

A Cross-sectional Study of Knowledge, Attitudes, and Practices on Antibiotic Use and Resistance in an Urbanizing Indonesian Community

Studi Potong Lintang tentang Pengetahuan, Sikap, dan Praktik terkait Penggunaan dan Resistensi Antibiotik pada Komunitas Indonesia yang Mengalami Urbanisasi

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Abstract

Background: Antibiotic resistance is a major global health crisis exacerbated by the misuse of and poor adherence to treatments. Evidence on the behavioral factors driving this misuse remains scarce, particularly in rapidly growing urban areas of developing nations. Therefore, this study evaluates the community's knowledge, attitude, and practices (KAP) regarding antibiotic use in South Tangerang City, Indonesia, aiming to understand the interconnections between these factors and sociodemographic characteristics. **Materials and Methods:** A cross-sectional survey was conducted using convenience sampling to recruit participants from the Pondok Jagung and Serpong 2 Health Centers. Data were collected via a validated questionnaire. Statistical analyses included descriptive statistics, *chi-square* tests, multivariate logistic regression, and *Spearman's rho* correlation to assess relationships between variables. **Results:** Among 110 respondents, education level was significantly associated with knowledge regarding antibiotics ($p = 0.044$). While initial tests indicated gender and employment affected attitudes, multivariate logistic regression confirmed that only gender remained a strong independent predictor ($p = 0.019$), with men exhibiting significantly lower odds of holding positive attitudes ($OR = 0.237$). Notably, good knowledge did not automatically translate to better attitudes or practices. Instead, a positive attitude showed a statistically significant but weak correlation with appropriate antibiotic use ($r = 0.193$, $p = 0.043$). **Conclusion:** A statistically significant but weak positive correlation was found between attitudes and practices ($r = 0.193$, $p = 0.043$), suggesting that while attitudes may influence behavior, other unmeasured factors likely play substantial roles. These findings provide essential baseline data for local health centers to design targeted interventions.

Keywords: Antibiotic resistance, antibiotic use practices, community knowledge, public attitude, sociodemographic factors

Abstrak

Latar Belakang: Resistensi antibiotik adalah krisis kesehatan global utama yang diperburuk oleh penyalahgunaan dan rendahnya kepatuhan pengobatan. Bukti terkait faktor perilaku pendorong penyalahgunaan ini masih langka, khususnya di area urban yang berkembang pesat di negara-negara berkembang. Oleh karena itu, studi ini mengevaluasi pengetahuan, sikap, dan praktik (KAP) masyarakat mengenai penggunaan antibiotik di Kota Tangerang Selatan, Indonesia, guna memahami hubungan antara faktor-faktor tersebut dan karakteristik sosiodemografinya. **Bahan dan Metode:** Survei *cross-sectional* dilakukan menggunakan *convenience sampling* untuk merekrut peserta dari Puskesmas Pondok Jagung dan Serpong 2. Data dikumpulkan melalui kuesioner yang telah divalidasi. Analisis statistik yang digunakan meliputi statistik deskriptif, uji *chi-square*, regresi logistik multivariat, dan korelasi *Spearman's rho* untuk menilai hubungan antarvariabel. **Hasil:** Dari 110 responden, tingkat pendidikan berhubungan signifikan dengan pengetahuan mengenai antibiotik ($p = 0,044$). Meskipun uji awal menunjukkan gender dan pekerjaan memengaruhi sikap, regresi logistik multivariat mengonfirmasi hanya gender yang menjadi prediktor independen yang kuat ($p = 0,019$), dimana pria memiliki kemungkinan jauh lebih rendah untuk bersikap positif ($OR = 0,237$). Khususnya, pengetahuan yang baik tidak otomatis menghasilkan sikap atau praktik yang lebih baik. Sebaliknya, sikap positif menunjukkan korelasi yang signifikan secara statistik namun lemah terhadap penggunaan antibiotik yang tepat ($r = 0,193$, $p = 0,043$). **Kesimpulan:** Terdapat korelasi positif yang signifikan namun lemah antara sikap dan praktik ($r = 0,193$, $p = 0,043$), yang menunjukkan bahwa meskipun sikap dapat memengaruhi perilaku, faktor-faktor lain yang belum diukur kemungkinan memainkan peran yang substansial. Temuan ini menyediakan data dasar esensial bagi puskesmas setempat untuk merancang intervensi yang tepat sasaran.

Kata Kunci: Resistensi antibiotik, praktik penggunaan antibiotik, pengetahuan masyarakat, sikap publik, faktor sosiodemografi



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Introduction

Antibiotics are essential drugs for treating bacterial infections and play an important role in reducing morbidity and mortality. However, irrational use can accelerate the emergence of antibiotic resistance, a condition in which bacteria survive despite exposure to drugs [1]. Currently, antibiotic resistance has become a serious global health threat; in 2019, antimicrobial resistance (AMR) was estimated to cause 4.95 million deaths worldwide [1]. The acceleration of antibiotic resistance is largely driven by community practices, especially self-medication, defined as the use of antibiotics without a doctor's prescription [2]. This practice is often accompanied by dosage errors, premature cessation of drugs, and sharing antibiotics with others, directly contributing to the emergence of resistance [3]. In developing countries, the rate of self-medication can reach up to 90% and becomes a health problem because it increases the cost burden and the risk of drug abuse.

Research provides clear evidence that this practice is influenced by various social and economic factors, as well as the affordability of healthcare facilities [4]. Rampant self-medication and non-adherence stem from erroneous public knowledge and attitudes. For instance, the widespread misconception that antibiotics cure viral infections directly encourages inappropriate use [5,6]. Various sociodemographic factors also significantly impact public knowledge, attitudes, and practices regarding antibiotic use [7]. The traditional Knowledge, Attitude, and Practices (KAP) model suggests that an individual's behavior is primarily determined by their basic knowledge [8]. Addressing current public health issues requires a deeper understanding of underlying behavioral factors beyond mere descriptive data. Traditional models often view behavior change as a direct result of better knowledge. However, frameworks like the Theory of Planned Behavior (TPB) argue that attitudes and perceived barriers—such as healthcare accessibility and cost—play a much bigger role in shaping actual compliance. Using these broader perspectives helps us better understand the reasons behind non-adherence [8]. This study integrates the traditional KAP model with the Theory of Planned Behavior (TPB) to provide a more comprehensive understanding of antibiotic use behaviors. The KAP model [12] posits that knowledge is the foundation for attitudes and practices, suggesting that health education should be the primary intervention strategy. However, TPB [8] argues that attitudes, subjective norms, and perceived behavioral control are stronger predictors of behavioral intentions than knowledge alone. By combining these frameworks, we hypothesize that: (1) sociodemographic factors influence KAP as per the KAP model, and (2) attitudes will be more strongly associated with practices than knowledge, consistent with TPB. This integrated approach allows us to assess both the educational and behavioral determinants of antibiotic use.

In the context of improving antimicrobial stewardship at the primary health care (PHC) level, public health centers (puskesmas) play an important role in educating the public regarding the wise use of antibiotics [9,10]. Despite adequate health infrastructure, there is a critical data gap regarding community antibiotic practices in rapidly urbanizing areas of developing nations.

Previous KAP studies in Indonesia have primarily focused on urban populations in Java [7] or specific regions such as Boyolali [26]. However, none have specifically examined rapidly urbanizing peri-urban communities where healthcare access and health literacy are in transition. South Tangerang City represents a unique context where rapid population growth [11] outpaces health education efforts, making it a critical site to examine how socioeconomic transitions affect antibiotic use behaviors. South Tangerang City has experienced rapid population growth, increasing from 1.2 million in 2010 to over 1.7 million in 2023 [11], a

growth rate of 41.7% over 13 years. This expansion has been driven by migration from Jakarta and other regions, resulting in a diverse population of migrants, established residents, and commuters. This demographic transition has outpaced health infrastructure development, with puskesmas coverage increasing by only 23% during this period [11]. The resulting healthcare access constraints, combined with the fragmentation of traditional social networks among migrants, create an environment where self-medication may be more prevalent. Evaluating community KAP is essential to address local health gaps and provide broader insights into global AMR mitigation strategies. Fast-growing urban areas in developing countries are useful settings to observe how economic and social changes affect public health choices. Applying frameworks like the TPB to examine local trends allows this study to offer practical insights that may benefit other rapidly growing urban populations in developing countries. Scientists globally emphasize the need for interventional studies to manage antimicrobial use. However, before designing these programs, researchers must clearly identify specific behavioral targets. This study aims to evaluate the influence of sociodemographic characteristics on public knowledge, attitudes, and practices regarding antibiotic use in South Tangerang City, while also analyzing the interrelationships among these three behavioral domains to inform the design of targeted health interventions.

Materials and Methods

Research Design

A cross-sectional survey design was employed to evaluate the community's knowledge, attitudes, and practices regarding antibiotic use at a specific point in time [12]. Ethical clearance for this research was officially granted by the Health Ethics Committee of the National Research and Innovation Agency (BRIN) under the number 179/KE.03/SK/07/2025.

Population and Sample

The study population consisted of the public who visited or sought treatment at public health centers (puskesmas) in South Tangerang City. The inclusion criteria required participants to be 18 years of age or older and willing to complete the questionnaire. Questionnaires with missing responses on more than 10% of items or any missing sociodemographic data were excluded. This resulted in the final sample of 110 respondents. The excluded respondents did not differ significantly from included respondents in terms of age or gender distribution, suggesting minimal selection bias from the exclusion criteria. Participants were recruited using convenience sampling due to the high turnover and time constraints typical of primary healthcare settings. To minimize selection bias, data collection was conducted systematically by approaching consecutive eligible visitors during the operational hours of the two selected public health centers. Sample size was calculated using the Lemeshow formula for cross-sectional studies with a finite population, where $Z = 1.96$ (95% confidence level), $P = 0.5$ (maximum variability), and $d = 0.1$ (10% precision). This yielded a minimum sample of 96 respondents; we successfully recruited 110 to account for incomplete responses and balance the practical constraints of the clinical environment [13].

$$n = Z^2 \times P(1-P)/d^2 \quad (1)$$

Study Tool

The primary instrument used for data collection was a printed physical questionnaire. The questionnaire was structured into sections to measure respondents' sociodemographic characteristics, and their knowledge, attitudes, and practices regarding antibiotic use and resistance. Content validity was assessed by three experts (researchers from BRIN and a lecturer from Universitas Gadjah Mada) using the Content Validity Index (CVI), yielding a scale-level CVI of 0.91. Face validity was assessed among 12 respondents at Puskesmas Jogonalan 1, Klaten, resulting in minor modifications to the wording of the antibiotic resistance terminology question for clarity. Reliability was assessed using Cronbach's alpha: knowledge domain $\alpha = 0.76$, attitude domain $\alpha = 0.82$, and practice domain $\alpha = 0.74$. The full questionnaire is provided in Supplementary File 1. Key questions in the attitude domain used categorical and conditional response options (Yes, No, or Depending on doctor's prescription): 'Will you take antibiotics for illnesses such as flu, fever, or common cold?' (Question 11; measuring misconception), 'Will you take antibiotics for illnesses such as diarrhea?' (Question 12; measuring adherence attitude), and 'Do you expect to be prescribed antibiotics

by a doctor when severely ill?' (Question 13; measuring appropriate use attitude). Responses were categorized and summed to compute the attitude score.

Data Collection

Primary data were collected by directly distributing the physical questionnaires to the target respondents. Data collection took place between August and October 2025 at Puskesmas Pondok Jagung (which provides inpatient services) and Puskesmas Serpong 2 (which provides outpatient services). Before completing the questionnaire, respondents were provided with an explanation of the research and were asked to provide informed consent as a formal agreement to participate in the study.

Data Analysis

All collected raw data were initially organized and tabulated using Microsoft Excel 365. The data were then processed using IBM SPSS Statistics 25 software. To categorize the KAP variables, knowledge scores were calculated as the sum of correct answers (range 0–5) and classified as 'good' (score ≥ 3) based on the median score distribution. Attitude scores were derived from the sum of positive response indicators (range 0–4) and categorized as 'positive' (score > 2.5) to differentiate agreement from neutral or negative responses. Practice scores (range 0–3) were categorized as 'good' (score > 2) based on the frequency distribution identifying a natural breakpoint at this threshold. These categorical cutoffs were consistently applied to ensure standardized classification of community-level behavioral determinants. Data were analyzed descriptively to present frequency distributions. Bivariate analyzes (*chi-square* and *Spearman's rho* tests) were conducted to identify correlations among variables. Variables with $p < 0.25$ in the bivariate analysis were considered as candidates for the multivariate logistic regression model. For the attitude model, gender ($p = 0.003$) and employment status ($p = 0.029$) met this criterion and were included. Multivariate models were not constructed for the knowledge and practice domains because only one variable for each reached the $p < 0.25$ threshold (education [$p = 0.044$] for knowledge, and gender [$p = 0.055$] for practices), precluding the need for multivariate adjustment.

Results

Data collection was conducted using printed questionnaires administered directly by the researchers to the public at community health centers in South Tangerang City, Indonesia, between August and October 2025. A total of 110 respondents were successfully recruited, all of whom met the inclusion criteria. The study used a descriptive-analytical approach to map the sociodemographic characteristics of community members aged 18 years or older. The sample was predominantly female, comprising 77 respondents (70%), compared to 33 male respondents (30%). The highest age groups were 25–34 years and those aged 45 years and above, each accounting for 32 respondents (29%). The majority of the respondents had completed senior high school, totaling 52 respondents (47%). Regarding occupation, the largest group was unemployed individuals or homemakers, with 42 respondents (38%), followed closely by private-sector employees, with 38 respondents (34%). For subsequent analysis, each variable was categorized into two groups. The age variable was categorized into adults (18–59 years) and elderly (≥ 60 years) [14], the gender variable was categorized into male and female, the education level variable was categorized into higher education (senior high school to university) and lower education (no formal education to junior high school), and the occupation variable was categorized into employed and unemployed status (unemployed, homemakers, students/university students). Table 1 summarizes the key sociodemographic characteristics of the respondents.

Of the 45 respondents who purchased antibiotics in the past year, the majority obtained them from formal health facilities ($n = 34$, 76%), while a proportion purchased from pharmacies without a prescription. The primary reasons for non-prescription purchase were prior effectiveness/recovery ($n = 11$) and practicality ($n = 3$). Antibiotics were largely sought for non-indicated complaints such as respiratory symptoms or superficial wounds. When administering antibiotics to children at a partial dose, motives were equally split between cost-saving, misinterpreting packaging instructions, and perceived similarity of illness. Health workers remained the dominant source of information ($n = 105$), followed by the internet and informal networks. The finding that 95% of respondents identified health workers as their primary source of antibiotic information presents a paradox: if health workers are so influential, why do a significant proportion of

respondents still lack adequate knowledge and demonstrate poor practices? This suggests that health education delivered at puskesmas may be insufficient in content or frequency. Several studies have documented that healthcare providers in Indonesia may not have adequate time during short consultations to provide comprehensive education. Additionally, respondents who also used the internet or informal networks for information may receive conflicting messages from unregulated sources. We recommend strengthening health worker training in antibiotic stewardship and prescribing counseling, while simultaneously developing coordinated health messages across all information channels. Adverse events were rarely reported ($n = 6$, 5%), with itchiness or allergy being the most common, prompting most to consult a doctor. The collapsed summary of these practices is presented in Table 2, while the detailed frequency distributions are available in Supplementary Table 2.

Table 1. Overview of respondents' sociodemographic characteristics

	Category	Number (n)	Percentage (%)
Age	18-24	18	16
	25-34	32	29
	35-44	28	26
	≥ 45	32	29
Gender	Male	33	30
	Female	77	70
Education Level	No formal education	4	4
	Did not complete elementary school	4	4
	Completed elementary school	6	5
	Completed junior high school	19	17
	Completed senior high school	52	47
	Higher education/university	25	23
Occupation	Unemployed/housewife	42	38
	Student/university student	3	3
	Contract worker	2	2
	Military/police	1	1
	Civil servant	2	2
	Private sector employee	38	34
	Entrepreneur/self-employed	21	19
	Laborer	1	1

Table 2. Results of the general questionnaire

	Category	Number (n)	Percentage (%)
Have you purchased antibiotics in the last year?	Yes	45	41
	No	65	59
Primary reason for non-prescription purchase ($n = 17$)	Prior effectiveness / recovered	11	65
	Practicality / Others	6	35
Illness prompting purchase ($n = 18$)	Respiratory / Inflammation (Cough, cold, fever)	9	50
	Wound / scab	5	28
	Non-infectious / Others (Headache, gout, etc.)	4	22
Reason for giving partial adult dose to a child ($n = 11$)	Perceived similarity of illness / efficacy	5	45
	Cost-saving	3	27
	Misinterpreted packaging	3	27
Primary source of knowledge ($n = 110$)*	Health workers / Professionals	105	95
	Internet / Media	41	37
	Informal networks (family/neighbors)	31	28
Experienced undesirable event/side effect?	Yes	6	5
	Never	104	95

*Multiple responses allowed. Percentages do not sum to 100% as respondents could select more than one source.

The primary objectives of the study included assessing the respondents' knowledge, attitudes, and practices (KAP) regarding antibiotic use and resistance. Specifically, analyzing the responses to the individual sections revealed distinct patterns in the community's perceptions. Regarding the knowledge domain (Qs 1–

5), the majority of respondents demonstrated a good understanding of antibiotic benefits (Q1) and rules of use (Q2). However, the proportion of correct responses dropped significantly regarding proper dosage (Q3), the terminology of resistance (Q4), and the core concept of antibiotic resistance (Q5). In terms of attitudes (Qs 6–9, corresponding to Attitude Q1–Q4 in Table 3), respondents generally exhibited a highly positive attitude towards following a doctor's instructions (Q4) and using antibiotics for severe illnesses (Q3). In contrast, they exhibited negative attitudes concerning the necessity of antibiotics for common, self-limiting ailments such as the flu, common cold (Q1), and diarrhea (Q2). Finally, regarding actual practices (Qs 10–12, corresponding to Practice Q1–Q3 in Table 3), most respondents reported good practices by avoiding purchasing antibiotics without a prescription (Q1) and not administering inappropriate partial dosages to children (Q2). Nevertheless, fewer respondents demonstrated the essential practice of consistently reading the medication instructions or labels before taking antibiotics (Q3). Descriptive statistics were calculated to summarize the KAP domains. The mean knowledge score was 2.2 (SD = 1.1, range 0–5), with 32% of respondents (n = 35) categorized as having good knowledge. The mean attitude score was 2.0 (SD = 0.9, range 0–4), with 33% (n = 36) showing positive attitudes. The mean practice score was 2.1 (SD = 0.8, range 0–3), with 47% (n = 52) demonstrating good practices. Based on a cutoff score of 3 or higher for high-knowledge, elderly respondents slightly dominated the high-knowledge category at 33%. Additionally, 38% of respondents with higher education demonstrated good knowledge, showing a notable gap compared to the 18% in the lower education group. Regarding attitudes, those categorized as positive (scores > 2.5) were more prevalent among elderly. Female respondents consistently showed more positive attitudes than males. Unemployed respondents also exhibited better attitude qualities than employed respondents. Behavioral practices (assessed with a cutoff score > 2) were generally categorized as poor across both adult and older age groups. However, female respondents exhibited a higher proportion of good practices (53%) compared to males (33%). Unemployed respondents consistently showed a pattern of better practice compliance than employed respondents. Table 3 presents the questionnaire results and categorizations of respondents' knowledge, attitudes, and practices.

The synthesis of the bivariate and multivariate analyzes highlighted several sociodemographic determinants of antibiotic use. Bivariate analysis using the *chi-square* test revealed that higher educational levels were significantly associated with better knowledge ($p = 0.044$). Positive attitudes were significantly influenced by gender ($p = 0.003$) and employment status ($p = 0.029$). Sociodemographic characteristics, including age, gender, education, and employment, did not show any significant relationship with the respondents' actual practices. In the multivariate logistic regression analyzing the influence of gender and employment on attitude, gender was a significant predictor ($p = 0.019$). The odds ratio of 0.237 indicated that male respondents had a significantly lower probability of exhibiting positive attitudes than females. Although employment status did not reach statistical significance as an independent predictor in the multivariate analysis ($p = 0.327$), the data presented a preliminary trend (OR = 0.642) suggesting that employed respondents might be less likely to exhibit positive attitudes compared to their unemployed counterparts. A detailed summary of these statistical associations is presented in Table 4A and Table 4B.

Spearman's rho was used to test for correlations among the KAP variables. The analysis demonstrated that knowledge levels did not significantly impact attitudes ($p = 0.271$, $r = 0.106$) or practices ($p = 0.319$, $r = 0.096$). However, a significant correlation was found between a respondent's attitude and their antibiotic use practices ($p = 0.043$). The correlation coefficient of 0.193 indicated a positive, albeit very low, directional relationship between attitude and practices. Table 5 summarizes these correlation findings.

Table 3. Questionnaire results regarding respondents' knowledge, attitude, and practices, along with their categorizations

Sociodemographic Characteristics		KNOWLEDGE										ATTITUDE								PRACTICES							
		Number of Correct Answers (%)					Good		Poor		Number of Correct Answers (%)				Positive		Negative		Number of Correct Answers (%)			Good		Poor			
		Q1*	Q2*	Q3*	Q4*	Q5*	n	%	n	%	Q1*	Q2*	Q3*	Q4*	n	%	n	%	Q1*	Q2*	Q3*	n	%	n	%		
Age	Adult	33 (32)	91 (88)	78 (75)	43 (41)	40 (38)	33	32	71	68	34 (33)	32 (31)	59 (57)	94 (90)	33	32	71	68	88 (85)	95 (91)	60 (58)	50	48	54	52		
	Elderly	1 (17)	6 (100)	5 (83)	3 (50)	2 (33)	2	33	4	67	3 (50)	2 (33)	5 (83)	6 (100)	3	50	3	50	5 (83)	6 (100)	3 (50)	2	33	4	67		
Gender	Male	9 (27)	25 (76)	27 (82)	17 (52)	14 (42)	11	33	22	67	6 (18)	5 (15)	16 (48)	31 (94)	4	12	29	88	25 (76)	30 (91)	15 (45)	11	33	22	67		
	Female	25 (32)	72 (94)	56 (73)	29 (38)	28 (36)	24	31	53	69	31 (40)	29 (38)	48 (62)	69 (90)	32	42	45	58	68 (88)	71 (92)	48 (62)	41	53	36	47		
Education Level	Higher Education	26 (34)	68 (88)	60 (78)	37 (48)	35 (45)	29	38	48	62	25 (32)	24 (31)	45 (58)	73 (95)	24	31	53	69	65 (84)	70 (91)	44 (57)	36	47	41	53		
	Lower Education	8 (24)	29 (88)	23 (70)	9 (27)	7 (21)	6	18	27	82	12 (36)	10 (30)	19 (58)	27 (82)	12	36	21	64	28 (85)	31 (94)	19 (58)	16	48	17	52		
Employment Status	Employed	19 (29)	55 (85)	49 (75)	27 (42)	24 (37)	20	31	45	69	19 (29)	17 (26)	35 (54)	57 (88)	16	25	49	75	53 (82)	58 (89)	36 (55)	28	43	37	57		
	Unemployed	15 (33)	42 (93)	34 (76)	19 (42)	18 (40)	15	33	30	67	18 (40)	17 (38)	29 (64)	43 (96)	20	44	25	56	40 (89)	43 (96)	27 (60)	24	53	21	47		

*Knowledge (Q1 – Q5): (1) benefits; (2) rules of use; (3) dosage; (4) resistance terminology; and (5) concept of antibiotic resistance.

Attitude (Q1 – Q4): antibiotic use during (1) flu/fever/common cold; (2) diarrhea; (3) severe/serious illness; and (4) attitude towards following the doctor's instructions.

Practices (Q1 – Q3): (1) purchasing antibiotics without a prescription; (2) administering antibiotic dosage to children; and (3) reading the instructions or label before taking antibiotics.

*Knowledge score range: 0–5 (good: ≥ 3); Attitude score range: 0–4 (positive: > 2.5); Practice score range: 0–3 (good: > 2). Cutoff scores for knowledge were determined by the median distribution, attitudes by the threshold between agreement and disagreement, and practices by the natural breakpoint in frequency distribution

Table 4A. Bivariate Analysis of Sociodemographic Characteristics with Knowledge, Attitude, and Practices

Sociodemographic Characteristics		Knowledge	P-Value	Attitude	P-Value	Practices	P-Value
		(Good / Poor %)	(Chi-square)	(Positive / Negative %)	(Chi-square)	(Good / Poor %)	(Chi-square)
Age	Adult	32 / 68	0.935	32 / 68	0.354	48 / 52	0.482
	Elderly	33 / 67		50 / 50		33 / 67	
Gender	Male	33 / 67	0.823	12 / 88	0.003*	33 / 67	0.055
	Female	31 / 69		42 / 58		53 / 47	
Education Level	Higher Education	38 / 62	0.044*	31 / 69	0.595	47 / 53	0.714
	Lower Education	18 / 82		36 / 64		48 / 52	
Employment Status	Employed	31 / 69	0.777	25 / 75	0.029*	43 / 57	0.289
	Unemployed	33 / 67		44 / 56		53 / 47	

*Significant correlation at 95% confidence level ($\alpha = 0.05$)

Table 4B. Multivariate Logistic Regression Analysis of Factors Influencing Positive Attitude

Variables		Adjusted Odds Ratio (OR)	95% Confidence Interval (CI)	P-Value
Gender	Female (Ref)	1.00	-	0.019*
	Male	0.237	0.07 – 0.79	
Employment Status	Unemployed (Ref)	1.00	-	0.327
	Employed	0.642	0.26 – 1.56	

*Significant correlation at 95% confidence level ($\alpha = 0.05$)

(Ref) indicates the reference category used for the logistic regression model.

Table 5. The association of knowledge with attitude and practices, and the association of attitude with practices

Variable	Attitude	Practices
Knowledge	$r = 0.106$	$r = 0.096$
	$p = 0.271$	$p = 0.319$
Attitude	-	$r = 0.193$
		$p = 0.043^*$

*Significant correlation at 95% confidence level ($\alpha = 0.05$)

Discussion

Our findings illustrate how economic and social changes in LMICs can directly affect people's health behaviors. The respondents' understanding of antibiotics was significantly influenced by their sociodemographic characteristics, such as age, gender, education, and employment. The finding that elderly respondents (≥ 60 years) demonstrated better knowledge than younger adults is notable given the well-documented cognitive changes associated with aging. Several factors may explain this counterintuitive finding: (1) survivorship bias—elderly respondents in our community-based sample may represent healthier individuals with preserved cognitive function; (2) cohort effects—older generations may have had different health education experiences or exposure to antibiotics; and (3) response bias—elderly respondents may have taken more time or asked for clarification on questions. Additionally, our sample of elderly respondents may not be representative of the broader elderly population, particularly those with cognitive impairment who would be less likely to attend puskesmas independently. Future research should assess knowledge using performance-based measures rather than self-report to reduce these potential biases. Regarding gender, male and female respondents showed equivalent levels of overall knowledge. This validates the findings of [16], who reported that gender is not significantly correlated with antibiotic knowledge. Higher educational backgrounds positively correlated with deeper cognitive understanding [17], establishing a significant link between academic history and antibiotic literacy [18]. Unemployed respondents exhibited slightly better knowledge, a phenomenon likely driven by the availability of free time that grants them greater flexibility to access information and socialize [19], validating previous reports that employment status lacks a meaningful relationship with antibiotic literacy [16].

Regarding attitudes toward antibiotic use, group showed more positive attitudes, supporting the notion that advancing age is associated with greater health awareness and optimal disease-prevention behaviors [20]. In contrast, adult demographics exhibited more negative attitudes, likely triggered by dense daily routines and economic pressures that limit healthcare access [21]. Gender played a massive role, with females consistently demonstrating more positive attitudes. This reflects their higher health awareness, protective instincts, and moral responsibilities for family welfare, particularly as mothers, which grants them better literacy in implementing appropriate treatments than men [22]. Although formal education is widely assumed to improve health guideline compliance, higher education in this cohort did not guarantee appropriate attitudes. Employment status also showed that unemployed respondents had better attitude qualities, though some studies argue that employment has no significant correlation with attitudes [23], or knowledge implementation [24].

When evaluating practical behavior, poor compliance was dominant across age groups, exacerbated by low public literacy regarding self-medication and a failure to read medication labels [25], as well as an implicit public awareness of loopholes to access antibiotics freely [26]. Females exhibited better compliance, which

aligns with the premise that men view health merely as the absence of physical disease. In contrast, women view it comprehensively, adopting protective lifestyles [27] and accessing medical facilities faster due to higher health-related anxiety [28]. Higher education did not inherently guarantee better practices, contradicting established concepts that academic attainment ensures efficient information absorption and proper implementation [29]. Unemployed individuals demonstrated slightly better compliance, echoing findings that adequate practices are often dominated by the unemployed and homemakers [30], though other statistical tests prove employment status relationship with adherence [31].

Bivariate and multivariate analyzes further clarified these sociodemographic impacts. Statistical tests confirmed that age and gender were not significantly correlated with respondents' levels of knowledge [16]. While education was significantly correlated with knowledge [32], employment status was not, contradicting past research that found a significant correlation between occupation and knowledge. Regarding attitudes, age, and education, no significant correlations were found [33]. However, gender was positively correlated with attitudes [34], and bivariate tests showed that employment was linked to attitudes [35]. Multivariate analysis confirmed gender's strong influence, driven by women's superior ability to remember family medications [36]. Still, it ultimately determined that employment status had no significant independent effect on attitudes, aligning with Dewi et al. [37]. The multivariate logistic regression model for attitudes included 60 respondents with positive attitudes and 50 with negative attitudes (total $n = 110$). With two predictors (gender and employment status), our model meets the recommended 10 events per predictor variable rule, as we have 30 events per predictor. However, the small number of males ($n = 33$) limits the stability of the gender coefficient. The Hosmer-Lemeshow goodness-of-fit test indicated adequate model fit. We recommend validation of these findings in a larger, gender-balanced sample. For behavior, age and gender lacked significant correlations with good practices [38]. The lack of statistical correlation between education and employment contradicts theories stating that higher academic attainment prompts positive practice changes [39] and that occupation influences usage practices [40].

The absence of a significant correlation between knowledge and practices ($r = 0.096$, $p = 0.319$) is a concerning phenomenon that warrants deeper exploration. This finding directly aligns with the Theory of Planned Behavior's assertion that general knowledge alone is insufficient to predict actual behavior [8]. This knowledge-practice gap may partially reflect limitations in our questionnaire, which primarily assessed theoretical knowledge rather than practical, actionable literacy. Furthermore, the overwhelmingly poor practice scores observed across all sociodemographic groups suggest that strong systemic barriers—such as the ease of obtaining antibiotics without a prescription at local pharmacies [4] and the ingrained cultural prevalence of self-medication [3]—frequently override individual health literacy. Therefore, simply knowing the rules of antibiotic use is not enough; modern interventions must comprehensively address both cognitive intentions and these structural barriers to effectively bridge the gap. Our finding that education is associated with knowledge ($p = 0.044$) but not practices ($p = 0.823$) has significant implications for health policy. This suggests that knowledge acquisition through formal education does not automatically translate into appropriate behavior—a finding consistent with the 'education-behavior gap' literature. Several factors may explain this disconnect: (1) even educated individuals may face structural barriers to proper antibiotic use, including limited access to healthcare, economic constraints, and the ease of obtaining antibiotics without prescription; (2) knowledge may be context-dependent, with individuals knowing the correct answers on a questionnaire but failing to apply this knowledge in real-world situations; and (3) social norms and peer behavior may override individual knowledge. These findings suggest that health interventions should go beyond education to address systemic barriers and social influences.

While we found a statistically significant correlation between attitudes and practices ($r = 0.193$, $p = 0.043$), this represents a weak association that explains only 3.7% of the variance in antibiotic use practices. This suggests that while attitudes contribute to appropriate antibiotic use, other factors—including healthcare access [4], economic constraints [2], and regulatory enforcement [6]—likely play substantial roles. Future research should examine these structural factors alongside attitudes to develop comprehensive interventions. While the Theory of Planned Behavior (TPB) informed our conceptual framework—specifically the hypothesis that attitudes, rather than knowledge alone, drive behavioral intentions—our cross-sectional survey did not fully operationalize all TPB constructs. Subjective norms and perceived behavioral control were not measured due to questionnaire length constraints and the focus on knowledge as the primary comparator to attitudes. However, we acknowledge that these unmeasured TPB constructs likely influence antibiotic use behaviors and should be included in future studies. Our finding that attitudes showed a weak but significant correlation with practices ($r = 0.193$) provides preliminary support for TPB's emphasis on attitudinal factors, while the

large unexplained variance suggests that subjective norms and perceived control may play important roles. In urban areas of LMICs, where healthcare access and regulations often vary, building positive public attitudes can be a practical way to reduce inappropriate self-medication. These findings suggest that focusing on attitude modification can help improve adherence, even when there are gaps in general health literacy. These results suggest that health initiatives in developing urban areas should prioritize shaping public attitudes rather than just providing basic health education to reduce antibiotic resistance.

Specifically, the finding that males had significantly lower odds of holding positive antibiotic attitudes (OR = 0.237, 95% CI: 0.07–0.79) has important implications for intervention design. As noted, men often view health merely as the absence of physical disease rather than adopting protective lifestyles [27], and they generally exhibit lower health-related anxiety, which delays their use of medical facilities [28]. Consequently, public health initiatives must be specifically tailored to reach this demographic. We recommend developing male-focused campaigns that: (1) utilize workplace health education programs, targeting the substantial proportion of respondents employed in the private sector; (2) engage male community leaders as champions for rational antimicrobial stewardship; and (3) leverage digital platforms, considering that the internet serves as a prominent source of health information for the community. However, changing attitudes is not enough if systemic barriers still exist. Health policies need to address the practical obstacles that prevent people from using antibiotics properly, even when they know the risks. Public health authorities must enforce strict regulatory oversight on pharmaceutical dispensing to eliminate the ease of accessing antibiotics without a prescription at local pharmacies. Integrating rational antibiotic coverage more comprehensively within national health insurance schemes can mitigate price factors and reduce the financial incentives driving irrational self-medication. Combining policy reforms with efforts to change public attitudes can help ensure that people use their knowledge to practice responsible antibiotic use. Based on our findings, we recommend the following specific strategies for attitude transformation: (1) Social Norms Campaigns—use mass media and social media to correct misperceptions about antibiotic use norms, particularly highlighting that most community members do not use antibiotics for viral infections; (2) Commitment Devices—develop patient commitment cards at puskesmas where patients pledge to complete full antibiotic courses and not share medications; (3) Behavioral Economics Approaches—use default options or structured guidance that promote appropriate antibiotic prescribing choices; and (4) Community Role Models—train community health volunteers (*kader kesehatan*) to serve as agents of attitude change, addressing the proportion of respondents who reported informal networks as information sources.

The cross-sectional design of this study precludes causal inference. While we found associations between sociodemographic factors and KAP domains, we cannot conclude that education 'causes' better knowledge or that gender 'causes' attitudes. These associations could also reflect reverse causation (e.g., health consciousness leading to both better attitudes and employment choices) or confounding by unmeasured variables (e.g., healthcare-seeking behavior, health literacy). Our findings should be interpreted as exploratory associations requiring verification through longitudinal or interventional studies. This study has several limitations that must be acknowledged. The reliance on convenience sampling and a relatively limited sample size of 110 respondents, which corresponds to a 10% margin of error, may restrict the broad generalizability of the findings to the wider population of South Tangerang City. However, by focusing strictly on patients actively seeking care at primary health centers, the sample accurately reflects the demographic most vulnerable to self-medication practices, providing a highly relevant snapshot of community-level antimicrobial stewardship. The predominance of female respondents (70%) in our sample raises questions about the generalizability of our gender-related findings. This distribution likely reflects both the population of puskesmas users—where women are more likely to seek care for themselves and family members—and potential sampling bias from convenience recruitment during weekday operational hours, which may exclude working men. To explore whether this imbalance affected our findings, we conducted sensitivity analyses comparing the association between gender and attitudes within subgroups. The association remained significant, suggesting that our finding of male-female attitude differences is robust. However, the small number of male respondents ($n = 33$) limits statistical power for subgroup analyses, and we recommend future studies with gender-balanced samples to confirm these patterns. While the KAP model successfully highlights existing behavioral patterns, it remains predominantly descriptive. To develop more targeted interventions, future public health research should transition from broad population surveys to more specific inquiries regarding the intention to comply with antibiotic prescriptions. We recommend using behavioral frameworks like the TPB in future research to better understand the social and cognitive reasons behind antibiotic adherence.

Conclusions

This study provides preliminary evidence that in a community setting, (1) sociodemographic factors, particularly gender, are associated with antibiotic attitudes, and (2) attitudes show a weak but significant correlation with practices ($r = 0.193$), while knowledge does not. Given these findings and the study's limitations, we recommend that: (1) health campaigns incorporate behavior change techniques to transform attitudes, particularly targeting males and employed individuals; (2) future research use longitudinal designs and fully operationalize behavioral frameworks to establish causality and identify additional behavioral determinants; and (3) interventions address both individual attitudes and systemic barriers (healthcare access, regulation enforcement). Until validated in larger, more representative samples, these findings should be considered hypothesis-generating rather than definitive.

Conflict of Interest

The authors have no conflicts of interest to declare.

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