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RESEARCH ARTICLE

# Antibiotic self-medication and knowledge among pharmacy students: A cross-sectional survey at Mosul University

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## Abstract

**Background:** Antimicrobial resistance (AMR) is a global health threat linked to antibiotic self-medication. Pharmacy students are particularly at risk due to their access to medications and confidence in self-prescribing. This study assessed the prevalence of antibiotic self-medication among pharmacy students at Mosul University, comparing knowledge and practices across different training stages, and explored their proposed solutions. **Methods:** A cross-sectional online survey was conducted among 382 students (187 second-year, 195 fifth-year) to assess demographics, knowledge, awareness, attitudes, and practices. Data were analysed using descriptive statistics and various statistical tests. **Results:** A total of 80.6% of students reported self-medication in the past year, with fifth-year students showing a higher prevalence (89.7%) compared to second-year students (71.1%; $p < 0.0001$). Fifth-year students had greater knowledge of antibiotic effectiveness (68.7% vs. 32.6%), AMR awareness (96.9% vs. 50.8%), and adverse consequences (94.4% vs. 27.8%). Despite these differences, multivariable analysis showed that the knowledge score was not independently associated with self-medication ($p = 0.761$), whereas fifth-year status remained significant ($p < 0.0001$). **Conclusion:** The findings indicate that greater knowledge is associated with higher rates of self-medication among fifth-year students. Integrating stewardship principles early in curricula, enforcing prescription-only policies, and launching collaborative awareness campaigns could address this knowledge-behaviour gap.

## Introduction

Since the discovery of penicillin, antibiotics have revolutionised medicine and provided effective treatment for bacterial infections, saving countless lives (Lobanovska & Pilla, 2017). However, their use has become widespread and has inappropriately accelerated the emergence of antimicrobial resistance (AMR), which is now a major threat to global health (Tang *et al.,* 2023). AMR is a priority challenge identified by the World Health Organisation (WHO, 2015) and is becoming a major threat to treatment effectiveness, resulting in higher morbidity, mortality and health-care costs.

Self-medication, defined as the use of antibiotics without medical advice, such as using leftover drugs, purchasing them from pharmacies without a prescription, or seeking advice from non-professionals, is one of the main causes of this crisis (Baxerres *et al.,* 2021). Self-medication prevalence is different across the globe, ranging from 26% to more than 90% (Gashaw *et al.,* 2025). Health science students are a particular concern, as they are more likely to have ready access to medicines and, as their knowledge grows, may become confident in diagnosing and treating themselves. But this confidence doesn't always lead to proper use. Antibiotics are used for viral infections or stopped

when symptoms get better, which contributes to resistance.

Even students with formal education engage in self-medication at high rates in Ethiopia, Nigeria, and Bangladesh (Siraj *et al.,* 2022; Popoola *et al.,* 2024; Jamil *et al.,* 2025). The pattern indicates a gap between knowledge and behaviour: the more people know about antibiotics, the less safe their practices are. A possible reason is that knowledge could increase self-prescribing confidence, which, paradoxically, leads to increased misuse. This is a speculative interpretation, however, because the degree of competence, confidence, and professional autonomy is usually not directly assessed in such surveys.

Self-medication is a cultural norm in Iraq where antibiotics are sold freely without a prescription. Although there are reports of high prevalence among university students (Salih & Abd, 2021; Al-Ameri *et al.,* 2017; Al-Shawi *et al.,* 2018; Mohammed & Mustafa, 2025), few studies have directly compared students at various stages of their pharmacy training with the aim of investigating the relationship between training and knowledge and self-medication behaviour. This relationship needs to be understood to design education interventions and regulatory policies.

The objectives of this study were therefore to estimate the prevalence of self-medication with antibiotics among undergraduates in the Pharmacy program at Mosul University, to compare the knowledge, attitudes, and practices of second-year students (early in training) with those of fifth-year students (near completion), and to evaluate students' own suggestions to reduce inappropriate use. This study compares students across various educational levels and combines quantitative effect sizes with qualitative analysis of student-proposed solutions, providing insights into the relationship between pharmacy education and self-medication patterns. These contributions can guide curriculum development and policy discussions but cannot be used to draw causal conclusions about the effect of training due to the cross-sectional design.

## Methods

### *Study design and participants*

The study was a cross-sectional study conducted at the College of Pharmacy, University of Mosul, during the academic year 2024/2025. Second-year (pre-clinical) and fifth-year (final year) students were invited. Official enrollment records indicated that there were some 406 eligible students, comprising 196 second-year and 210 fifth-year students. A post-hoc power calculation indicated that the achieved sample of 382 provided over 90% power to detect a 15 percentage-point difference in self-medication prevalence between groups (assuming 80% overall prevalence and $\alpha = 0.05$). The study therefore aimed to recruit all eligible students rather than a fixed sample. Typically, second-year students had not yet taken any formal coursework in antibiotic pharmacology, while fifth-year students had finished the coursework and clinical training. There was no coercion into participation, and informed consent was assumed upon return of the questionnaire.

### *The development and validation of questionnaires*

The survey instrument was developed after a thorough review of the literature on antibiotic self-medication and student practices (Alhomoud *et al.,* 2017; Salih & Abd, 2021; Elmahi *et al.,* 2022). The items addressed four domains: demographic, knowledge of antibiotics, attitudes toward self-medication, and actual practice. The questionnaire was face-validated by a panel of 10 experts in pharmacology, clinical pharmacy, and public health to ensure content validity.

Cronbach's alpha was used to evaluate the reliability of the knowledge and attitude items combined (the only scaled items) and was calculated as 0.86, indicating good internal consistency. Domain-specific reliability coefficients were calculated for the knowledge/awareness subscale (four items; $\alpha = 0.77$) and the attitude/practice subscale (eight items; $\alpha = 0.83$). The combined 12-item scale had $\alpha = 0.86$. Demographic questions were not included in reliability calculations because they do not contribute to scale consistency. The instrument was tested with 30 students (not included in the final analysis) to evaluate the clarity, timing, and feasibility. One item reordering and minor wording changes were made based on pilot feedback. The entire questionnaire is attached as an appendix.

### *Definition of self-medication*

Self-medication with antibiotics was identified as using an antibiotic without a prescription from a physician, such as using leftover antibiotics from a previous prescription, purchasing an antibiotic without a prescription, using an antibiotic based on the advice of a pharmacist without a physician's prescription, or obtaining an antibiotic from a family member or friend. The survey question was: "Have you ever used antibiotics without a prescription from a health care provider?" with answers of "Yes" or "No". If the answer was "Yes", the respondents were asked: "How many times in the last 12 months have you taken antibiotics

without a prescription from a health care provider?" with answers of 0, 1, 2-3 or more than 3.

***Data collection***

The final questionnaire was created using Google Forms. The survey link was sent via the official Google Classroom platform used for communication between faculty and students, so all enrolled second- and fifth-year students received the survey invitation. Two weeks later, a reminder was sent to encourage participation, and cookies were used to prevent duplicate responses. The data collection period was from October to December 2024.

The study was approved by the Pharmaceutical Research Ethics Committee at the College of Pharmacy, University of Mosul (Ref. No.: 2413). No identifying information was gathered; all responses were anonymous. Students were told that they were free to withdraw at any time and that participation was optional. The survey was self-administered online with students assured that individual responses would not be shared with faculty or impact their academic standing, to minimise social desirability bias.

***Variables***

Demographic data included age, sex, year of study, and place of residence. Academic exposure was captured by asking whether students had taken an antibiotics course. Four multiple-choice and awareness questions were used to assess knowledge, which included the effectiveness of antibiotics (for bacteria only, for viruses or both), recognition of risks from inappropriate use (yes/no/maybe), possible consequences from self-medication (antibiotic resistance, toxicity, both, or neither), and awareness of the global problem of antimicrobial resistance (yes/no). Each correct or affirmative response was scored as one point, yielding a composite score ranging from 0 to 4. Equal weighting was applied as no item was considered a priori more important than another, and this approach has been used in similar studies (Elmahi *et al.,* 2022; Jairoun et al., 2019). This composite score is a study-specific measure and should be interpreted as a summary indicator of antibiotic-related knowledge rather than a validated psychometric scale. Higher scores reflected greater knowledge. For clarity, both composite scores and individual item responses are reported in the Results.

Attitudes included perceptions of safety, acceptability of using leftover antibiotics, and likelihood of consulting a health professional if symptoms persisted. Self-medication history, frequency, reasons, sources, specific antibiotics used, conditions treated, and adherence behaviours (completing a full course or stopping early) were also assessed.

***Statistical analysis***

Descriptive statistics (counts, percentages, means, standard deviations) were calculated for all variables. Normality was tested using the Shapiro-Wilk test to guide selection of appropriate inferential tests. Pearson's chi-square test or Fisher's exact test was used to compare proportions in categorical data, and two-proportion z-tests were used to compare proportions between second- and fifth-year students. Effect sizes were expressed as risk differences (RD) and odds ratios (OR) with 95% confidence intervals (CI). A Mann-Whitney U test was used to compare the composite knowledge score between groups, with rank-biserial correlation reported as the non-parametric effect size. A multivariable logistic regression model was fitted with self-medication as the dependent variable and academic year, knowledge score, sex, residence, and prior antibiotic coursework as independent predictors. A $p$-value < 0.05 was considered statistically significant. Analyses were conducted using SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA).

***Qualitative analysis***

The questionnaire included an open-ended question inviting students to suggest ways to reduce inappropriate antibiotic use. This item had a 100% response rate from all 382 participants. Descriptive content analysis (Elo & Kyngas, 2008) was used to analyse the qualitative responses. Two authors independently read all responses and assigned preliminary codes. Codes were then grouped into broader categories through discussion and consensus, with no major discrepancies requiring a third reviewer. Because the analysis focused on summarising the content of responses rather than exploring deeper interpretive themes, we describe this approach as descriptive content analysis or thematic categorisation rather than thematic analysis in the qualitative tradition. The proportion of participants mentioning each theme was calculated to indicate relative importance. Illustrative quotes were translated from Arabic to English by bilingual researchers and back-translated to verify accuracy.

## Results

A total of 382 students completed the questionnaire, representing approximately 94% of the eligible cohorts. Of these, 187 were second-year, and 195 were fifth-

year students. Overall, 61.3% were female, and 70.4% reported living in the city centre.

### *Demographic characteristics*

Table I summarises demographic characteristics. The proportion of women was similar in both groups (63.1% of second-year students vs. 59.5% of fifth-year students; *p*=0.535). A notable difference was observed in residence: 77.9% of fifth-year students reported living in the city centre compared with 62.6% of second-year students (RD = +0.15, 95% CI: 0.06-0.24; OR = 2.11, 95% CI: 1.35-3.32; *p*=0.002). Self-medication with antibiotics in the past 12 months was reported by 80.6% of all participants. Prevalence differed significantly by year: 71.1% of second-year students versus 89.7% of fifth-year students (RD = +0.19, 95% CI: 0.11-0.26; OR = 3.55, 95% CI: 2.03-6.22; *p*<0.0001). Almost all fifth-year students (99.0%) had studied antibiotics in their curriculum, compared with 27.8% of second-year students (RD = +0.71, 95% CI: 0.65-0.78; OR = 250.53, 95% CI: 60.0-1046.2; *p*<0.0001).

**Table I: Baseline characteristics, academic exposure, and self-medication prevalence among second- and fifth-year Pharmacy students**

| Demographic characteristic | 2nd yr N=187 n (%) | 5th yr N=195 n (%) | RD (95% CI) | OR (95% CI) | *p* |
|---|---|---|---|---|---|
| **Gender** | | | | | **0.535** |
| Female | 118 (63.1) | 116 (59.5) | -0.04 (-0.13 to 0.06) | 0.86 (0.57-1.30) | |
| Male | 69 (36.9) | 79 (40.5) | | | |
| **Residence** | | | | | **0.002** |
| City center | 117 (62.6) | 152 (77.9) | +0.15 (0.06 to 0.24) | 2.11 (1.35-3.32) | |
| Other | 70 (37.4) | 43 (22.1) | | | |
| **Self-medication (past 12 mo)** | | | | | **<0.0001** |
| Yes | 133 (71.1) | 175 (89.7) | +0.19 (0.11 to 0.26) | 3.55 (2.03-6.22) | |
| No | 54 (28.9) | 20 (10.3) | | | |
| **Studied antibiotics** | | | | | **<0.0001** |
| Yes | 52 (27.8) | 193 (99.0) | +0.71 (0.65 to 0.78) | 250.5 (60.0-1046.2) | |
| No | 135 (72.2) | 2 (1.0) | | | |

Note. RD = Risk difference; CI = Confidence interval; OR = Odds ratio. *P*-values from Pearson chi-square test.

### *Knowledge and awareness*

Table II presents knowledge and awareness data. Correct knowledge that antibiotics are effective only against bacteria was reported by 32.6% of second-year students and 68.7% of fifth-year students (RD = +0.36, 95% CI: 0.27-0.46; OR = 4.54, 95% CI: 2.95-6.98; $p < 0.0001$). Awareness of AMR was much higher among fifth-year students (96.9%) compared with second-year students (50.8%; RD = +0.46, 95% CI: 0.39-0.54; OR = 30.51, 95% CI: 12.89-72.22; $p < 0.0001$). Similarly, recognition of adverse consequences of self-medication rose sharply with training (94.4% vs. 27.8%; RD = +0.67, 95% CI: 0.59-0.74; OR = 43.43, 95% CI: 21.84-86.35; $p < 0.0001$).

**Table II: Comparison of antibiotic knowledge and awareness between second- and fifth-year pharmacy students**

| Knowledge item | 2nd yr N=187 n (%) | 5th yr N=195 n (%) | RD (95% CI) | OR (95% CI) | *p* |
|---|---|---|---|---|---|
| **Correct: Only on bacteria** | | | | | **<0.0001** |
| Correct | 61 (32.6) | 134 (68.7) | +0.36 (0.27 to 0.46) | 4.54 (2.95-6.98) | |
| Incorrect | 126 (67.4) | 61 (31.3) | | | |
| **Aware of AMR** | | | | | **<0.0001** |
| Yes | 95 (50.8) | 189 (96.9) | +0.46 (0.39 to 0.54) | 30.51 (12.89-72.22) | |
| No/Maybe | 92 (49.2) | 6 (3.1) | | | |
| **Aware of consequences** | | | | | **<0.0001** |
| Yes | 52 (27.8) | 184 (94.4) | +0.67 (0.59 to 0.74) | 43.43 (21.84-86.35) | |
| No/Maybe | 135 (72.2) | 11 (5.6) | | | |

Note. RD = Risk difference; CI = Confidence interval; OR = Odds ratio. *P*-values from Pearson chi-square test.

***Composite knowledge score***

When combining the four knowledge and awareness items into a composite score (0-4), second-year students had a mean score of 1.68 +/- 1.13 (median = 2, IQR 1-2) compared with fifth-year students who had a mean of 3.07 +/- 0.81 (median = 3, IQR 3-4). Both distributions deviated from normality (Shapiro-Wilk $p < 0.001$). A Mann-Whitney U test confirmed a highly significant difference between groups (U = 6420, $p < 0.0001$), with a rank-biserial correlation of r = 0.648 and a common language effect size of 0.824, indicating that a randomly selected fifth-year student had an 82.4% probability of scoring higher than a randomly selected second-year student (Table III).

**Table III: Comparison of composite antibiotic knowledge scores between second- and fifth-year pharmacy students**

| Academic year | Mean +/- SD | Median [IQR] | Range |
|---|---|---|---|
| 2nd Year (n = 187) | 1.68 +/- 1.13 | 2 [1-2] | 0-4 |
| 5th Year (n = 195) | 3.07 +/- 0.81 | 3 [3-4] | 1-4 |

Note. Mann-Whitney U: U = 6420, $p < 0.0001$. Rank-biserial r = 0.648. CLES = 0.824.

***Attitudes toward self-medication***

Attitudes were mixed across groups (Table IV). The belief that self-medication was safe was expressed by 9.6% of second-year students and 14.4% of fifth-year students (RD = +0.05, 95% CI: -0.02-0.11; OR = 1.57, 95% CI: 0.84-2.95; $p = 0.206$). Acceptance of using leftover antibiotics without consultation was higher among second-year students (18.7%) than fifth-year students (13.8%), though the difference was not statistically significant (RD = -0.05, 95% CI: -0.12-0.03; OR = 0.70, 95% CI: 0.40-1.21; $p = 0.249$). Across both groups, over 92% said they would seek professional help if symptoms persisted (RD = +0.03, 95% CI: -0.02-0.08; OR = 1.80, 95% CI: 0.77-4.23; $p = 0.246$). Recognition of both resistance and adverse effects as consequences was significantly higher among fifth-year (92.3% vs. 24.1%; RD = +0.68, 95% CI: 0.61-0.75; OR = 35.20, 95% CI: 20.09-61.67; $p < 0.0001$).

**Table IV: Comparison of attitudes toward antibiotic self-medication between second- and fifth-year pharmacy students**

| Attitude item | 2nd yr N=187 n (%) | 5th yr N=195 n (%) | RD (95% CI) | OR (95% CI) | *p* |
|---|---|---|---|---|---|
| **Recognises resistance+AE** | | | | | **<0.0001** |
| Yes | 45 (24.1) | 180 (92.3) | +0.68 (0.61 to 0.75) | 35.20 (20.09-61.67) | |
| Other | 142 (75.9) | 15 (7.7) | | | |
| **Believes SM is safe** | | | | | **0.206** |
| Yes | 18 (9.6) | 28 (14.4) | +0.05 (-0.02 to 0.11) | 1.57 (0.84-2.95) | |
| No/Maybe | 169 (90.4) | 167 (85.6) | | | |
| **Leftover acceptable** | | | | | **0.249** |
| Yes | 35 (18.7) | 27 (13.8) | -0.05 (-0.12 to 0.03) | 0.70 (0.40-1.21) | |
| No/Maybe | 152 (81.3) | 168 (86.2) | | | |
| **Would consult if persists** | | | | | **0.246** |
| Yes | 172 (92.0) | 186 (95.4) | +0.03 (-0.02 to 0.08) | 1.80 (0.77-4.23) | |
| No | 15 (8.0) | 9 (4.6) | | | |

Note. SM = Self-medication. RD = Risk difference; CI = Confidence interval; OR = Odds ratio.

***Practices related to antibiotic use***

Reading package instructions was more common among fifth-year students (54.9%) than second-year students (34.2%; RD = +0.21, 95% CI: 0.11-0.30; OR = 2.34, 95% CI: 1.55-3.53; $p < 0.0001$). Stopping antibiotics when symptoms improved was frequent among second-year students (55.6%) but less so among fifth-year students (31.8%; RD = -0.24, 95% CI: -0.34--0.14; OR = 0.37, 95% CI: 0.25-0.56; $p < 0.0001$). Completion of a full course was reported by 68.2% of fifth-year students versus 44.4% of second-year students. Switching antibiotics during self-medication was rare in both groups (7.0% vs. 9.2%; RD = +0.02, 95% CI: -0.03-0.08; OR = 1.36, 95% CI: 0.65-2.86; $p = 0.414$; Table V).

**Table V: Comparison of antibiotic use practices between second- and fifth-year Pharmacy students**

| Practice | 2nd yr N=187 n (%) | 5th yr N=195 n (%) | RD (95% CI) | OR (95% CI) | *p* |
|---|---|---|---|---|---|
| **Reads instructions** | | | | | **<0.0001** |
| Yes | 64 (34.2) | 107 (54.9) | +0.21 (0.11 to 0.30) | 2.34 (1.55-3.53) | |
| Sometimes/No | 123 (65.8) | 88 (45.1) | | | |
| **Switches antibiotics** | | | | | **0.414** |
| Yes | 13 (7.0) | 18 (9.2) | +0.02 (-0.03 to 0.08) | 1.36 (0.65-2.86) | |
| No | 174 (93.0) | 177 (90.8) | | | |
| **Stops when symptoms improve** | | | | | **<0.0001** |
| Yes | 104 (55.6) | 62 (31.8) | -0.24 (-0.34 to -0.14) | 0.37 (0.25-0.56) | |
| Completes course | 83 (44.4) | 133 (68.2) | | | |

Note. RD = Risk difference; CI = Confidence interval; OR = Odds ratio

### *Illnesses treated, antibiotics used, sources, and reasons*

Table VI presents these findings among students who reported self-medication (n = 308). The most common conditions were sore throat (74.0%), fever (42.9%), nasal discharge (39.0%), and cough (36.0%). Fifth-year students more frequently reported treating urinary tract infections (34.3% vs. 15.0%; $p < 0.0001$), while second-year students more often reported fever (57.1% vs. 32.0%; $p < 0.0001$) and cough (51.9% vs. 24.0%; $p < 0.0001$).

Amoxicillin was the most commonly used antibiotic overall (81.8%), followed by azithromycin (44.5%) and first-generation cephalosporins (26.6%). There were no major differences in antibiotic choice between the two groups.

**Table VI: Indications, antibiotics used, sources, and reasons for self-medication among second- and fifth-year Pharmacy students who self-medicated**

| Variable | 2nd yr (n=133) | 5th yr (n=175) | *p* |
|---|---|---|---|
| **Illnesses treated*** | | | |
| Sore throat | 91 (68.4) | 137 (78.3) | 0.051 |
| Fever | 76 (57.1) | 56 (32.0) | <0.0001 |
| Nasal discharge | 69 (51.9) | 51 (29.1) | <0.0001 |
| Cough | 69 (51.9) | 42 (24.0) | <0.0001 |
| Dental pain | 40 (30.1) | 52 (29.7) | 0.947 |
| UTI | 20 (15.0) | 60 (34.3) | <0.0001 |
| **Antibiotics used*** | | | |
| Amoxicillin | 109 (82.0) | 143 (81.7) | 0.949 |
| Azithromycin | 54 (40.6) | 83 (47.4) | 0.218 |
| Cephalosporins | 34 (25.6) | 48 (27.4) | 0.719 |
| **Sources*** | | | |
| Pharmacy (no Rx) | 92 (69.2) | 162 (92.6) | <0.0001 |
| Leftover meds | 53 (39.8) | 55 (31.4) | 0.121 |
| **Reasons*** | | | |
| Mild symptoms | 110 (82.7) | 132 (75.4) | 0.102 |
| Prior experience | 73 (54.9) | 107 (61.1) | 0.260 |
| Convenience | 28 (21.1) | 53 (30.3) | 0.063 |
| **Selection method** | | | |
| Personal knowledge | 35 (26.3) | 92 (52.6) | <0.0001 |
| Pharmacist advice | 58 (43.6) | 64 (36.6) | 0.202 |
| Family/friends | 24 (18.0) | 3 (1.7) | <0.0001 |

Note. Among students who self-medicated (n = 308). *Multiple responses allowed; percentages sum to > 100%. UTI = urinary tract infection.

Community pharmacies without a prescription were the primary source (82.5%), followed by leftover medications from previous prescriptions (35.1%). Fifth-year students were more likely to obtain antibiotics directly from pharmacies (92.6% vs. 69.2%; $p < 0.0001$), while reliance on leftover medications was similar between groups (31.4% vs. 39.8%; $p = 0.121$).

The most common reasons for self-medication were perceiving symptoms as mild (78.6%), relying on prior experience with similar symptoms (58.4%), and convenience or time-saving (26.3%). Fifth-year students were more likely to cite convenience or time-saving (30.3% vs. 21.1%; $p = 0.063$).

When choosing an antibiotic, fifth-year students relied more on personal knowledge or experience (52.6% vs. 26.3%; $p < 0.0001$) and less on family or friends' advice (1.7% vs. 18.0%; $p < 0.0001$) compared with second-year students. Reliance on pharmacist advice was the most common selection method overall (39.6%).

***Multivariable analysis***

Table VII presents the results of the multivariable logistic regression model. After adjustment for knowledge score, sex, residence, and prior antibiotic coursework, fifth-year status remained a significant predictor of self-medication (adjusted OR = 6.33, 95% CI: 2.90-13.81; $p < 0.0001$). Notably, the composite knowledge score was not independently associated with self-medication behaviour (OR = 1.04, 95% CI: 0.80-1.35; $p = 0.761$), suggesting that greater knowledge alone does not explain the higher self-medication rates among advanced students. Having studied antibiotics was associated with lower odds of self-medication (OR = 0.39, 95% CI: 0.19-0.78; $p = 0.008$), possibly reflecting a selection effect among the few second-year students who had early exposure. Sex and residence were not significant predictors.

**Table VII: Multivariable logistic regression predicting antibiotic self-medication among pharmacy students**

| Predictor | Adjusted OR | 95% CI | *p*-value |
|---|---|---|---|
| Fifth-year (vs. second) | 6.33 | 2.90-13.81 | <0.0001 |
| Knowledge score (per pt) | 1.04 | 0.80-1.35 | 0.761 |
| Female (vs. male) | 1.25 | 0.72-2.17 | 0.421 |
| City centre residence | 1.18 | 0.66-2.11 | 0.583 |
| Studied antibiotics | 0.39 | 0.19-0.78 | 0.008 |

Note. OR = Odds ratio; CI = Confidence interval. Dependent variable: self-medication (yes/no). Pseudo R-sq. = 0.078

***Students' suggestions to reduce misuse***

The question was open-ended, and all 382 students answered it. Of those, 316 (82.7%) gave any suggestions at all, whereas 66 (17.3%) did not give any suggestions (e.g., “I don't know”, “I am not sure” or blank). Four main themes emerged from descriptive content analysis. The most common theme, expressed by 77.7% of all participants (79.7% of second-year students, 75.9% of fifth-year students), was a need for more education on antibiotics and antimicrobial stewardship. Representative comments: “more lectures and workshops on antibiotic resistance and appropriate use” and “Students need to be more educated on the need for antibiotics and antimicrobial stewardship.” Second, when asked about public awareness campaigns, 60.2% of the students said yes; this includes 51.3% of second-year and 68.7% of fifth-year. One student said, "Awareness campaigns should be done in the community, not just among students, as everybody uses antibiotics without knowing the consequences." Third, there was the suggestion that sales of over-the-counter antibiotics should be more regulated: 47.4% (36.9% of second-year students, 57.4% of fifth-year students). A fifth-year student remarked: "Legislation should be enacted to stop the sale of antibiotics without prescriptions, particularly the more powerful ones that have a dramatic impact on the body." Fourth, greater access to health care professionals at clinics or via telemedicine (36.4% = 28.9% second-year, 43.6% fifth-year). One respondent put forward the idea: "Easy access to doctors or specialists so that people don't self-treat." Other suggestions included peer-led educational programs, incorporating stewardship issues early in the curriculum, and proactive counselling by community pharmacists.

## Discussion

In this study, the authors found that the prevalence of antibiotic self-medication among pharmacy students at Mosul University was high, with more than 80% of students using antibiotics without a prescription in the

last 12 months. On the other hand, fifth-year students self-medicated to a significantly higher degree than second-year students (89.7% vs. 71.1%), even though they also showed higher knowledge and awareness. This is confirmed by the composite knowledge score, which averaged 3.1 for fifth-year students and 1.7 for second-year students. This association between greater knowledge and greater self-medication is consistent with a cross-sectional association, but cannot be interpreted to mean that training led to an increase in knowledge or self-medication.

A potential explanation for this trend is that pharmacy students begin to feel confident to self-diagnose and self-treat as they make progress in their studies. This study should be acknowledged as not directly measuring perceived competence, clinical confidence, professional identity and self-efficacy. Thus, the self-medication hypothesis for overconfident students needs to be corroborated in future studies using validated instruments that assess overconfidence and self-medication.

Another possibility is that fifth-year students just have more opportunities and perceived justification to self-medicate for this same reason, because they are older and clinically more experienced. Fifth-year students were more likely to live in the city centre (77.9% vs. 62.6%), this may be because they are more likely to be close to community pharmacies where they can buy medicines without a prescription from a pharmacist. The multivariable analysis provides further detail: a composite knowledge score was not an independent predictor (OR = 1.04, $p$ = 0.761), whereas fifth-year status was strongly associated with self-medication (adjusted OR = 6.33). The relationship between knowledge and self-medication behaviours may be driven by factors not measured in this study, such as perceived professional autonomy, age, clinical exposure, and proximity to pharmacies, rather than by a direct effect of knowledge. Unmeasured confounders such as socioeconomic status, healthcare access, and academic performance may also explain part of the observed gap and should be examined in future studies.

These results are in line with the regional and international reports. Even with formal training, there was widespread self-medication in Ethiopia and Nigeria (Siraj *et al.,* 2022; Popoola *et al.,* 2024). However, Salih and Abd noted a prevalence of 67% among students of Pharmacy in Baghdad, Iraq, and Al-Shawi reported a prevalence of over 75% in Anbar and Fallujah, Iraq (Al-Shawi *et al.,* 2018; Salih & Abd, 2021). The overall prevalence of 80.6% in our sample is slightly high, indicating that the issue is especially prevalent in Mosul. This may be due to easy access to antibiotics (no prescription needed), cultural acceptance of self-medication, and the stress of clinical training years.

This is noteworthy because several attitude items did not differ significantly between groups. A higher level of knowledge does not seem to correlate with consistent safety attitudes: second- and fifth-year students had similar beliefs about self-medication and the acceptance of discarded antibiotics. This indicates that merely providing factual knowledge about self-medication might not change the attitudes that enable self-medication practices. Fortunately, more than 92% of students in both groups said they would seek professional help if the symptoms remained, indicating that most students still have a limit beyond which they will seek help even in the face of self-medication.

Fifth-year students demonstrated better adherence practices: they were more likely to read package instructions (54.9% vs. 34.2%), less likely to stop antibiotics when symptoms improved (31.8% vs. 55.6%), and more likely to complete the full course (68.2% vs. 44.4%). The results of these differences indicate that training does affect certain aspects of antibiotic use, although not necessarily the overall tendency to self-medicate. Most of the antibiotics prescribed (amoxicillin, azithromycin, and cephalosporins) and most of the conditions treated (sore throat, fever, and cold-like symptoms) are also consistent with previous reports from the region and indicate a need for improved knowledge of viral and bacterial infections.

Proposed actions by participants include increased education, more stringent regulations, and greater access to healthcare—all of which are objectives outlined in the WHO Global Action Plan on Antimicrobial Resistance (World Health Organisation, 2015). Introducing these strategies into pharmacy curricula may require more than just teaching, as they may need to be integrated with other strategies. The integration of practical, case-based exercises that emphasise diagnostic uncertainty and the dangers of incorrect prescribing may help close the gap between knowledge and responsible prescribing. These recommendations must be interpreted as exploratory, as they were not directly measured in the present study for professional identity, diagnostic confidence, or ethical reasoning.

***Recommendations***

Several recommendations can be made based on the results of this study, but they should be taken with a grain of salt due to its cross-sectional design and single-site nature. Principles of antimicrobial stewardship should be incorporated earlier and more clearly into the curriculum of all pharmacy students. Fifth-year

students' high rates of self-medication indicate that the knowledge gained during training might not be sufficient to influence individual behaviour. In addition to didactic teaching, case-based learning and discussions on professional and self-care boundaries could be used. Second, at the systems level, policies must be implemented more rigorously around the use of antibiotics, and education can't compensate for easy access. Health authorities could establish relationships with universities to monitor community pharmacy practice. Simultaneously, better access to student-friendly consultation and/or affordable telemedicine services may decrease the need for self-medication. Third, the suggestions the students made for public awareness campaigns and for improving access to healthcare professionals show the importance of involving target groups in the design of the interventions. These views can be used to design stewardship programs that are more acceptable and feasible.

***Limitations***

The results of this study have to be interpreted with some caution. First, because of its cross-sectional design, it is not possible to make causal inferences regarding the relationship between education and self-medication. This comparison is between the second- and fifth-year students, not a pre-post comparison within the same students. The differences between groups might be due to cohort effects, age, or other unmeasured factors that may have confounded the findings. Second, self-reported data may be subject to reporting bias: students may have underestimated self-medication because they do not want to seem "bad" or inflated because they think they are "showing off". This bias was intended to be minimised by using an anonymous format on the Internet and maintaining confidentiality, but it cannot be avoided. Recall bias could also have influenced the accuracy, particularly regarding the number of episodes of self-medication during the previous 12 months. Another area of limitation is the lack of a defined recall period verification mechanism. Thirdly, the definition of self-medication was explicitly provided in the questionnaire, but could have been understood in a variety of ways by the participants. Few students may not have thought about using leftover drugs or pharmacist-recommended drugs as "self-medication," and thus may not have classified them as such. Fourth, important potential confounders were not measured, such as family income, health insurance status, access to health care facilities, academic performance and personal or family history of chronic illness. Such factors could affect self-medication behaviour and self-medication knowledge, and should be considered in future studies. Fifth, knowledge scores (Composite) are study-specific and poorly validated. Internal consistency was acceptable, although no tests of construct, test-retest or criterion validity were conducted against an objective test of antibiotic knowledge. Lastly, the study was a single-centre study, and thus may not be generalisable to other Iraqi or regional pharmacy schools. The qualitative analysis was descriptive, and the meaning and context of student responses were not explored. Additional studies are needed to use longitudinal designs that will track student behaviours as they progress through their training, to increase the evidence about the impact of education on behaviours over time. Qualitative interviews could also help triangulate self-reports with dispensing information from the pharmacy. Regional or international comparisons of experiences might be conducted to put the Iraqi experience in the context of other experiences worldwide.

## Conclusion

This cross-sectional study revealed that self-medication was prevalent among Mosul University students of Pharmacy, and fifth-year students had more knowledge and self-medication than second-year students. This association should not be taken to mean that the increase in self-medication was due to the training; rather, it demonstrates a knowledge-behaviour pattern that could be influenced by a variety of factors, including unmeasured confounders such as professional confidence, clinical exposure or access to medicines. Results of the multivariable analysis revealed that the knowledge score was not independently associated with self-medication, whereas fifth-year status remained a strong predictor. These results corroborate those from the rest of Europe, South Asia and the Middle East, which illustrate the multifaceted nature of the knowledge-to-action continuum. This challenge may necessitate a comprehensive solution, which includes areas of educational reform, more demanding laws on the purchase of antibiotics and more efficient access to affordable health care. Antimicrobial stewardship principles can be incorporated into pharmacy curricula and may help in the national and global control of AMR by training students as responsible practitioners, with further study needed to identify the most effective intervention strategies.

## Authors' contribution

All the authors contributed to designing the protocol and survey, collecting, extracting and analysing data, interpreting results, creating tables and figures, and drafting and revising the manuscript. MIA and ZAH provided feedback on the report.

## Conflict of interest

All authors have no conflicts to declare.

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## Data availability

The anonymised datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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