness campaigns about the dangers of self-medication. In previous study in Jakarta, antibiotics are taken self-medication by participants of education seminar in Faculty of Medicine Unika Atma Jaya Jakarta to treat symptoms such as runny nose, cough, sore throat, fever, and other conditions. (Arrang, S. T., Cokro, F., & Sianipar, E. A., 2019). Actually, antibiotic was belonging to "OBAT KERAS" or drugs available to the public on prescription only. Therefore, antibiotic was able in health facility under control of doctor and pharmacist, such as hospital, primary health care, and pharmacy (Kementerian Kesehatan RI, 2021).

Duration of Consumption and Perceived Outcomes

The duration of antibiotic consumption varied widely, ranging from "1/2 day" to "2 weeks" or even "1 month" and "2 months." The most frequently reported durations were "3 days" (24.0%), "5 days" (20.8%), and "3-5 days" (55.2%). This variation in duration indicates non-adherence to recommended durations, which generally require patients to complete the entire antibiotic prescription, even if symptoms have subsided. Very short durations, such as "1/2 day" or "1 day," are highly alarming as they directly contribute to the risk of resistance. In general, durations have increased compared with the early days of antimicrobials when patients with pneumococcal pneumonia, for example, were treated for 1 to 4 days. The long-standing belief that antimicrobials had few significant adverse effects likely contributed to the paucity of trials to critically evaluate minimum effective treatment durations (Grant, J & Le Saux, N, 2021). However, antibiotics duration depended on type of infection, severity level, complication (secondary infection), and individual (age, genetic, other clinical condition). Bacteria that are not fully eradicated due to overly short treatment have a greater chance of developing resistance, making future treatments less effective.

After consuming antibiotics, the majority of respondents reported "Improved" (57.8%) or "Healthy" (21.2%). However, some also reported side effects (3.5%) such as "Diarrhea" (2.3%), "Nausea" (1.0%), or "Drowsiness" (0.2%). Side effects like diarrhea or nausea reported after antibiotic consumption indicate that the public experiences common side effects, but their perception of these effects may not always be linked to inappropriate use, but rather as "normal outcomes." This can affect their future adherence. If respondents report "symptoms reduced" or "improved" after inappropriate antibiotic use (e.g., for non-bacterial complaints or short durations), this creates a false positive perception of antibiotic effectiveness, encouraging the same behaviour in the future. This is a negative feedback loop that needs to be broken. Education must emphasize that "feeling better" does not always mean a bacterial infection has been resolved or that antibiotics are the sole cause of recovery, and that placebo effects or natural healing also play a role. In journal and book of antibiotic guide, amoxicillin have side effect of diarrhea and nausea. Another penicillin group such as cefixime and cefadroxil also have those side effects (Kementerian Kesehatan RI, 2013; Fymat, A. L, 2017).

Public Knowledge Level about Antibiotics

Comprehensive Analysis of Knowledge Scores

Knowledge scores were calculated from 30 questions (A1-A30). The average knowledge score of respondents was 18.7 out of 30 (approximately 62.3%), with a standard deviation of 6.0. The score distribution shows that 15.7% of respondents had a low knowledge level (score < 10), 50.3% had a moderate knowledge level (score 10-20), and 34.0% had a high knowledge level (score > 20). The total score indicating moderate to high knowledge for most respondents suggests that comprehensive basic education interventions are still greatly needed, especially for groups with low knowledge.

Table 2. Summary of Antibiotic Usage Patterns (N=509)

Characteristic of Antibiotic Use	Category	Frequency (n)	Percentage (%)
Ever Used Antibiotics?	Yes	450	88.4
	No	59	11.6
Top 5 Types of Antibiotics Used	Amoxicillin	327	64.2
	Cefixime	15	2.9
	Cefadroxil	8	1.6
	Metronidazole	4	0.8
	Ampicillin	2	0.4
	Tetracycline	1	0.2
	Chloramphenicol	1	0.2
	Antibiotic dispensing compound	7	1.4
	Non-Antibiotics (Acetaminophen, some in brand name)	50	9.8
	Don't Know/Forgot/None	87	17.1
Top 5 Sources of Recommendation	Doctor	353	69.4
	Pharmacy	9	1.8
	Midwife	4	0.8
	Nurse	5	1.0
	Primary Health Care	41	8.1
	Clinic	14	2.8
	Neighbour	50	9.8
	Self-initiative	33	6.5
Top 5 Places of Procurement	Pharmacy	166	32.6
	Midwife	2	0.4
	Doctor	29	5.7
	Primary Health Care	176	34.6
	Clinic	67	13.2
	Hospital	53	10.4
	Warung (Small Shop)	16	3.1
Distribution of Consumption Duration	< 3 days	122	24
	> 5 days	106	20.8
	3-5 days	281	55.2
Body Condition After Consumption	Improved/Better/Healthy/Fresh	294	57.8
	Healthy	108	21.2
	Side Effects (Diarrhea, Nausea, Drowsiness)	18	3.5
	No change/Normal	89	17.5

Specific Knowledge about Definition, Indication, and Risks of Antibiotics

Although the average knowledge score was sufficient, a deeper analysis of specific questions revealed several fundamental misconceptions:

Definition and Function

Only 68.6% of respondents correctly identified antibiotics as drugs to fight bacterial infections (A1). Some respondents mistakenly considered antibiotics as "pain relievers" or "immune boosters."

Indications for Use

Only 69.1% of respondents correctly stated that the appropriate indication for antibiotic use is to treat infections caused by specific pathogenic bacteria (A2). Common misconceptions were evident in questions A24 and A25, where 79.6% of respondents correctly stated that antibiotics work against bacterial infections (A24), but only 48.2% correctly stated that antibiotics are used to treat "inflammation" (A25), with many choosing "pain" or "fever." These misconceptions, such as considering antibiotics for viruses, fever, or pain, are clearly visible through the high percentage of incorrect answers on questions related to indications. However, the public needs to understand that antibiotics are only effective against bacteria, not viruses or fungi. Using antibiotics without proper indications can increase the occurrence of resistance. This fundamental misunderstanding of antibiotic function is the primary cause of inappropriate use for non-bacterial conditions, accelerating resistance. This implies that educational campaigns must explicitly address these misconceptions in easily understandable language.

Risks and Resistance

The majority of respondents (80.1%) understood that the main risk of inappropriate antibiotic use is the emergence of bacterial resistance (A3). However, this understanding was not always consistent across all aspects of resistance. For example, only 60.7% correctly stated that frequent antibiotic consumption without a prescription can lead to bacteria becoming resistant (A11). Furthermore, only 57.6% correctly stated that the long-term impact of resistance is that infections become more difficult to treat (A13), and only 66.5% correctly stated that indiscriminate use makes bacteria stronger (A14). If many respondents do not understand the long-term impact of resistance or why storing leftover antibiotics triggers resistance (A12), this indicates a lack of awareness of personal and collective threats.

Preventing antibiotic resistance involves efforts to prevent bacteria from becoming stronger. Without an understanding of the long-term consequences of individual behavior on public health, the motivation to comply will be low. Superbugs are bacteria resistant to one or more antibiotics, and they make it difficult to treat or cure infections that once were easily treated. The antibiotic has lost its ability to control or kill bacterial growth. The bacteria can even grow in a sea of antibiotics because the antibiotics does not touch them. The bacteria have acquired the ability to destroy the antibiotic in order to protect themselves. They have developed a gene for resistance to, say, penicillin, and that gene protects them. A genetic mutation might enable bacteria to produce enzymes that inactivate antibiotics. Or, a mutation might eliminate the target that the antibiotic is supposed to attack. Bacteria may have developed resistance to five or six antibiotics so, in treatment, we do not know which one to choose or whether it will be effective. The bacteria have accumulated resistance by developing new genes. Misuse of antibiotics to treat viruses rather than bacteria for which they are intended only contributes to antibiotic resistance (Fymat, A. L., 2017).

Procurement and Storage

The majority of respondents (88.0%) understood that the correct way to obtain antibiotics is based on a prescription and advice from healthcare professionals (A4), and 85.3% knew that legal and safe places of procurement are clinics/Puskesmas based on a doctor's prescription (A5). However, there is a gap between this knowledge and behavior, which will be discussed in the next section.

Understanding of Antibiotic Resistance

Respondents' understanding of antibiotic resistance still needs improvement, especially in an applied context. Although 80.1% of respondents understood the definition of resistance (A3), only 57.6% understood its long-term impact (A13). Furthermore, only 60.7% of respondents knew that frequent antibiotic consumption without a prescription can lead to bacteria becoming resistant (A11). If respondents have good knowledge of the definition of AMR (A28) but poor knowledge of indications (A2) or personal risks (A11), this indicates a gap between conceptual and applied knowledge. They may understand the global concept but not its relevance to their personal practices. The correlation of knowledge with age, gender, marital status, occupation and last education, monthly income is displayed in Figure 1.

In addition to descriptive statistics, multivariate analysis was conducted to examine the influence of demographic variables on knowledge related to antibiotic use. This approach aimed to provide deeper insights into which demographic characteristics are most strongly associated with rational antibiotic practices, thus informing more targeted intervention strategies.

This study confirmed the significant correlations were found between knowledge and education level, as well as income whereas occupation had more influence on behaviour than knowledge. Age, gender, and marital status did not show strong or reported statistical correlations with knowledge in the article as describe by following statistical analysis.

Table 3. Knowledge Levels about Antibiotics by Category (N=509)

Knowledge Category	Key Questions	Percentage of Correct Answers (%)
Definition & Function	A1 (Antibiotic Definition)	68.6
	A24 (Function Against Infection)	79.6
Indications & Risks Procurement & Storage	A2 (Appropriate Indication)	69.1
	A15 (Antibiotics for Diarrhea)	57.6
	A16 (Antibiotics for Pregnant Women/Elderly)	64.4
	A21 (Habits Causing Resistance)	67.5
	A25 (What Antibiotics Treat)	48.2
	A29 (Side Effects)	88.0
	A4 (Correct Procurement Method)	88.0
	A5 (Legal Procurement Place)	85.3
	A8 (Importance of Storage)	84.3
	A30 (Guaranteed Quality Purchase Place)	90.1
Resistance & Environmental Impact	A3 (Main Risk)	80.1
	A10 (Impact of Improper Disposal)	70.7
	A11 (Impact of Consumption Without Prescription)	60.7
	A12 (Why Storing Leftovers Triggers Resistance)	57.6
	A13 (Long-term Impact of Resistance)	57.6
	A14 (Risk of Indiscriminate Use)	66.5
	A28 (Term for Resistant Bacteria)	80.1
Dose & Duration Adherence	A6 (Correct Usage Method)	84.3
	A7 (Correct Frequency Rule)	84.3
	A17 (Forgot to Take)	72.3
	A19 (Importance of Schedule Adherence)	80.6
	A20 (3x Daily Administration Time)	75.4
	A23 (Impact of Overdose)	75.9
	A26 (Impact of Incomplete Treatment)	70.7
	A27 (Antibiotic Use Provisions, Except)	70.7

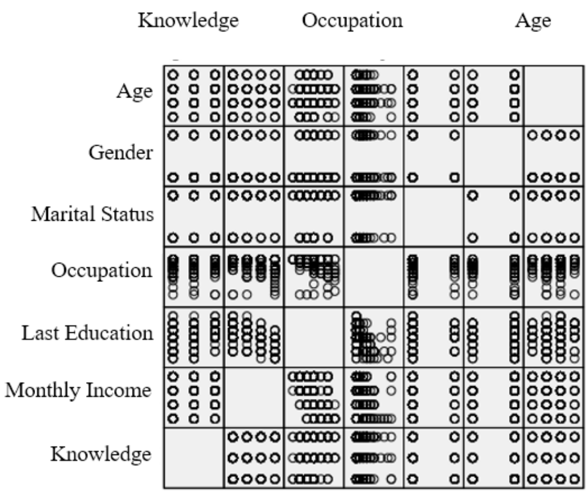

Figure 1. Scatter chart of correlation of knowledge with age, gender, marital status, occupation, last education, monthly income

Tabel 4. Correlation of Knowledge with Demographic Factors

Demographic Factor	Correlation with Knowledge	Interpretation
Age	*Not explicitly significant*	No clear linear correlation is reported; however, older age groups (30–49 years) had the highest participation but not necessarily the highest knowledge.
Gender	*Not significantly correlated*	Although the majority of respondents were female (86.6%), the study did not report a significant gender-based difference in knowledge levels.
Marital Status	*Not emphasized in correlation*	While 91.2% were married, there is no reported statistical correlation with knowledge.
Occupation	Significant ($p = 0.042$)	Occupation influenced behavior more than knowledge, with employed individuals (teachers, employees) showing more rational behavior despite similar knowledge scores.
Last Education	Highly significant ($p < 0.001$)	Strong positive correlation: Higher education levels (e.g., bachelor's, postgraduate) were associated with higher knowledge scores.
Monthly Income	Moderate positive correlation ($r = 0.312$; $p < 0.01$)	Higher income groups were correlated with higher knowledge scores, possibly due to better access to healthcare and information.

Education Level and Knowledge Score

A One-Way ANOVA analysis revealed that education level significantly influenced respondents' knowledge scores regarding antibiotic use ($p < 0.001$). Respondents with higher education levels, such as bachelor's and postgraduate degrees, demonstrated significantly higher knowledge scores compared to those with only elementary or high school education. This finding underscores the role of formal education in enhancing understanding of antibiotic indications, usage protocols, and resistance risks.

Monthly Household Income and Knowledge/Behaviour Scores

A positive correlation was found between monthly household income and both knowledge ($r = 0.312$; $p < 0.01$) and behavior scores ($r = 0.284$; $p < 0.01$). Households earning above Rp 3,000,000 per month were more likely to demonstrate better knowledge and engage in appropriate antibiotic use. This could be attributed to better access to healthcare services and educational resources.

In the previous study of Mardiati, et al., the scoring about knowledge of antibiotics was analyzed but not for antibiotic resistance knowledge. These multivariate insights reinforce the conclusion that antibiotic-related knowledge is not only an individual choice but is also shaped by socio-demographic contexts. Educational interventions must therefore be tailored to address these specific factors to maximize impact in combating antimicrobial resistance (AMR).

CONCLUSION

In conclusion, this study conducted in Bogor City between March and May 2025 revealed a high prevalence of prior antibiotic use among residents, alongside identified gaps in public knowledge regarding their appropriate application. The presence of self-medication and premature cessation of treatment highlights risky behaviors that could contribute to antimicrobial resistance. The significant positive correlation observed between knowledge levels and rational antibiotic use underscores the necessity for targeted educational interventions within the Bogor City community to improve understanding and promote responsible antibiotic management, so that the goal of combating increasing antibiotic resistance can be realized.

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CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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