Original Article

# Comparative Study on Knowledge and Awareness of Antibiotics and Antibiotic Resistance Among Healthcare and Non-Healthcare Students

**Jemisha J[1], Kenneth N[2], Ancy S[3], Jenifer R M[3], Jenila J H[3], Keerthi D[3]**

[1] Assistant Professor, Department of Pharmacy practice, Immanuel Arasar College of Pharmacy, Marthandam, Tamil Nadu 629165, India.

[2] Principal, Immanuel Arasar College of Pharmacy, Marthandam, Tamil Nadu 629165, India.

[3] B. Pharm students, Immanuel Arasar College of Pharmacy, Marthandam, Tamil Nadu 629165, India.

***Corresponding author's E-mail:** Jemisha2000j@gmail.com

**Received:** 15-04-2026; **Revised:** 26-06-2026; **Accepted:** 03-07-2026; **Published online:** 20-07-2026.

**ABSTRACT**

Antimicrobial resistance (AMR) is a major global public health concern, primarily driven by the inappropriate and excessive use of antibiotics. University students, particularly those in healthcare-related fields, represent an important population whose knowledge and practices may significantly influence AMR trends. This study aimed to assess and compare the knowledge and awareness of antibiotics and antibiotic resistance among healthcare and non-healthcare university students. A cross-sectional study was conducted among 200 students, including 100 healthcare and 100 non-healthcare students, using a structured and validated questionnaire distributed through Google Forms. The questionnaire assessed background awareness, knowledge of antibiotics, patterns of antibiotic use, and understanding of antibiotic resistance, and the collected data were analyzed using descriptive statistics. The findings revealed that healthcare students demonstrated consistently higher knowledge scores across all assessed domains compared to non-healthcare students. Overall awareness of antibiotic resistance was 78.5%; however, several misconceptions were identified, including the belief that antibiotics are effective against viral infections (61.5% incorrect) and that it is safe to discontinue antibiotics once symptoms improve (64% incorrect). Although the overall level of awareness regarding antibiotic resistance was moderate to high, important knowledge gaps persist among both groups. These findings highlight the urgent need for targeted educational interventions and strengthened antibiotic stewardship programs, particularly among non-healthcare students.

**Keywords:** Antibiotic resistance, antimicrobial stewardship, healthcare students, knowledge attitude practice, self-medication, antibiotic misuse.

## INTRODUCTION

The term "antibiotics" was first coined by the American microbiologist Selman Waksman and his colleagues to describe chemical substances produced by microorganisms that have antagonistic effects on the growth of other microorganisms. Antibiotics are obtained from bacteria, fungi, and actinomycetes and may suppress or destroy microbial growth. They differ in physical, chemical, pharmacological properties, antibacterial spectra, and mechanism of action.

Antibiotics are among the most important therapeutic agents in the treatment of bacterial infections and have significantly reduced morbidity and mortality worldwide. However, the inappropriate and excessive use of antibiotics has led to the rapid emergence of antibiotic resistance, now recognized as one of the major global public health threats. The World Health Organization (WHO) has identified antibiotic resistance as a serious challenge that threatens the effective prevention and treatment of a growing number of infectious diseases (WHO, 2023).

Antibiotic resistance occurs when bacteria develop the ability to survive exposure to antibiotics that were previously effective. This results in prolonged illness, increased healthcare costs, treatment failures, and higher mortality rates. Recent global reports indicate a significant rise in resistant infections, particularly in low- and middle-income countries, including India, where over-the-counter availability and self-medication are common practices.

University students represent an important population group, as they are future professionals and key decision-makers in society. Health-related students—including medical, pharmacy, and nursing students—are expected to possess greater knowledge regarding antibiotics due to their academic training. In contrast, non-health-related students may harbor misconceptions that lead to self-medication and inappropriate antibiotic use.

Therefore, a comparative study of knowledge and awareness between these two groups is essential to identify gaps and develop targeted educational strategies. Such studies can inform policymakers, educators, and healthcare institutions in designing effective antibiotic stewardship programs.

### Historical Background

The earliest evidence of intentional antibiotic use dates to ancient Nubian societies (350–550 CE), where populations consumed tetracycline through fermented grain beverages. In various ancient civilizations including Egypt, China, Greece, and Rome, moldy bread was applied topically to treat infections. Synthetic antibiotic chemotherapy as a science began in Germany with Paul Ehrlich in the late 1880s. Alexander Fleming discovered modern penicillin in 1928, with widespread use proving critical during wartime.

The first systemically active antibacterial drug, Prontosil (a sulphonamide), was developed by Gerhard Domagk in 1932–1933 at Bayer Laboratories, Germany.

The effectiveness and accessibility of antibiotics have, paradoxically, accelerated bacterial resistance. The WHO has classified antimicrobial resistance (AMR) as a "serious threat that is no longer a prediction for the future, it is happening right now in every region of the world." Nearly 5 million deaths are associated with AMR globally each year, with 1.27 million deaths directly attributable in 2019 alone.

## CLASSIFICATION OF ANTIBIOTICS

Antibiotics can be classified across three primary frameworks:

### Classification by Mechanism of Action

This is the most clinically relevant classification, targeting specific bacterial processes:

- Inhibition of Cell Wall Synthesis: Beta-lactams (penicillin's, cephalosporins, carbapenems), glycopeptides (vancomycin)
- Inhibition of Protein Synthesis: 30S subunit inhibitors (aminoglycosides, tetracyclines); 50S subunit inhibitors (macrolides, chloramphenicol)
- Inhibition of Nucleic Acid Synthesis: Fluoroquinolones (DNA gyrase), rifampin (RNA polymerase)
- Disruption of Plasma Membrane: Polymyxins (colistin), lipopeptides (daptomycin)
- Inhibition of Essential Metabolites: Sulfonamides, trimethoprim

### Classification by Spectrum of Activity

| Category | Description | Examples |
|---|---|---|
| Narrow Spectrum | Effective against specific bacterial groups only. Minimizes damage to normal flora. | Penicillin G, Vancomycin |
| Broad Spectrum | Effective against both Gram-positive and Gram-negative bacteria. | Tetracyclines, Amoxicillin, Carbapenems |
| Extended Spectrum | Chemically modified narrow-spectrum drugs with expanded coverage. | Ampicillin |

### Classification by Mode of Action

- Bactericidal ("Killers"): Result in bacterial cell death; irreversible action. Examples: penicillin's, cephalosporins, aminoglycosides, metronidazole.
- Bacteriostatic ("Stoppers"): Inhibit growth and reproduction without immediately killing bacteria; reversible. Examples: tetracyclines, sulphonamides, macrolides.

### Antibiotic Misuse and Global Burden

Antibiotic misuse—encompassing frequent, unnecessary, or incorrectly prescribed antibiotic use—is the primary driver of the global AMR crisis. Antibiotics are inappropriately prescribed for viral infections such as the common cold, flu, or most sore throats, against which they have no therapeutic effect. Unnecessary antibiotic use creates a "selection pressure" where resilient bacteria survive, mutate, and multiply, developing defence mechanisms such as enzyme production, efflux pumps, and horizontal gene transfer.

The consequences extend beyond individual patients, contributing to "superbugs" resistant to multiple drug classes. Without urgent intervention, drug-resistant infections are projected to cause up to 10 million deaths annually by 2050 and lead to massive economic losses. Recent global surveillance shows that antibiotic consumption has risen approximately 16.3% since 2016. India remains one of the world's largest antibiotic consumers, with growing use of high-risk "Watch group" antibiotics (WHO Global Antibiotic Resistance Surveillance Report, 2025; ICMR, 2024).

## MATERIALS AND METHODS

### Study Design

A cross-sectional descriptive study was conducted to assess and compare knowledge and awareness regarding antibiotics and antibiotic resistance among healthcare and non-healthcare university students.

### Study Population and Sampling

A total of 200 students were enrolled: 100 healthcare students and 100 non-healthcare students, selected using a convenience sampling method. Participants were required to be currently enrolled students aged 18 years or above, willing to participate, and able to access the online questionnaire. Students below 18 years of age, those who submitted incomplete or duplicate responses, and non-enrolled individuals were excluded.

### Data Collection Instrument

A structured questionnaire was developed and validated with expert review for content validity (coverage of all relevant aspects), construct validity (measures intended constructs), and question clarity. The questionnaire comprised five sections:

- Section A: Demographic details (course of study, gender, age, antibiotic use in the past 12 months)

- Section B: Background awareness (8 items)
- Section C: Knowledge about antibiotics (10 items)
- Section D: Knowledge about antibiotic use (6 items)
- Section E: Knowledge about antibiotic resistance (11 items)

All items were formatted as Yes/No questions. The questionnaire was converted into a Google Form and distributed via WhatsApp, email, and Instagram.

### Statistical Analysis

Collected data were checked for completeness and exported from Google Forms. Descriptive statistics including percentage, mean, and mode were used to analyse and compare responses between healthcare and non-healthcare student groups.

### Ethical Considerations

Participation was entirely voluntary. Responses were kept confidential and no personal identification data were collected.

## RESULTS

### Demographic Profile

Of the 200 respondents, 50% were healthcare students and 50% were non-healthcare students. The gender distribution showed 65% female (n=130) and 35% male (n=70). Regarding age, the majority (67%) were in the 21–30 years group, followed by 29% in the 18–20 group. Within the past 12 months, 71% (n=142) reported using antibiotics.

### Background Awareness

**Table 1:** Background Awareness of Antibiotic Resistance Among Respondents

| Parameter | Total (%) | Healthcare (%) | Non-Healthcare (%) |
|---|---|---|---|
| Aware of the term antibiotic resistance | 78.5 | 46.5 | 34.0 |
| Aware that misuse affects future generations | 72.5 | 37.5 | 35.0 |
| Aware of antimicrobial stewardship | 50.5 | 32.0 | 18.5 |
| Know antibiotics used in animals and humans | 87.0 | 46.5 | 40.5 |
| Believe antibiotic resistance is a serious healthcare problem | 80.5 | 44.0 | 36.5 |
| Aware of WHO agenda on antibiotic resistance | 67.5 | 39.5 | 28.0 |

Healthcare students consistently demonstrated greater background awareness across all items. Awareness of antimicrobial stewardship was notably lower (50.5%) compared to other items, highlighting a gap requiring targeted educational focus. A total of 35.5% of respondents reported attending any seminar or training on antibiotic resistance in the previous year.

### Knowledge About Antibiotics

**Table 2:** Knowledge About Antibiotics Among Respondents

| Knowledge Item | Total (%) | HC (%) | Non-HC (%) |
|---|---|---|---|
| Antibiotics effective against bacterial infections | 88.0 | 46.0 | 42.0 |
| Paracetamol is NOT an antibiotic (correct: No) | 52.5 | 31.0 | 21.5 |
| Amoxicillin and penicillin are antibiotics | 81.5 | 44.0 | 37.5 |
| Antibiotics require medical consultation to start | 83.5 | 45.0 | 38.5 |
| Unprescribed antibiotic use is self-medication | 75.5 | 39.5 | 36.0 |
| Antibiotics can cause side effects (allergy/diarrhea) | 70.0 | 37.5 | 32.5 |
| Non-prescription sale increases resistance | 63.0 | 32.5 | 30.5 |
| Antibiotics NOT effective against viral infections (correct: No) | 38.5 | 19.5 | 19.0 |
| Dose and duration affect effectiveness | 74.0 | 35.0 | 39.0 |
| Human body contains good bacteria | 84.0 | 44.5 | 39.5 |

(HC = Healthcare; Non-HC = non-healthcare)

Most respondents (88%) correctly identified antibiotics as effective against bacterial infections. However, a significant misconception was revealed: 61.5% incorrectly believed antibiotics are effective against viral infections—a major knowledge gap relevant to self-medication behaviour. Nearly half (47.5%) incorrectly identified paracetamol as an antibiotic.

**Knowledge About Antibiotic Use**

**Table 3:** Knowledge About Antibiotic Use Among Respondents

| Knowledge Item | Total (%) | HC (%) | Non-HC (%) |
|---|---|---|---|
| Antibiotics should NOT be used for fever (correct: No) | 31.0 | 14.5 | 16.5 |
| It is NOT safe to stop when feeling better (correct: No) | 36.0 | 20.5 | 15.5 |
| Antibiotics should NOT be used for common cold (correct: No) | 35.0 | 16.0 | 19.0 |
| Antibiotics unsafe without doctor consultation (correct: No) | 53.5 | 24.0 | 29.5 |
| Leftover antibiotics should NOT be reused (correct: No) | 58.5 | 31.0 | 27.5 |
| Low-dose antibiotics delay treatment | 63.5 | 34.0 | 29.5 |

Results in this section revealed widespread misconceptions about appropriate antibiotic use. Only 31% knew antibiotics are inappropriate for fever, and only 35% understood they should not be used for the common cold. The finding that 64% believed stopping antibiotics early is safe is particularly concerning, as it directly contributes to the development of antibiotic resistance.

**Knowledge About Antibiotic Resistance**

**Table 4:** Knowledge About Antibiotic Resistance Among Respondents

| Knowledge Item | Total (%) | HC (%) | Non-HC (%) |
|---|---|---|---|
| Resistance occurs when bacteria survive previously effective antibiotics | 79.5 | 42.5 | 37.0 |
| Resistance increases cost and duration of treatment | 68.0 | 40.0 | 28.0 |
| Resistance can occur naturally without misuse | 60.5 | 32.5 | 28.0 |
| Antibiotic resistance is a worldwide public health problem | 77.5 | 41.5 | 36.0 |
| Frequent use reduces antibiotic effectiveness | 76.0 | 40.0 | 36.0 |
| Incorrect dosage is a major cause of resistance | 82.0 | 45.0 | 37.0 |
| Skipping doses does NOT contribute to resistance (correct: No) | 44.0 | 20.0 | 24.0 |
| Important to gain more knowledge on proper antibiotic use | 81.5 | 45.0 | 36.5 |
| Resistant bacteria can spread in hospitals with poor infection control | 75.5 | 37.5 | 38.0 |
| Resistance is NOT limited to hospital settings (correct: No) | 39.5 | 19.0 | 20.5 |
| Antibiotic-resistant bacteria spread person to person | 64.5 | 33.0 | 31.5 |

Overall knowledge of antibiotic resistance was moderately high, with most scores ranging from 60% to 82%. Incorrect dosage as a cause of resistance was well-recognized (82%), as was the global public health significance of AMR (77.5%). However, notable gaps were identified: only 44% correctly knew that skipping doses contributes to resistance, and only 39.5% knew that antibiotic resistance is not limited to hospital settings.

## DISCUSSION

The findings of the present study are largely consistent with the published literature on knowledge, attitudes, and practices (KAP) regarding antibiotic use and resistance among university students globally. Healthcare students demonstrated consistently higher knowledge than non-healthcare students across all domains, a finding aligned with Precha et al. (2024), Huang et al., and Abbasi et al., attributing superior performance to formal academic exposure in pharmacology and microbiology.

Despite better performance among healthcare students, misconceptions were prevalent in both groups. The finding that 61.5% incorrectly believed antibiotics to be effective against viral infections mirrors findings reported by Precha et al. and Jairoun et al. Similarly, inappropriate practices such as stopping antibiotics once symptoms improve and reusing leftover antibiotics were identified in both groups, consistent with reports by Biswas et al. and Zafar et al.

The study identified the academic curriculum as the primary driver of knowledge among healthcare students, consistent with findings by Pulcini et al. non-healthcare students are more reliant on informal sources such as the internet, rendering them more susceptible to misinformation. This reinforces the need for structured antibiotic education across all university disciplines.

Awareness of antimicrobial stewardship was notably low (50.5%), underscoring a need to integrate stewardship concepts into broader educational curricula. The finding that only 35.5% of respondents had attended a seminar on antibiotic resistance in the past year highlights the limited reach of current awareness programs.

The observed differences between healthcare and non-healthcare students may also reflect variations in healthcare system access, antibiotic prescribing regulations, and

cultural practices, consistent with contextual differences observed in international comparative studies.

## CONCLUSION

The present study concludes that overall awareness of antibiotics and antibiotic resistance among university students is moderate to high, with healthcare students demonstrating significantly better knowledge than non-healthcare counterparts. However, critical misconceptions persist in both groups—particularly regarding the use of antibiotics for viral infections, premature discontinuation of antibiotic courses, and the scope of antibiotic resistance beyond hospital settings.

These findings highlight the urgent need for continuous, targeted educational programs and antibiotic stewardship campaigns across all university disciplines. Strengthening knowledge, correcting misconceptions, and promoting responsible antibiotic use are essential steps in combating the global AMR crisis.

**Source of Support:** The author(s) received no financial support for the research, authorship, and/or publication of this article

**Conflict of Interest:** The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## REFERENCES

1. Siltrakool B, Berrou I, Griffiths D, Alghamdi S. Antibiotics' use in Thailand: Community pharmacists knowledge, attitudes and practices. Antibiotics. 2021.
2. Lubwama M, Onyuka J, Ayazika KT, et al. Knowledge, attitudes, and perceptions about antibiotic use and antimicrobial resistance among final year undergraduate medical and pharmacy students in East Africa. PLoS One. 2021.
3. Jairoun A, Hassan N, Ali A, Jairoun O, Shahwan M. Knowledge, attitude and practice of antibiotic use among university students: A cross sectional study in UAE. BMC Public Health. 2019.
4. Nepal A, Hendrie D, Robinson S, Selvey LA. Knowledge, attitudes and practices relating to antibiotic use among community members of the Rupandehi District in Nepal. BMC Public Health. 2019.
5. Prestinaci F, Pezzotti P, Pantosti A. Antimicrobial resistance: A global multifaceted phenomenon. Pathog Glob Health. 2015.
6. Podolsky SH. The evolving response to antibiotic resistance (1945–2018). Palgrave Commun. 2018.
7. Limaye D, Limaye V, Krause G, Fortwengel G. A systematic review of the literature on survey questionnaires to assess self-medication practices. Int J Community Med Public Heal. 2017.
8. Wang Y, Guo F, Wei J, et al. Knowledge, attitudes and practices in relation to antimicrobial resistance amongst Chinese public health undergraduates. J Glob Antimicrobial Resist. 2020.
9. Efthymiou P, Gkentzi D, Dimitriou G. Knowledge, attitudes and perceptions of medical students on antimicrobial stewardship. Antibiotics. 2020.
10. World Health Organization. WHO global strategy for containment of antimicrobial resistance. Geneva: World Health Organization; 2001.
11. Levy SB. The challenge of antibiotic resistance. Sci Am. 1998.
12. Okeke IN, Laxminarayan R, Bhutta ZA, et al. Antimicrobial resistance in developing countries. Part I: recent trends and current status. Lancet Infect Dis. 2005.
13. Asharani N, Dhanalakshmi T, Shyamanth M. Knowledge, attitude, and practices toward antibiotic usage and antibiotic resistance among medical students and interns: A cross-sectional study. J Med Sci Heal. 2020.
14. Higuita-Gutierrez LF, et al. Knowledge regarding antibiotic use among students of three medical schools in Colombia: A cross-sectional study. BMC Med Educ. 2020.
15. Chanvatik S, Kosiyaporn H, Lekagul A, et al. Knowledge and use of antibiotics in Thailand: A 2017 national household survey. PLoS One. 2019.