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Knowledge and attitudes toward rational antibiotic use among non-health-related undergraduate students in Lampung, Indonesia: a cross-sectional study

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ABSTRACT

Background: Inappropriate antibiotic use drives antimicrobial resistance (AMR), a growing global health threat. Non-health-related undergraduate students represent a population with limited formal health education yet significant potential to influence community antibiotic use behaviors.

Objective: This study assessed knowledge and attitudes toward rational antibiotic use among non-health-related undergraduate students at Institut Teknologi Sumatera (ITERA), Lampung, Indonesia, and examined the relationship between the two.

Methods: A cross-sectional study was conducted among 288 non-health-related undergraduate students from three faculties at ITERA between July and September 2025. Data were collected using a validated, adapted questionnaire. Descriptive statistics, Kruskal-Wallis and one-way ANOVA tests, and Spearman's rank correlation were performed.

Results: Mean knowledge and attitude scores were 59.98 (SD = 20.20) and 59.23 (SD = 20.82), respectively, both in the moderate category. Key misconceptions included beliefs that antibiotics treat viral infections (48.97%), reduce fever (45.52%), and can be purchased online without a prescription (62.76%). A moderate-to-strong positive correlation was identified between knowledge and attitude ($\rho = 0.650$; 95% CI: 0.575 to 0.714; $p < 0.001$).

Conclusion: Non-health-related undergraduate students at ITERA demonstrated moderate yet insufficient antibiotic knowledge and attitudes. University-level educational interventions are warranted to improve antibiotic literacy and support AMR containment efforts.

Keywords: antibiotic literacy, antimicrobial resistance, cross-sectional study, non-health students, rational antibiotic use

Introduction

Antibiotics have substantially reduced the burden of bacterial infections and remain essential to modern medicine [1]. However, inappropriate antibiotic use has contributed substantially to antimicrobial resistance (AMR), which directly caused an estimated 1.27 million deaths worldwide in 2019 [2]. The 2023 Indonesian Health Survey reported that among 22.1% of the

population who used oral antimicrobials in the past year, 41% obtained these antimicrobials without a prescription [3]. Excessive and improper antibiotic use, such as self-medication, dispensing without prescription, and use for an incorrect duration, has been shown to significantly accelerate the emergence and spread of AMR [4].

Unsupervised antibiotic use remains prevalent, largely driven by the misconception that antibiotics can cure all types of infections, including viral illnesses such as influenza [4,5]. Addressing this problem requires promoting the rational use of antibiotics,

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defined as ensuring that patients receive antibiotics appropriate for their clinical condition, at the correct dose and duration, and at the lowest possible cost to both the individual and the community [6]. Achieving rational use depends on adequate knowledge and positive attitudes among both healthcare professionals and the general public.

Knowledge about antibiotics plays a crucial role in shaping antibiotic use behavior within the community. Studies have demonstrated that individuals with lower levels of antibiotic knowledge are significantly more likely to use antibiotics irrationally [7], whereas higher knowledge and positive attitudes have been associated with more rational antibiotic use behaviors [8]. These findings underscore the importance of educational interventions aimed at improving public antibiotic literacy, which may in turn help reduce inappropriate antibiotic use at the community level.

University students represent a strategic target population for such interventions, as they are not only active medicine users but also future professionals and community decision-makers. Studies have shown that non-health-related undergraduate students tend to have lower levels of antibiotic knowledge compared with health-related students, which may increase the risk of irrational antibiotic use [9,10]. Among non-health-related undergraduate students at Universitas Pelita Harapan, more than 50% demonstrated good knowledge and attitudes toward antibiotic use despite not being enrolled in health-related programs [10]. In contrast, non-health-related undergraduate students at Universitas Garut showed lower levels of knowledge, attitudes, and practices regarding antibiotic use [11]. These variations across institutions and regions highlight the importance of context-specific assessments to identify gaps and guide targeted interventions.

To date, no study has assessed antibiotic knowledge and attitudes among non-health-related undergraduate students at Institut Teknologi Sumatera (ITERA), representing a gap in the regional evidence base. This study therefore aimed to (1) assess the levels of knowledge and attitudes of non-health-related undergraduate students toward rational antibiotic use at ITERA; (2) compare knowledge and attitude levels among students from different faculties; and (3) examine the relationship between students' knowledge and attitudes regarding antibiotic use. The findings are expected to provide empirical evidence for designing educational interventions at the university level and

may contribute to the growing evidence base informing institutional antibiotic stewardship efforts in Indonesia.

Methods

Study design

This study employed a cross-sectional design to assess knowledge and attitudes toward appropriate antibiotic use among non-health-related undergraduate students. Data were collected between July and September 2025 at Institut Teknologi Sumatera (ITERA), Lampung, Indonesia, using a self-administered questionnaire distributed both in person and via Google Forms. Ethical approval was obtained from the Ethics Committee of Jend. A. Yani Regional General Hospital, Metro, Lampung (reference number 370/656/KEPK-LE/LL-02/2025).

Study population and sampling

The study population consisted of non-health-related undergraduate students from the 2022 intake at ITERA, which comprises three faculties: the Faculty of Science (FS), the Faculty of Industrial Technology (FTI), and the Faculty of Infrastructure and Regional Technology (FTIK). Participants were eligible if they were actively enrolled at the time of data collection, able to read and understand the questionnaire, and willing to participate by providing written informed consent. Pharmacy students were excluded, as were respondents who submitted incomplete questionnaires, duplicate demographic entries, or responses with identical answer patterns across all items.

The minimum required sample size was calculated using the Slovin formula with a 5% margin of error, yielding a minimum of 365 respondents. A total of 288 valid responses were obtained after applying the exclusion criteria, corresponding to approximately 7.5% of the target population and an estimated margin of error of 5.7%. Although the final sample did not reach the calculated minimum, this margin of error remains acceptable for descriptive cross-sectional studies, and the sample size is sufficient to detect the observed correlation ($\rho = 0.650$) with high statistical power.

Instrument

Data were collected using a questionnaire adapted from the Knowledge, Attitude, and Practice towards Antibiotics Questionnaire (KAPAQ) developed and validated by Karuniawati et al. [12]. The original items

were reviewed for contextual appropriateness, and the adapted version underwent revalidation with 123 second-year ITERA students who were not included in the main study sample.

Construct validity was assessed using item-total correlation analysis, with a critical r value of 0.1771 (Pearson, $p = 0.05$, $n = 123$) as the minimum acceptable threshold. All items met this criterion (knowledge: $r = 0.184$ to 0.707 ; attitude: $r = 0.592$ to 0.797). Internal consistency was evaluated using Cronbach's alpha, yielding acceptable reliability for both scales (knowledge: $\alpha = 0.791$; attitude: $\alpha = 0.898$).

The knowledge scale comprised 20 items across six domains: identification of antibiotics (S1 to S3), role of antibiotics (S4 to S7), antibiotic access (S8 to S11), effects of antibiotic misuse (S12 to S15), side effects of antibiotics (S16 to S17), and antibiotic use (S18 to S20). The attitude scale comprised 12 items across four domains: antibiotic resources (A1 to A5), leftover antibiotics (A6 to A8), antibiotic use (A9 to A10), and expectations regarding antibiotics (A11 to A12). All items were scored on a scale of 0 to 100, and respondents were categorized into three levels: low (below 50%), moderate (50% to 70%), and high (above 70%) [13].

Statistical analysis

Respondent characteristics, knowledge scores, and attitude scores were summarized using descriptive statistics. Differences in knowledge scores among faculties were assessed using the Kruskal-Wallis test, while differences in attitude scores were assessed using one-way ANOVA. The relationship between knowledge and attitude levels was examined using Spearman's rank correlation. Statistical significance was set at $p < 0.05$. All analyses were performed using SPSS version 30.

Results

Participant characteristics

A total of 288 participants met the inclusion and exclusion criteria and were included in the final analysis. All participants were non-health-related undergraduate students from the 2022 intake at ITERA. The majority were aged 21 to 22 years (78.82%), female (60.07%), enrolled in the Faculty of Industrial Technology (51.04%), and from Lampung Province (44.10%). The complete demographic characteristics of all participants are presented in Table 1.

Table 1. General characteristics of respondents

Variable	Total (N=288)	Percentage (%)
Age (years old)		
19-20	53	18.40
21-22	227	78.82
23-24	7	2.43
25-26	1	0.35
Sex		
Male	115	39.93
Female	173	60.07
Faculty		
FS	80	27.78
FTI	147	51.04
FTIK	61	21.28
Province of origin		
Aceh	1	0.35
Bangka Belitung Islands	1	0.35
Banten	12	4.17
Bengkulu	4	1.39
DKI Jakarta	13	4.51
Jambi	5	1.74
West Java	24	8.33
East Java	2	0.69
Riau Islands	4	1.39
Lampung	127	44.10
Riau	6	2.08
West Sumatera	17	5.90
North Sumatera	52	18.06
South Sumatera	20	6.94

FS= Faculty of Science; FTI=Faculty of Industrial Technology; FTIK=Faculty of Infrastructure and Regional Technology

The mean knowledge score was 59.98 (SD = 20.20) and the mean attitude score was 59.23 (SD = 20.82), both falling within the moderate category (50% to 70%) (Table 2). Only 28.47% of respondents demonstrated a high level of knowledge, and 31.60% demonstrated a positive attitude toward antibiotic use. A substantial proportion of respondents fell in the low category for both knowledge (30.56%) and attitude (31.60%).

The Kruskal-Wallis test indicated no statistically significant difference in knowledge scores among the three faculties ($H = 3.509$; $p = 0.173$). Similarly, one-way ANOVA revealed no significant difference in attitude scores among faculties ($F = 0.415$; $p = 0.661$; $\eta^2 = 0.003$), indicating a negligible effect size. These findings suggest that knowledge and attitude levels were relatively uniform across FS, FTI, and FTIK.

Table 2. Distribution of respondents' knowledge and attitude scores

Variabel	Number of items	Score range	Total score (%) (Mean ± SD)	Number of respondents (%) N = 288		
				Low (<50%)	Moderate (50-70%)	High (>70%)
Knowledge	20	0-100	59.98 ± 20.20	88 (30.56)	118 (40.97)	82 (28.47)
Attitude	12	0-100	59.23 ± 20.82	91 (31.60)	106 (36.80)	91 (31.60)

Knowledge questionnaire responses

Detailed responses to each knowledge item are presented in Table 3. Overall, respondents demonstrated adequate knowledge in certain areas but exhibited notable gaps and misconceptions across several domains.

In the identification domain, 91.38% correctly identified amoxicillin as an antibiotic (S1), while 33.45% incorrectly identified paracetamol as an antibiotic (S3). Familiarity with less commonly known antibiotics was limited, as only 46.90% correctly identified Supertetra® as an antibiotic (S2), with 40.34% selecting "don't know."

In the role of antibiotics domain, 90.69% correctly recognized that antibiotics are used to kill bacteria (S4), and 70.00% correctly identified that colds and flu can resolve without antibiotics (S6). However, 48.97% incorrectly believed that antibiotics can be used to treat viral infections (S5), and 45.52% incorrectly believed that antibiotics can reduce fever (S7).

In the antibiotic access domain, the most prominent knowledge gap was observed: 62.76% of respondents incorrectly believed that antibiotics can be purchased online without a prescription (S8), and 41.83% believed that amoxicillin can be obtained at a pharmacy without a doctor's prescription (S10). By contrast, 70.34% correctly identified that taking antibiotics obtained from others is inappropriate (S9), and 71.72% correctly recognized that antibiotics cannot be purchased at a grocery store (S11).

In the effects of antibiotic misuse domain, the majority of respondents demonstrated awareness of the consequences of inappropriate use: 73.45% correctly identified that it can lead to antimicrobial resistance (S12), 70.00% recognized that it can render antibiotics ineffective in the future (S13), 67.59% acknowledged that it can cause more severe illness (S14), and 64.83% recognized that it increases treatment costs (S15). Nevertheless, between 15.86% and 19.66% of respondents selected "don't know" across these items,

suggesting limited depth of understanding despite generally correct responses.

In the side effects domain, knowledge was comparatively limited. Only 57.93% correctly recognized that antibiotics can cause allergic reactions such as skin redness (S16), and only 37.93% correctly identified that antibiotics can disrupt beneficial intestinal bacteria (S17), with 30.69% selecting "don't know" for the latter item.

In the antibiotic use domain, 44.83% of respondents incorrectly believed that antibiotics should be stored for future illness (S18), and 42.76% incorrectly believed that antibiotic treatment can be stopped once symptoms improve (S20). Only 58.28% correctly recognized that leftover antibiotics should not be reused (S19).

Attitude questionnaire responses

Detailed responses to each attitude item are presented in Table 4. For items reflecting irrational or unsafe attitudes (A1 to A8, A10, A11, and A12), the proportion of respondents selecting "agree or strongly agree" represents the prevalence of unfavorable attitudes. For item A9, which reflects a rational practice (completing the full antibiotic course), "agree or strongly agree" represents a favorable response.

In the antibiotic resources domain, a notable proportion of respondents demonstrated attitudes inconsistent with rational antibiotic use. Nearly half (45.86%) agreed or strongly agreed that they would obtain antibiotics from a pharmacy when not prescribed by their physician (A4), and 32.48% agreed or strongly agreed that they hoped a pharmacist would dispense amoxicillin without a prescription (A1). In addition, 22.76% indicated they would feel pleased about purchasing antibiotics without a prescription (A3), and 32.76% agreed or strongly agreed that they would feel disappointed if they did not receive antibiotics during a medical consultation (A5). Only 11.38% agreed or strongly agreed that they would purchase antibiotics

Table 3. Respondents' answers to the knowledge questionnaire

Domain	Statements	Expected ideal response	Correct n (%)	Incorrect n (%)	Don't know n (%)
Identification of antibiotics	S1. <i>Amoxicillin adalah antibiotik</i> (Amoxicillin is an antibiotic)	Yes	265 (91.38)	3 (1.03)	20 (6.90)
	S2. <i>Supertetra® adalah antibiotik</i> (Supertetra® is an antibiotic)	Yes	136 (46.90)	35 (12.07)	117 (40.34)
	S3. <i>Paracetamol adalah antibiotik</i> (Paracetamol is an antibiotic)	No	184 (63.45)	97 (33.45)	7 (2.41)
Role of antibiotics	S4. <i>Antibiotik adalah obat yang digunakan untuk membunuh bakteri</i> (Antibiotics are drugs used to kill bacteria)	Yes	263 (90.69)	16 (5.52)	9 (3.10)
	S5. <i>Antibiotik dapat digunakan untuk mengobati infeksi karena virus</i> (Antibiotics can be used to treat infections caused by viruses)	No	120 (41.38)	142 (48.97)	26 (8.97)
	S6. <i>Pilek dan flu dapat sembuh tanpa antibiotik</i> (Colds and flu can be cured without antibiotics)	Yes	203 (70.00)	69 (23.79)	16 (5.52)
	S7. <i>Antibiotik dapat menurunkan demam</i> (Antibiotics can reduce fever)	No	126 (43.45)	132 (45.52)	30 (10.34)
Antibiotic access	S8. <i>Antibiotik bisa dibeli secara online</i> (Antibiotics can be purchased online)	No	75 (25.86)	182 (62.76)	31 (10.69)
	S9. <i>Antibiotik pemberian orang lain boleh diminum</i> (Antibiotics given by others may be taken)	No	204 (70.34)	55 (18.97)	29 (10.00)
	S10. <i>Amoxicillin dapat dibeli di apotek tanpa resep dokter</i> (Amoxicillin can be purchased at a pharmacy without a doctor's prescription)	No	143 (49.31)	120 (41.83)	25 (8.62)
	S11. <i>Antibiotik dapat dibeli di warung kelontong</i> (Antibiotics can be purchased at a grocery store)	No	208 (71.72)	52 (17.93)	28 (9.66)
Effects of antibiotic misuse	S12. <i>Penggunaan antibiotik yang tidak sesuai akan menyebabkan kuman menjadi kebal</i> (Inappropriate use of antibiotics will cause antimicrobial resistance)	Yes	213 (73.45)	29 (10.00)	46 (15.86)
	S13. <i>Penggunaan antibiotik yang tidak sesuai akan menyebabkan antibiotik tersebut kelak tidak bisa digunakan lagi</i> (Inappropriate use of antibiotics will render them ineffective in the future)	Yes	203 (70.00)	32 (11.03)	53 (18.28)
	S14. <i>Penggunaan antibiotik yang tidak sesuai dapat menyebabkan penyakit tambah parah</i> (Inappropriate use of antibiotics can cause more severe illness)	Yes	196 (67.59)	35 (12.07)	57 (19.66)
	S15. <i>Penggunaan antibiotik yang tidak sesuai menyebabkan biaya meningkat</i> (Inappropriate use of antibiotics increases treatment costs)	Yes	188 (64.83)	43 (14.83)	57 (19.66)
Side effects of antibiotics	S16. <i>Antibiotik bisa menyebabkan alergi seperti kemerahan pada kulit</i> (Antibiotics can cause allergic reactions such as skin redness)	Yes	168 (57.93)	36 (12.41)	84 (28.97)
	S17. <i>Antibiotik dapat membunuh bakteri baik yang ada di usus</i> (Antibiotics can kill beneficial bacteria in the intestines)	Yes	110 (37.93)	89 (30.69)	89 (30.69)
Antibiotic use	S18. <i>Antibiotik perlu disimpan untuk jaga-jaga jika sakit di kemudian hari</i> (Antibiotics should be stored in case of future illness)	No	133 (45.86)	130 (44.83)	25 (8.62)
	S19. <i>Antibiotik sisa bisa digunakan kembali jika sakit</i> (Leftover antibiotics can be reused when feeling ill)	No	169 (58.28)	80 (27.59)	39 (13.45)
	S20. <i>Antibiotik bisa dihentikan jika sakit sudah membaik</i> (Antibiotic treatment can be stopped once symptoms improve)	No	148 (51.03)	124 (42.76)	16 (5.52)

from a grocery store when ill (A2), suggesting that the boundary between formal and informal antibiotic access is partially recognized.

In the leftover antibiotics domain, 24.49% of respondents agreed or strongly agreed that they would keep leftover antibiotics for future use (A7), and 18.62% believed that doing so would save them the cost of a doctor visit (A6). Furthermore, 14.82% indicated they would share their leftover antibiotics with others to help them recover (A8).

In the antibiotic use domain, responses to A9 and A10 revealed an internal inconsistency. While 54.82% agreed or strongly agreed that they would complete the full antibiotic course even after symptom improvement (A9), reflecting a favorable attitude, 38.27% also agreed or strongly agreed that they would stop taking antibiotics once feeling better (A10), reflecting an unfavorable attitude. The coexistence of these opposing responses within the same domain suggests that a proportion of respondents held contradictory attitudes regarding antibiotic adherence.

In the expectations domain, more than half of respondents (55.52%) agreed or strongly agreed that they would take antibiotics in the hope of speeding recovery from a cold or flu (A12), and 40.69% hoped that a physician would prescribe antibiotics when they had a cold (A11). These findings indicate a persistent tendency to expect antibiotic prescriptions for viral illnesses, which is consistent with the knowledge gaps identified in the role of antibiotics domain (S5 and S7, Table 3).

Correlation between knowledge and attitude

Spearman's rank correlation analysis revealed a statistically significant positive relationship between knowledge and attitude scores ($\rho = 0.650$; 95% CI: 0.575 to 0.714; $p < 0.001$), indicating a moderate-to-strong association (Table 5). This finding suggests that respondents with higher levels of antibiotic knowledge tended to demonstrate more positive attitudes toward rational antibiotic use.

Discussion

This cross-sectional study assessed knowledge and attitudes toward rational antibiotic use among non-health-related undergraduate students at ITERA, Lampung, Indonesia. The mean scores for both knowledge (59.98 ± 20.20) and attitude ($59.23 \pm$

20.82) fell within the moderate category, with only 28.47% of respondents demonstrating high knowledge and 31.60% demonstrating positive attitudes toward rational antibiotic use. Several critical misconceptions were identified, including the belief that antibiotics can treat viral infections (48.97%), that antibiotics can reduce fever (45.52%), and that antibiotics can be purchased online without a prescription (62.76%). A moderate-to-strong positive correlation was found between knowledge and attitude ($\rho = 0.650$; 95% CI: 0.575 to 0.714; $p < 0.001$), indicating that improvements in antibiotic knowledge are likely to be accompanied by more rational attitudes toward antibiotic use.

The moderate levels of knowledge and attitude observed in this study are consistent with findings reported among non-health-related undergraduate students in Garut and Bangkalan [11,14]. Statistical analysis further indicated that knowledge and attitude levels were relatively uniform across the three faculties at ITERA, suggesting that the observed gaps are not specific to any particular academic discipline but rather reflect a broader pattern among non-health-related students at this institution. These findings highlight the need for university-wide educational interventions on appropriate antibiotic use, rather than faculty-specific approaches.

Misconceptions regarding the role of antibiotics were prevalent in this study. Nearly half of respondents (48.97%) incorrectly believed that antibiotics can be used to treat viral infections, and 45.52% believed that antibiotics can reduce fever. The belief that paracetamol is an antibiotic (33.45%) is closely related to these misconceptions, as paracetamol is commonly used as an antipyretic and is not classified as an antibiotic. These misconceptions were further reflected in respondents' attitudes, where 40.69% hoped a physician would prescribe antibiotics when they had a cold, and 55.52% indicated they would take antibiotics in the hope of speeding recovery from a cold or flu (A11 to A12, Table 4). Similar misconceptions have been reported among community populations in Yogyakarta, Malang, and Boyolali [13,15,16], suggesting that these misunderstandings are not confined to student populations but reflect broader gaps in public antibiotic literacy in Indonesia. These findings underscore the need for educational interventions that help students distinguish between bacterial and viral infections and understand the specific indications for antibiotic use.

Table 4. Respondents' answers to the attitude questionnaire

Domain	Statements	Strongly Disagree n (%)	Disagree n (%)	Doubtful n (%)	Agree n (%)	Strongly Agree n (%)
Antibiotic resources	A1. <i>Saya berharap petugas apotek memberi saya amoxicillin ketika saya membelinya di apotek tanpa resep dokter</i> (I hope the pharmacist gives me amoxicillin when I buy it at the pharmacy without a doctor's prescription)	57 (19.66)	93 (32.07)	48 (16.55)	69 (23.79)	21 (7.24)
	A2. <i>Jika saya sakit, saya akan membeli antibiotik di warung kelontong</i> (If I am ill, I will buy antibiotics at a grocery store)	107 (36.90)	100 (34.48)	48 (16.55)	26 (8.97)	7 (2.41)
	A3. <i>Saya senang ketika saya bisa membeli antibiotik di apotek tanpa resep dokter</i> (I am pleased when I can buy antibiotics at the pharmacy without a physician's prescription)	73 (25.17)	96 (33.10)	53 (18.28)	51 (17.59)	15 (5.17)
	A4. <i>Ketika saya tidak mendapatkan antibiotik dari dokter, maka saya akan membeli antibiotik di apotek</i> (When I do not receive antibiotics from the doctor, I will buy antibiotics at the pharmacy)	49 (16.90)	72 (24.83)	34 (11.72)	106 (36.55)	27 (9.31)
	A5. <i>Saya akan kecewa jika saya berobat tidak mendapatkan antibiotik</i> (I will be disappointed if I seek treatment but do not receive antibiotics)	41 (14.14)	86 (29.66)	66 (22.76)	68 (23.45)	27 (9.31)
Leftover antibiotics	A6. <i>Menggunakan antibiotik sisa akan menghemat biaya karena tidak perlu periksa ke dokter</i> (Using leftover antibiotics will save money because I do not need to see a doctor)	84 (28.97)	110 (37.93)	40 (13.79)	48 (16.55)	6 (2.07)
	A7. <i>Saya akan menyimpan antibiotik sisa karena bermanfaat di kemudian hari</i> (I will keep leftover antibiotics because they may be useful in the future)	83 (28.62)	78 (26.90)	56 (19.31)	55 (18.97)	16 (5.52)
	A8. <i>Saya akan memberikan antibiotik sisa saya kepada orang lain untuk membantu kesembuhannya</i> (I will give my leftover antibiotics to others to help them recover)	103 (35.52)	106 (36.55)	36 (12.41)	34 (11.72)	9 (3.10)
Antibiotic use	A9. <i>Saya akan minum antibiotik sampai habis walaupun sakit saya sudah membaik</i> (I will complete the full antibiotic course even if my condition has improved)	39 (13.45)	56 (19.31)	34 (11.72)	69 (23.79)	90 (31.03)
	A10. <i>Jika sakit sudah membaik, saya akan menghentikan minum antibiotik</i> (If I feel better, I will stop taking antibiotics)	73 (25.17)	70 (24.14)	34 (11.72)	69 (23.79)	42 (14.48)
Expectations regarding antibiotics	A11. <i>Ketika saya mengalami flu dan pilek, saya berharap dokter memberi saya antibiotik</i> (When I have a cold or flu, I hope the doctor prescribes me antibiotics)	38 (13.10)	50 (17.24)	82 (28.28)	90 (31.03)	28 (9.66)
	A12. <i>Saya akan minum antibiotik dengan harapan antibiotik bisa mempercepat penyembuhan flu pilek saya</i> (I will take antibiotics in the hope that they will speed up my recovery from a cold or flu)	29 (10.00)	38 (13.10)	60 (20.69)	122 (42.07)	39 (13.45)

Table 5. Spearman's rank correlation between knowledge level and college students' attitude toward antibiotic use (N = 288)

Variables correlated	Spearman's ρ (r_s)	95% Confidence interval	p-value
Knowledge-attitude toward antibiotic use	0.650	0.575-0.714	<0.001

The most prominent knowledge gap identified in this study concerned antibiotic access: 62.76% of respondents incorrectly believed that antibiotics can be purchased online without a prescription, and 41.83% believed that amoxicillin can be obtained at a pharmacy without a doctor's prescription. These findings are particularly concerning in the context of Indonesia's expanding e-commerce and digital health landscape, where the regulatory boundaries of online pharmaceutical sales remain incompletely enforced. Current Indonesian regulations prohibit the online sale of prescription-only medicines, including antibiotics, yet public awareness of this restriction appears limited among this population. Consistent with these knowledge gaps, 45.86% of respondents agreed or strongly agreed that they would obtain antibiotics from a pharmacy when not prescribed by their physician (A4, Table 4), and 22.76% reported feeling pleased about purchasing antibiotics without a prescription (A3, Table 4). These attitudes reflect a pattern of self-medication that has been documented across many low- and middle-income countries [17,18] and is driven in part by weak regulatory enforcement at the point of dispensing [19]. Strengthening both public awareness of prescription requirements and pharmacy-level regulatory oversight is therefore essential to reduce unsupervised antibiotic access in this population.

An associated finding is the tendency among respondents to seek antibiotics from a pharmacy when their physician did not prescribe them (A4, Table 4). This behavior likely reflects not only limited knowledge of when antibiotics are clinically indicated but also a degree of distrust in clinical decision-making when treatment expectations are unmet. Addressing this issue requires educational approaches that explain the medical rationale behind a physician's decision not to prescribe antibiotics, enabling patients to better understand and accept such decisions [19].

Awareness of the consequences of inappropriate antibiotic use was relatively higher compared with other knowledge domains, with 73.45% correctly identifying that inappropriate use can lead to antimicrobial resistance (S12, Table 3). However, between 15.86% and 19.66% of respondents selected "don't know" across items in this domain, suggesting that awareness does not always translate into a thorough understanding of the mechanisms and implications of AMR. Furthermore, 42.76% of respondents incorrectly believed that antibiotic treatment can be stopped once symptoms

improve (S20, Table 3), a finding consistent with a study conducted in Bali [20]. Early discontinuation of antibiotic therapy is a well-recognized driver of treatment failure and resistance development, and this misconception likely contributes to the storage and reuse of leftover antibiotics observed in this study.

Regarding leftover antibiotic practices, 24.49% of respondents agreed or strongly agreed that they would keep leftover antibiotics for future use (A7, Table 4), 18.62% believed this practice would save them the cost of a doctor visit (A6, Table 4), and 14.82% indicated they would share leftover antibiotics with others (A8, Table 4). These practices not only increase the risk of AMR but may also lead to inappropriate or ineffective treatment. Similar patterns have been reported in studies conducted in Saudi Arabia, the United States, and Malaysia [21,22,23,24], indicating that leftover antibiotic management is a global public health concern that warrants targeted behavioral interventions.

Knowledge of antibiotic side effects was notably limited in this study, with only 37.93% correctly recognizing that antibiotics can disrupt beneficial intestinal bacteria (S17, Table 3) and 28.97% unaware that antibiotics can cause allergic reactions (S16, Table 3). This gap is particularly relevant from a patient safety perspective, as inadequate awareness of potential adverse effects may reduce vigilance and delay appropriate responses to adverse drug reactions. Incorporating antibiotic side effect education into broader antibiotic literacy programs is therefore warranted.

The moderate-to-strong positive correlation between knowledge and attitude ($\rho = 0.650$; $p < 0.001$) observed in this study is consistent with findings from studies conducted in Bangladesh and Bali [7,8], and suggests that knowledge is a meaningful determinant of rational antibiotic attitudes among this population. However, it is important to note that a positive attitude does not necessarily translate into rational behavior, as the relationship between attitude and practice is mediated by additional factors including social norms, access to healthcare, and regulatory enforcement. Future studies should extend the assessment to include antibiotic use practices, and should examine the relative contributions of knowledge, attitude, and contextual factors to actual antibiotic use behavior among non-health-related students in Indonesia.

This study has several limitations. The final sample size ($n = 288$) did not reach the calculated minimum

of 365, although the resulting margin of error of 5.7% remains acceptable for descriptive analysis, and the sample is sufficient to detect the observed correlation with high statistical power. Voluntary participation may limit the generalizability of findings to the broader non-health-related student population at ITERA. As data were collected using a self-administered questionnaire, recall bias and social desirability bias cannot be excluded. Additionally, this study did not examine the influence of demographic variables such as sex or province of origin on knowledge and attitude scores, which may represent important sources of variation. Finally, the study was conducted at a single institution, and findings should be interpreted within this institutional context rather than extrapolated to the national level without further evidence.

Conclusion

This study demonstrates that non-health-related undergraduate students at ITERA possess moderate levels of knowledge and attitudes toward rational antibiotic use, with only 28.47% and 31.60% achieving high scores in knowledge and attitude, respectively. Critical misconceptions persist regarding the role of antibiotics in treating viral infections and reducing fever, the legality and safety of purchasing antibiotics without a prescription, and the importance of completing a full antibiotic course. Unsafe attitudes toward leftover antibiotic storage, reuse, and sharing were also identified. A moderate-to-strong positive correlation between knowledge and attitude indicates that strengthening antibiotic knowledge is likely to support more rational attitudes among students. These findings provide empirical evidence for the design of university-level educational interventions to improve antibiotic literacy and contribute to institutional efforts to combat antimicrobial resistance in Indonesia.

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Conflict of Interest

None.

Author contributions

YO contributed to the conception and design of the study, literature research and selection, supervised the research process, data analysis, and the drafting and revision of the manuscript. UH, JJ, and DM contributed by providing feedback, suggestions, and assisting with the preparation and implementation of the research. DYA and SNA supported field data collection and interpretation, and documentation activities. All authors reviewed and approved the final version of the manuscript.

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