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Prevalence of self-medication practices with antibiotics and associated factors among students in five colleges in Eritrea: a cross-sectional study

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Abstract

Background Despite their significant contribution to reducing mortality and morbidity from infectious diseases, antibiotics face challenges due to their inappropriate use, one of which is self-medication. This study assessed the prevalence of|| self-medication with antibiotics among Eritrean college students and its associated factors.

Methods An analytical cross-sectional study evaluated the prevalence of self-medication with antibiotics among students from five colleges from September 2019 to February 2020. Participants were selected through simple random sampling, and each participant completed a structured questionnaire covering socio-demographic characteristics, knowledge and attitudes toward antibiotics, and self-medication practices. Logistic regression analysis was employed to identify factors associated with self-medication with antibiotics.

Results The study distributed 380 questionnaires, with 375 returned, yielding a response rate of 98.68%. Findings revealed that 80.3% of participants were familiar with antibiotics. Additionally, 18.8% agreed with non-prescription antibiotic use for simple ailments. Of the 252 respondents who answered, 67.1% reported self-medication with antibiotics. Within the preceding six months, the prevalence of such self-medication was 34.3%. Factors associated with self-medication included college affiliation, with participants from the College of Science (COS) exhibiting lower odds (AOR = 0.38, 95% CI: 0.16–0.91, $p = 0.03$) compared to the College of Business and Social Sciences (CBSS) students. Those living in dormitories had 2.4 times higher odds (AOR = 2.42, 95% CI: 1.7–5.02, $p = 0.017$) to self-medicate compared to those living with family. Moreover, individuals unaware of antibiotic resistance had higher odds (AOR = 2.41, 95% CI: 1.24–4.7, $p = 0.009$) of self-medication. Attitude score was also significantly associated with self-medication (AOR = 0.88, 95% CI: 0.8–0.98, $p = 0.027$).

Conclusions These results highlight the necessity for tailored educational programs to advocate for appropriate antibiotic utilization and mitigate the prevalent misuse of antibiotics among college students. Initiatives focused on

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increasing knowledge about the dangers linked with self-medication and advocating for conscientious antibiotic usage are essential in combating the escalating challenge of antibiotic resistance and safeguarding public health.

Keywords Self-medication, Irrational antibiotic use, Antibiotics, Eritrea, College students

Background

Antibiotic medications have been crucial in reducing mortality and morbidity from infectious diseases, but their inappropriate use has greatly diminished these benefits. Despite growing public awareness and concerns among healthcare providers, the global trend of antibiotic misuse continues to rise at an alarming rate [1, 2]. This misuse leads to the emergence of antibiotic-resistant microorganisms, which is a growing public health threat [3, 4]. It is estimated that 700,000 lives are lost annually due to antibiotic resistance, and this figure could rise to at least 10 million by 2050 if current trends continue [5]. The economic burden of antibiotic resistance is also substantial, with countries facing increased healthcare costs and lost productivity [6–8]. This issue requires urgent multisectoral attention as the world is on the brink of a post-antibiotic era, where common infections and minor injuries could once again become fatal [9].

In developing countries, antibiotic resistance is driven by surveillance gaps, poor antibiotic quality, clinical misuse, and easy access, while in developed countries, it is fueled by poor hospital regulation and excessive use in food-producing animals [10]. The ease of access to antibiotics in many regions promotes self-medication, which is one of the primary behaviors contributing to antibiotic resistance [4, 11, 12]. Self-medication, as defined by the World Health Organization (WHO), involves the use of medicinal products by the consumer to treat self-diagnosed disorders or symptoms or the inappropriate use of prescribed medications [13]. This behavior includes self-prescription and the improper use of physician-prescribed antibiotics, such as incorrect selection, dosage, and duration [14]. Antibiotics used in self-medication are often obtained through over-the-counter sales, leftover supplies, or drugs shared by family or friends [15, 16]. Globally, it is estimated that more than 50% of antibiotics are purchased without a prescription from formal and informal sectors [17].

The challenge of improper antibiotic use is particularly pronounced in low- and middle-income countries (LMICs), where regulatory frameworks are often lacking or insufficient [18]. In poor regions, self-medication is a common practice for addressing health issues due to limited access to healthcare services [4, 15, 19]. In Sub-Saharan Africa, the combined rate of non-prescription antibiotic requests or consultations resulting in antibiotic supply without a prescription is as high as 69% [20]. Consequently, developing countries report more antimicrobial resistance cases than developed nations [21]. Several factors motivate the use of antibiotics without prescription, including financial and time constraints, social influence, consumer attitudes, and advertisements [14, 19]. Self-medication may offer short-term benefits such as easier access to medication and lower healthcare costs, but it can lead to widespread antibiotic resistance with severe global public health consequences [22].

Studies conducted among college and university students have shown alarmingly high rates of antibiotic misuse. A systematic review and meta-analysis reported a self-medication rate of 70.1% among students [23]. A review focusing on self-medication with antibiotics among university students in LMICs revealed that Africa had the highest combined prevalence at 55.30% [24]. For instance, a survey among university students in Kampala, Uganda, found that nearly 7 out of 10 students had self-medicated with antibiotics [25]. Similarly, a study among undergraduate students in Mekelle, Ethiopia, reported that 44.5% had self-medicated with antibiotics at some point, with 27.5% having done so within the past three months [26]. In China [27], 47.9% of university students reported self-medication with antibiotics, while in the United Arab Emirates [28], a six-month prevalence study showed a rate of 38.2%.

In Eritrea, the Ministry of Health has implemented various initiatives to address this issue, including regulatory policies, public awareness campaigns, and training healthcare providers [29]. However, studies on self-medication in Eritrea are limited to specific areas. One survey among Asmara College of Health Sciences students reported a self-medication prevalence of 79.2% [30]. Another study found that 93.7% of participants in 20 pharmacy outlets in Asmara had practiced self-medication, with 87.6% obtaining antibiotics without a prescription [31]. A community-based study in Asmara reported a self-medication prevalence of 45.5% [32]. These studies highlight the urgent need to address self-medication practices in Eritrea, particularly among college students, as many colleges are located in areas with limited access to comprehensive healthcare services. Understanding the factors associated with self-medication in this group could inform targeted interventions and contribute to broader efforts to combat antibiotic resistance. Therefore, this study aimed to assess the prevalence of self-medication with antibiotics (SMA) among Eritrean college students and identify the associated factors.

Methodology

Study design

This study employed an analytical cross-sectional study design to assess the prevalence of self-medication practice with antibiotics among college students.

Study setting and population

The study was conducted in five colleges of Eritrea, namely, Orotta College of Medicine and Health Sciences (OCMHS), Mai-Nefhi College of Engineering (COE), Mai- Nefhi College of Science (COS), Adi-Keih College of Business and Social Science (CBSS) and Hamelmalo College of Agriculture (HAC). OCMHS is found in Asmara, the capital city of Eritrea. COE and COS are found in the Maekel region, around 25 km southwest of Asmara, whereas CBSS is located at Adi-Keih in the Debub region, 110 km southeast of Asmara. HAC is located in Hamelmalo, a few kilometers outside Keren (in the Anseba region), which is 91 km northwest and far from Asmara. The study was conducted from September 2019 to February 2020. The study population was all degree program students of the above-listed five Eritrea colleges registered for the first semester of the 2019–2020 academic year. The total number of students enrolled in these colleges during the data collection time was 3394.

Inclusion and exclusion criteria

Degree program college students (2nd year and above) who were registered for the first semester in the academic year 2019–2020 and those willing to consent were eligible to participate. Upgrading students and students unavailable during the data collection time were excluded from the study. Upgrading students are government employees with a monthly salary and several years of work experience before returning to college, making them distinct from the typical student population.

Sample size and sampling technique

A single population proportion formula was used to calculate the sample size [n= $(Z\ \alpha/2)^2$ x P (1-p)/d^2]. Where: n_1=Sample size, d=margin of error 5% = 0.05, *P*=the proportion of self-medication with antibiotics (0.5), Z value for 95% confidence=1.96. Based on the above parameters, it was 384. Then n_2 was calculated using the formula n_2= (n_1 *N)/(n_1+N). Where N=Size of the study population (total number of students of the five colleges registered for the semester, 3394). This gave a $n_{2=}345$. Finally, we added 10% of n_2 for non-response, and the final sample size was 380. The sample was distributed to each college proportional to its total student number. Then, within each college, the allocated sample was divided proportionally among the departments. The same procedure was used to divide the sample among the years of study. Finally, each department was asked to provide a list of names of its students by department and year of study to be used as the sampling frame. Then, the study units were selected using a simple random sampling technique.

Data collection instruments and measurements

The data collection instrument used was a structured self-administered questionnaire with close-ended questions. It was developed by consulting the existing literature and previously conducted similar studies. Experts in the pharmacy department assessed the face and content validity of the questionnaires. The questionnaire consisted of four sections: (1) questions related to participants' socio-demographic characteristics (college, age, sex, ethnic city, etc.); (2) questions related to knowledge on antibiotics; (3) questions related to attitude towards antibiotic use; (4) questions related to practice assessment concerning self-medication with antibiotic. A pre-test of the questionnaire was conducted among 20 randomly selected students in the College of Education to assess its understandability and ease of administration. Based on the results, the questions that the participants did not understand were modified.

Knowledge

Knowledge questions contain 20 items, which could be responded to using two options, i.e., "Yes" or "No." The responses for the items were stated as correct when the right and wrong answers were answered as "Yes" and "No," respectively. Every single correct answer was scored using one point. To estimate the performance of overall knowledge, a cumulative correct response of knowledge items was calculated, i.e., the sum of scores of the 20 items. Then, the cumulative correct responses (i.e., ranging from 0 to 20 points) were divided into three categories based on the median score. The results were categorized as "poor" for the scores below the median line, "moderate" for those at the median line, and "adequate" for those above the line.

Attitude

The procedure for data analysis of the attitude-related questions was similar to the knowledge section. The criteria were formed to assess respondents' attitudes towards self-medication: First, the numbers 1, 2, 3, 4, and 5 were assigned to represent strongly disagree, disagree, neutral, agree, and strongly agree, respectively. The performance of overall attitudes was estimated by calculating the scores of the five attitude items, the sum of scores of A1 to A5, in which the potential range of the cumulative attitudes score could be 5–25. The attitude performance was then also categorized into three, based on the median score as "appropriate" for those below the

median line, as "moderate" for those at the median line, and as "inappropriate" for those above the median line.

Study variables

The dependent variable in this study was self-medication with antibiotics. The independent variables included socio-demographic characteristics (age, sex, religion, college, year of study, ethnicity, marital status, accommodation, permanent residence, average monthly allowance or income, parent's level of education and work), knowledge about antibiotics and antibiotic resistance: knowledge score and attitude score.

Data analysis

Data was entered in Microsoft Excel and then imported into Statistical Package for the Social Sciences (SPSS) version 23 for analysis. First, descriptive analysis was performed using frequency and percentage for all study variables. Furthermore, mean, standard deviation or median and interquartile range (IQR) were reported for continuous variables when appropriate. Bivariate and multivariate logistic regression were performed to determine associations and effect sizes between the study variables. Variables found to be significant in the bivariate analysis were included in the multivariate logistic regression analysis. In addition, variables with $p<0.2$, found to be substantial in other related literature, were also included in the multivariate logistic analysis. Statistical significance for all analyses was set at $p<0.05$.

Results

A total of 380 questionnaires were distributed, out of which 375 were filled and returned, resulting in a response rate of 98.68%. The mean age of the participants was 20.40 (SD ± 1.158), with the majority (54.6%) categorized under the age group of 18–20 years. Of the total respondents, 52.4% were females, and most of the participants belonged to the Christian religion (92.5%). Second-year students comprise the most significant proportion (37.1%) of the participants. Most students (87.4%) permanently reside in urban areas, and 81.2% of the total participants live in dormitories. Regarding the respondents' parents' educational level, 40.1% of the mothers had middle-secondary education, while 47.5% of the fathers had tertiary education. Most mothers and fathers work in non-health-related occupations, 89.3% and 70.8%, respectively (Table 1).

Knowledge of respondents on the use of antibiotics

In this study, most (80.3%) of the participants had ever heard about a drug called antibiotic. When asked about the infections antibiotics are meant to treat, 86.8% said "bacterial infection," and 5.8% said "viral infections." However, when asked about diseases treated with antibiotics, 35.5% said "common cold," 44% said "diarrhea," and 52.6% said "tuberculosis," among others. As to the time to stop the antibiotic treatment course, the majority (56.6%) of the respondents said it was "after completion of the treatment," followed by "after antibiotics run out" (17.4) and "after symptoms disappear" (12.5%) (Table 2).

Attitude of respondents on the use of antibiotics

The attitude of participants towards self-medication with antibiotics was assessed using five questions with five-point Likert-type answers (strongly disagree, disagree, neutral, agree, strongly agree). Accordingly, 18.8% agreed that it is okay to use antibiotics without prescriptions if the disease is deemed simple. Just 9.4% of the participants agreed that it is acceptable to share antibiotics with others if their illnesses appear similar. Furthermore, 7.9% indicated that retaining leftover antibiotics for future use with different ailments is permissible. Most respondents (57.5%) believed that leftover antibiotics should be disposed of in regular garbage or flushed down toilets. In contrast, only a small percentage (8.5%) agreed with increasing antibiotic dosage for faster recovery (Table 3).

Of 311 respondents, 81% were found to have used antibiotics regardless of prescription status. A total of 252 participants gave a response to the question, "Have you ever self-medicated with antibiotics?" Of these, 67.1% (CI: 60.8 −72.8%) responded positively. In addition, the prevalence of self-medication with antibiotics within the past six months preceding the data collection time was 34.3%. Participants were asked if they had ever stopped taking antibiotics before completing the entire course of treatment, of which 50.3% of the 173 respondents said "Yes." Almost one-third (32%) of 172 respondents have ever changed the dosage of antibiotics deliberately, and 11.1% have taken antibiotics, although health professionals advised them that it is not necessary. Regarding suggesting antibiotics to others, 57.6% of 170 respondents acknowledged that they have ever advised someone they know to take an antibiotic drug. In the current study, the commonly used antibiotics were Amoxicillin, Cotrimoxazole, Ciprofloxacin, and Metronidazole, in that order (Table 4).

The most common complaints or symptoms for which antibiotics were used included diarrhea (90.6%), tonsillitis (67.2%), aches and pain (24.6%), and common cold (23.7%). In this study, the participants put forward several reasons why they self-medicate with antibiotics. These include perceiving the disease as not serious (37.4%), previous successful experience (31.4%), quick relief (28.8%), time constraint (18.7%), and knowledge acquired from previous prescriptions (17.3%). The most commonly mentioned sources of antibiotics for self-medication were drug stores or pharmacies (58.3%), followed by friends or family members (28.1%), and health facilities (18.7%).

Table 1 Socio-demographic characteristics of respondents

Variables	Category	Frequency	%
College (*n* = 375)	CBSS	107	28.5
	HAC	63	16.8
	COS	88	23.5
	COE	85	22.7
	OCMHS	32	8.5
Age category (*n* = 357)	18–20	195	54.6
	21–24	162	45.4
Sex (*n* = 374)	Male	178	47.6
	Female	196	52.4
Religion (*n* = 375)	Christian	347	92.5
	Muslim	28	7.5
Year of study (*n* = 375)	Second year	139	37.1
	Third year	101	26.9
	Fourth-year	103	27.5
	Fifth year	32	8.5
Permanent residence (*n* = 373)	Rural	47	12.6
	Urban	326	87.4
Accommodation status (*n* = 372)	With family	69	18.5
	Dormitory	302	81.2
	With relatives	1	0.3
Mother's level of education (*n* = 372)	Illiterate	20	5.4
	Can read and write- elementary	106	28.5
	Middle- Secondary	149	40.1
	College and above- tertiary	94	25.3
	Do not know	3	0.8
Father's level of education (*n* = 366)	Illiterate	8	2.2
	Can read and write- elementary	43	11.7
	Middle- Secondary	135	36.9
	College and above- tertiary	174	47.5
	Do not know	6	1.6
Mother's work (*n* = 373)	Health-related occupations	30	10.7
	Non-health-related occupations	333	89.3
Father's work (*n* = 366)	Health-related occupations	107	29.3
	Non-health-related occupations	259	70.8

OCMHS: Orotta College of Medicine and Health Sciences, COE: Mai-Nefhi College of Engineering, COS: Mai-NeFhi College of Science, ACBSS: Adi-Keih College of Business and Social Science, HAC: Hamelmalo College of Agriculture

As for stopping antibiotics before the entire course of treatment, 66.3% said "because conditions improved," and 11.2% said, "got a better medication." For those who have ever changed the dosage of antibiotic medications, the reasons to do so were improving conditions (45.5%), insufficient drugs (16.4%), reducing adverse reactions (14.5%), and worsening conditions (12.7%). Regarding handling leftover antibiotic medications, 28.7% said they usually don't have leftovers, 41.3% said they keep them for future use, and 20.4% said they dispose of them in a rubbish bin (Table 5).

Knowledge and attitude scores and their medians were computed for each participant, and the Wilcoxon rank test was used to evaluate the associations between the median score and the socio-demographic characteristics of the study participants. Accordingly, participants from OCMHS had statistically significant higher scores in knowledge (Mdn=17) than participants from other colleges CBSS (Mdn=8), HAC (Mdn=7), COS (Mdn=8) and COE (Mdn=8), (P=0.00; Kruskal–Wallis test). Similarly, participants from OCMHS had statistically significant higher attitude scores (Mdn=21) than participants from other colleges CBSS (Mdn=19), HAC (Mdn=20), COS (Mdn=20), and COE (Mdn=19), (P=0.01; Kruskal–Wallis test). Fifth-year students' knowledge score was higher (Mdn=9) as compared to the second (Mdn=7), third (Mdn=8), and fourth (Mdn=8) year students, which was statistically significant (P=0.00; Kruskal–Wallis test). A statistically significant difference in attitude score was also observed between years of study, second year (Mdn=19), third-year (Mdn=20), fourth-year (Mdn=20), and fifth year (Mdn=20), (P=0.02;

Table 2 Knowledge of respondents on the use of antibiotics

Variable	Category	Frequency	Percentage
Ever heard of a drug called antibiotics ($n=375$)	Yes	301	80.3
Antibiotics are medicines used to treat illnesses caused by?	Virus	18	5.8
	Bacteria	269	86.8
	Fungus	2	0.6
	Do not Know	20	6.5
Which of these diseases do you think are treated with antibiotics?	Common cold	111	35.8
	Diarrhea	137	44.2
	Tuberculosis	164	52.9
	Dengue fever	31	10
	Pneumonia	63	20.3
	Aches and pains	47	15.2
	Malaria	58	18.7
When do you think people should stop taking antibiotics treatment?	After a few days, regardless of the outcome	7	2.3
	After symptoms disappeared	38	12.5
	A few days after recovery	33	10.9
	After antibiotics ran out	53	17.4
	After the completion of the treatment	172	56.6

Table 3 Attitude of respondents on the use of antibiotics

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
People should sometimes use antibiotics without a prescription if they think their illness is simple.	6 (1.9%)	52 (16.9%)	39 (12.7%)	101 (32.8%)	110 (35.7%)
Sharing antibiotics with family members or friends is okay if your illness looks the same.	4 (1.3%)	25 (8.1%)	21 (6.8%)	118 (38.3%)	140 (45.5%)
Keeping leftover antibiotics and using them later for other illnesses is okay.	2 (0.7%)	22 (7.2%)	39 (12.7%)	87 (28.3%)	157 (51.1%)
Leftover antibiotics should be disposed of with regular garbage or flashed at toilets.	70 (22.9%)	106 (34.6)	32 (10.5%)	59 (19.3%)	39 (12.7%)
People should sometimes increase the dosage of antibiotics during self-treatment for faster recovery.	7 (2.3%)	19 (6.2%)	32 (10.5%)	70 (22.9%)	178 (58.2%)

Table 4 Practice of respondents on the use of antibiotics

Variables	Frequency	Percentage
Ever used antibiotics ($n=311$)	252	81
Ever self-medicated with antibiotics ($n=252$)	169	67.1
Self-medicated with antibiotics within the past six months ($n=169$)	58	34.3
Ever stopped taking antibiotics before completing the entire course of treatment ($n=173$)	87	50.3
Ever changed the dosage of antibiotics deliberately ($n=172$)	55	32
Ever gave or suggested antibiotics to someone ($n=170$)	98	57.6
Ever taken antibiotics against a health professional's advice ($n=171$)	19	11.1
Commonly used antibiotics for self-medication by respondents ($n=171$)		
Amoxicillin	123	71.9
Cotrimoxazole	9	5.3
Ciprofloxacin	5	2.9
Metronidazole	4	2.4
Benzathine benzylpenicillin	3	1.8
Amoxicillin + clavulanic acid (Augmentin)	3	1.8

Table 5 Characteristics of self-medication practice with antibiotics

Variables	Categories	Frequency	Percentage
Complaints for which antibiotics were self-medicated ($n=138$)	Common cold	33	23.7
	Fever	11	8.0
	Aches and pain	34	24.6
	Diarrhea	125	90.6
	Vomiting	3	2.2
	Skin wound	33	8.8
	Tonsillitis	92	67.2
Reasons for self-medicating with antibiotics ($n=211$)	Health facility far from school or home	6	4.3
	Time constraint	26	18.7
	To save money	14	10.1
	To get quick relief	40	28.8
	Disease not serious	52	37.4
	Knowledge from previous prescriptions	24	17.3
	Previous successful experience	44	31.4
Source of antibiotics for self-medication ($n=176$)	Health facility	26	18.7
	Drug store/pharmacy	81	58.3
	Friends or family members	39	28.1
	From leftovers	11	7.9
	From abroad	10	7.2
Reason for stopping taking antibiotics before completing the entire course of treatment ($n=89$)	The condition didn't improve	5	5.6
	Condition improved	59	66.3
	Due to adverse effects	7	7.9
	Advised by a friend or family	7	7.9
	I didn't think it works	1	1.1
	I got better medication	10	11.2
Motives behind changing the dosage of antibiotics during the course of self-treatment ($n=55$)	Improving conditions	25	45.5
	Worsening conditions	7	12.7
	To reduce adverse reactions	8	14.5
	Drug insufficient for complete treatment	9	16.4
Handling of leftover antibiotics ($n=167$)	Usually don't have leftovers	48	28.7
	Keeping it for future use	69	41.3
	Pour it down in a sink or toilet bowl	15	9
	Dispose of it in a rubbish bin	34	20.4

Kruskal–Wallis test). Respondents whose fathers were illiterate had statistically significant lower attitude scores (Mdn=16) as compared to those whose fathers had elementary (Mdn=20), secondary (Mdn=20), and tertiary (Mdn=19) levels of education ($P=0.01$; Kruskal–Wallis test) (Table 6).

Factors associated with self-medication with antibiotics

Binary logistic regression was used to assess the association between several background characteristics of the participants and self-medication behavior with antibiotics. On bivariate analysis, five variables achieved significant levels below 0.25, three of which had statistically significant values. As compared to students from CBSS, students from COS and OCMHS had lower odds of self-medication with antibiotics (COR=0.41, 95% CI: 0.18–0.93, $p=0.033$) and (COR=0.32, 95% CI: 0.12–0.89, $p=0.029$), respectively. Those students living in dormitories had 2.9 (COR=2.91, 95% CI: 1.52–5.57, $p=0.001$) times higher odds to self-medicate with antibiotics than those living with their families or relatives. A higher attitude score was also associated with decreased odds of self-medication with antibiotics (COR=0.89, 95% CI: 0.81–0.98, $p=0.023$). Multivariate logistic regression included the three variables with significant p values and two with p values less than 0.25 on bivariate analysis. Accordingly, COS participants had statistically significantly lower odds (AOR=0.38, 95% CI: 0.16–0.91, $p=0.03$) of self-medication compared to those from CBSS. Students living in the dormitory had 2.4 times higher odds (AOR=2.42, 95% CI: 1.7–5.02, $p=0.017$) to self-medicate with antibiotics than those who lived with their families. Those who had never heard about antibiotic resistance were at higher odds (AOR=2.41, 95% CI: 1.24–4.7, $p=0.009$) of self-medication with antibiotics than their counterparts. Finally, participants' attitude score was also found to have a statistically significant

Table 6 Knowledge and attitude scores with sociodemographic characteristics of participants (Wilcoxon rank test results)

Variables	Knowledge score Median (IQR)	*p*-value	Attitude score Median (IQR)	*p*-value
Sex				
Male	8 (6–9)	0.55 †	20 (17–21)	0.69 †
Female	8 (7–10)		19 (17–21)	
College				
CBSS	7 (6–9)	< 0.00 ‡	19 (17–21)	0.01 ‡
HAC	8 (6–10)		20 (18–21)	
COS	7 (6–9)		20 (17–21)	
COE	8 (6–9)		19 (17–21)	
OCMHS	17 (12–19)		21 (19–23)	
Age category				
18–20	8 (6–9)	0.09 †	20 (17–21)	0.52 †
21–24	8 (7–10)		20 (17–21)	
Religion				
Christian	8 (6–10)	0.33 †	19 (17–21)	0.51 †
Muslim	9 (7–9)		19 (17–21)	
Year of Study				
Second year	7 (6–9)	< 0.00 ‡	19 (17–21)	0.02 ‡
Third year	8 (7–9)		20 (18–21)	
Fourth-year	8 (6–11)		20 (17–21)	
Fifth year	9 (7–18)		20 (18–23)	
Permanent Residence				
Rural	8 (6–11)	0.98 †	20 (17–21)	0.87 †
Urban	8 (7–10)		19 (17–21)	
Accommodation status				
With family	8 (6–13)	0.08 †	20 (18–22)	0.30 †
Dormitory	8 (7–9)		19 (17–21)	
Mother's level of education				
Illiterate	7 (5–9)	0.18 ‡	19 (15–21)	0.30 ‡
Can read and write- elementary	8 (6–10)		20 (18–21)	
Middle- Secondary	8 (6–10)		20 (17–21)	
College and above- tertiary	8 (7–9)		19 (17–21)	
Father's level of education				
Illiterate	6 (6–7)	0.34 ‡	16 (12–18)	0.01 ‡
Can read and write- elementary	8 (6–13)		20 (19–21)	
Middle- Secondary	8 (6–10)		20 (17–21)	
College and above- tertiary	8 (7–9)		19 (17–21)	
Mother's work				
Health-related occupations	8 (6–10)	0.34 †	20 (17–21)	0.33 †
Non-health-related occupations	8 (7–10)		19 (17–21)	
Father's work				
Health-related occupations	8 (6–9)	0.67 †	19 (17–21)	0.69 †
Non-health-related occupations	8 (6–10)		20 (17–21)	

† Mann-Whitney U test, ‡ Kruskal–Wallis test

association with self-medication practice with antibiotics (AOR = 0.88, 95% CI: 0.0.8–0.98, $p = 0.027$). (Table 7)

Discussion

This research aimed to evaluate the prevalence of SMA among college students in Eritrea and to identify the factors associated with this practice. The study reveals that a significant proportion of the participants possessed knowledge of antibiotics. Specifically, 80.3% of the respondents reported being familiar with antibiotics, a finding consistent with research conducted among Nigerian university students, where 91.4% had prior knowledge of antibiotics [33]. Furthermore, 86.8% of the participants in the current study accurately identified the pathogens targeted by antibiotics. Although this rate is somewhat lower compared to the 99.2% reported among medical students at the University of Zambia [34], it is plausible that the discrepancy is because medical

Table 7 Factors associated with self-medication with antibiotics

Variables	COR [95% CI]	AOR [95% CI]
College		
CBSS	1	1
HAC	1.3 [0.51–3.28]	1.03 [0.38–2.76]
COS	0.41 [0.18–0.93] *	0.38 [0.16–0.91] *
COE	0.46 [0.21–1.06]	0.46 [0.19–1.12]
OCMHS	0.32 [0.12–0.89] *	0.42 [0.13–1.31]
Accommodation		
With Family	1	1
Dormitory	2.91 [1.52–5.57] **	2.42 [1.17–5.02] *
Heard about antibiotic resistance		
Yes	1	1
No	1.62 [0.91–2.87] [a]	2.41 [1.24–4.7] **
Know the target pathogens of antibiotics.		
No	1	1
Yes	0.42 [0.15–1.17] [b]	0.38 [0.12–1.18]
Attitude score	0.89 [0.81–0.98] *	0.88 [0.8–0.98] *

*$p<0.05$, ** $p<0.01$, [a]$p=0.096$, [b]$p=0.1$. OCMHS: Orotta College of Medicine and Health Sciences, COE: Mai-Nefhi College of Engineering, COS: Mai-Nefhi College of Science, ACBSS: Adi-Keih College of Business and Social Science, HAC: Hamelmalo College of Agriculture

students are more extensively educated about antibiotics through their specialized curriculum.

The most frequently mentioned conditions antibiotics could be used for include the common cold, diarrhea, and tuberculosis. Some have used antibiotics to treat pain, aches, and the common cold. This aligns with findings from various studies that have highlighted the widespread use of antibiotics for flu-like symptoms [35–38]. The prevalence of ever and six-month self-medication with antibiotics was 67.1% and 34.3%, respectively. These figures are comparable to those reported in studies from three universities in Uganda, where the prevalence was 69.4% [39]. In contrast, a study in the United Arab Emirates reported a six-month SMA prevalence of 38.2% [28]. Higher prevalence rates have been observed elsewhere, such as 40.2% in western China [34] and 82% in Qatar [40]. The prevalence observed in the current study also surpasses the 45.1% self-medication rate among the general community in Asmara [32], suggesting that SMA is particularly prevalent among university students.

Half of the respondents in this study admitted to having discontinued their prescribed antibiotic courses prematurely, and one-third reported having intentionally altered the dosage. The primary reasons for discontinuation included improvement in symptoms and switching to alternative medications. These findings are consistent with those of a Qatari study, which noted that 45% of respondents did not complete their last course of antibiotics [40]. Similarly, a survey in Jordan revealed that 65.2% of respondents had interrupted their treatment course, with 59.1% citing feeling better as the reason [41]. A similar trend was observed at Prince Mohammad Bin Fahd University in Saudi Arabia, where 38.4% of students believed that antibiotic courses could be stopped upon feeling improvement [42]. Over 44% of Chinese university students also reported modifying their antibiotic dosages [43]. A potential contributing factor to this behavior could be inadequate information from healthcare providers about the importance of completing the prescribed course. Additionally, students might be influenced by their experiences with other over-the-counter medications, which are often used only as needed. Notably, almost 10% of the students reported using antibiotics against health professionals' advice. This is reminiscent of a Chinese study where patients successfully pressured doctors for antibiotic prescriptions in 100% of cases [36]. Such behavior could stem from comparison with past symptoms, advice from peers or family, or lack of trust in healthcare providers. This highlights the challenge of curbing irrational antibiotic use, which can undermine efforts to address antibiotic resistance.

Amoxicillin emerged as the most frequently self-medicated antibiotic in this study, a trend corroborated by various other studies [28, 32, 33]. Conversely, studies among university students in Kampala [39] and Lebanon [44] found amoxicillin to be the least commonly used antibiotic, with only 4% and 9% of participants reporting its use, respectively. While the familiarity and availability of amoxicillin may drive its use for self-medication, excessive and irrational use can lead to increased resistance by microorganisms, potentially reducing its effectiveness in future treatments. The frequently cited reasons for SMA by respondents included perceiving the illness as non-serious, previous successful experiences with self-medication, seeking rapid relief, time constraints, and knowledge from past prescriptions. These reasons align with findings from a systematic review and meta-analysis that identified past successful use and the perceived severity of illness as significant determinants of self-medication [15]. Moreover, a substantial proportion of participants reported recommending antibiotic use to acquaintances, emphasizing the potential to propagate this behavior.

Pharmacies were the most common source of antibiotics for self-medication, with 58.3% of participants acquiring antibiotics from these outlets. This finding aligns with previous research conducted in Asmara [32] and is supported by the fact that 87.6% of drug outlets in the country dispensed antibiotics without prescriptions [31]. Similar patterns have been observed in Nigeria [45], China [43], and Qatar [40], where antibiotics were often purchased without prescriptions. Improper disposal or retention of leftover antibiotics is a concerning practice, with many participants either saving them for future use or discarding them improperly. A Jordanian study found that 73.1% of students kept leftover antibiotics, primarily

"in case they were needed again" [41]. This behavior suggests that some aspects of self-medication are planned rather than spontaneous.

The study identified several factors associated with self-medication practices. Students from the COE exhibited 81.7% lower odds of SMA than those from the CBSS. This association might be attributed to the proximity of COE to healthcare facilities in Asmara, making access to medical care more convenient compared to the location of CBSS in the outskirts of Adi-Keih Town. Residence of students has been reported to be associated with self-medication with antibiotics in several studies [46, 47]. Those living in dormitories were 2.4 times more likely to engage in SMA. This increased likelihood could be due to time constraints related to academic activities or financial problems to see a doctor, and the practice of sharing medications with roommates. Participants who had never heard of antibiotic resistance were 2.4 times more likely to self-medicate. This finding is consistent with research from Turkish Cypriots [40], Thailand [41], and Bangladesh [42], which also highlighted a relationship between awareness of antibiotic resistance and self-medication practices. Additionally, in line with the findings of previous studies [48, 49], a higher score in attitude correlated with lower odds of self-medication.

Regarding knowledge and attitudes, OCMHS students exhibited significantly higher median scores than those from other colleges. This observation aligns with findings from a systematic review indicating better antibiotic knowledge among health sciences students [44]. However, a study of medical students in Malaysia revealed differences in knowledge between clinical and pre-clinical years [50], a pattern also observed in the current study where first-year students demonstrated statistically lower knowledge and attitude scores. Previous research from Jordan [41], Lebanon [44], and Sudan [51] also found better knowledge and attitudes among medical students compared to their non-medical peers.

The study comprehensively included all the colleges in the country, providing a comprehensive and representative sample. It thoroughly assessed the effect of demographics, knowledge, and attitude on SMA, offering valuable insights into the factors influencing these behaviors across a diverse student population. The study was limited to students in the degree program, potentially excluding the experiences of those in diploma or certificate programs. Additionally, there may be recall bias regarding antibiotic SMA, as participants need to remember or report their past behaviors.

Conclusion

In conclusion, this study revealed substantial knowledge regarding antibiotic drugs among participants, with the majority correctly identifying the target pathogens of antibiotics. However, significant gaps existed in knowledge concerning appropriate antibiotic use, particularly about treating viral infections and the consequences of self-medication. Self-medication practices with antibiotics were prevalent among university students, with a considerable proportion reporting ever using antibiotics without professional guidance. Factors contributing to self-medication included ease of access to antibiotics without prescription, perceptions of illness severity, and previous successful experiences with self-medication. Notably, drug stores or pharmacies were the primary sources of antibiotics for self-medication, highlighting the need for stricter regulation and enforcement of prescription requirements. Factors such as college of study, residence, knowledge of antibiotic resistance, and attitude toward self-medication influenced self-medication practices.

Abbreviations

WHO	World Health Organization
SMA	Self-medication with antibiotics
OTC	Over-the-counter
OCMHS	Orotta College of Medicine and Health Sciences
COE	Mai-Nefhi College of Engineering
COS	Mai-Nefhi College of Science
ACBSS	Adi-Keih College of Business and Social Science
and HAC	Hamelmalo College of Agriculture
IQR	Interquartile Range
AOR	Adjusted odds ratio
COR	Crude odds ratio

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Author contributions

The conceptualization and design of the study were done by BT, HH, NM, TBN, and NKG. Data collection, data entry, and initial draft writing were undertaken by BT, HH, and NM. TBN and NKG provided contextualization and supervision and conducted the data analysis. All authors contributed equally to this study and reviewed and approved the final manuscript.

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Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

The study received ethical clearance from the Research Ethics and Protocol Review Committee, Research and Human Resource Development Unit of the Ministry of Health, Eritrea, and permissions were obtained from relevant authorities at each college. Written informed consent was obtained from participants after providing a detailed explanation of the study's purpose, and confidentiality was maintained by anonymizing participants' identities. Participants were assured the right to withdraw from the study at any point. The research adhered to ethical principles outlined in the Declaration of Helsinki, ensuring the protection of human subjects in medical research. Participants retained the autonomy to withdraw their participation during the interview process.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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