

Self-medication of antibiotics: investigating practice among university students at the Malaysian National Defence University

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Mainul Haque¹
Nor Azlina A Rahman²
Judy McKimm³
Golam Mohammad Kibria¹
Md Anwarul Azim Majumder⁴
Seraj Zohurul Haque⁵
Md Zakirul Islam⁶
Shahidah Leong Binti Abdullah¹
Aqil Mohammad Daher¹
Zainal Zulkifli⁷
Sayeeda Rahman⁸
Russell Kabir⁹
Siti Nur Najihah Binti Lutfi¹
Nur Syamirah Aishah Binti Othman¹

¹Faculty of Medicine and Defence Health, Universiti Pertahanan Nasional Malaysia (National Defence University of Malaysia), Kuala Lumpur, 57000, Malaysia; ²Department of Physical Rehabilitation Sciences, Kulliyah of Allied Health Sciences, International Islamic University Malaysia, Kuantan, 25200, Malaysia; ³Swansea University School of Medicine, Grove Building, Swansea University, Swansea, Wales, SA2 8PP, UK; ⁴Department of Medical Education, Faculty of Medical Sciences, The University of the West Indies, Bridgetown, Barbados, West Indies; ⁵Department of Orthopedic Surgery, Ninewells Hospital & Medical School, Dundee, DD1 9SY, Scotland, UK; ⁶Department of Pharmacology, Eastern Medical College, Burichang 3520, Bangladesh; ⁷Department of Surgery, Sultan Haji Ahmad Shah Hospital, Temerloh, Pahang, 28000, Malaysia; ⁸Department of Pharmacology and Public Health, School of Medicine, American University of Integrative Sciences, Bridgetown, Barbados; ⁹School of Allied Health, Faculty of Health, Education, Medicine and Social Care, Anglia Ruskin University, Chelmsford, Essex, UK

Correspondence: Mainul Haque
Universiti Pertahanan Nasional Malaysia
(National Defence University of Malaysia),
Kem Perdana Sungai Besi, Kuala Lumpur
57000, Malaysia
Tel +60 109 265 543
Email runurono@gmail.com

Background: Self-medication of drugs to alleviate symptoms is a common global behavior, helping relieve burdens on health services, but many drugs eg, antibiotics are prescription-only. Self-medication of antibiotics (SMA) is an irrational use of drugs, contributing to microbial resistance increasing health care costs and higher mortality and morbidity. This study aimed to assess SMA among university students.

Methods: This was a cross-sectional study conducted among medical and non-medical students of the National Defence University of Malaysia. A validated instrument was used to gather data. Ethics approval was obtained. Random and universal sampling was adopted, and SPSS 21 was used for data analysis.

Results: A total of 649 students participated in the study: 48.5% male and 51.5% female, 39.3% reported self-medicating with antibiotics. Penicillin, doxycycline, clarithromycin were the antibiotics most used with the majority reporting no adverse drug reactions. Cost savings and convenience were the principal reasons for SMA which were mainly obtained from local retail pharmacies. Despite medical students (particularly the more senior) having better knowledge of antibiotic use than non-medical students, 89% of all research participants responded that practicing SMA was a good/acceptable practice.

Conclusion: SMA is common amongst Malaysian students and, despite understanding why SMA is unwise, even medical students self-medicate.

Keywords: antibiotics, self-medication, antibiotic resistance, university students, medical students, non-medical students

Introduction

The World Health Organization (WHO) defines self-medication as “the use of drugs to treat self-diagnosed disorders or symptoms, or the intermittent or continued use of a prescribed drug for chronic or recurrent disease or symptoms”.¹ Self-medication of antibiotics (SMA) has been recognized as inappropriate and irrational use of antibiotics and overall self-medication is considered as irrational.² Globally, the non-prescription consumption of antimicrobials has been growing and is recognized as a key risk factor for antimicrobial resistance (AMR). Because of this, in most of the countries legislation forbids patients from buying antimicrobials over the counter³ as it seen “as fuelling the evolution of resistant microbes”.⁴ However, in some countries (eg, Latin America) the law is often not executed, and patients can obtain such medicines without prescriptions.⁵ In Malaysia, the context of this study, antibiotics are

supposed to be prescription-only medicines⁶ but, nevertheless, studies report that antimicrobials can be bought over the counter.^{7,8} Around the world, pathogenic microorganisms that were principally affecting hospital patients are also infecting people in the community.^{9–12} and multi-drug-resistance of diseases such as tuberculosis, malaria, and gonorrhoea, which are usually treated in the community is being reported.^{13,14}

Self-medication can also be defined “as the selection and use of medicines by individuals (or a member of the individuals’ family) to treat self-recognized or self-diagnosed conditions or symptoms.”¹⁵ It involves the procurement of medicines without a prescription; using old prescriptions to buy medicines; using surplus medicines from friends or relatives for similar symptoms, and giving medications to other household members or dependent relatives, eg, children and older family members.^{1,16} Self-medication is one of the leading global causes of AMR¹⁷ and can lead to health hazards because of the wrong diagnosis; dosage; formulation; route; risk of adverse drug reactions; and drug interactions.¹⁵ SMA can also lead patients to defer a professional medical consultation which, in turn, may lead to more severe disease, drug dependence, and misuse.^{15,18} From a public health perspective, a critical issue is how to inform and educate patients to both take responsibility for their own health care (which may involve self-medication eg, of analgesics) whilst understanding when they should not self-medicate with drugs such as antibiotics.¹⁹

Antimicrobial resistance

Globally, AMR is developing at great speed, threatening the efficacy of antibiotics, and endangering millions with life-threatening infectious diseases (including pneumonia, tuberculosis, malaria, gonorrhoea, and foodborne diseases) that were once easily treatable.²⁰ A combination of biotic, behavioral, monetary, ecological, and community factors has led to the present situation of AMR being described as catastrophic and, as such, it is high on the global political health care agenda.^{17,21,22} Indeed, the threat of AMR is so calamitous that microbiologists, epidemiologists, and doctors are positing that we are moving into a “post-antibiotic” period²³ in which humans may well be in as much danger of microbial infections as they were before penicillin was discovered.²⁴ In 2014, the WHO wrote a serious cautionary letter, noting that “the world is headed for a post-antibiotic era, in which common infections and

minor injuries, which have been treatable for decades, can once again kill.”²⁵

These threats are found in both low and high resource settings. For example, Professor Dame Sally Davies, the Chief Medical Officer for England, described AMR as both a “catastrophic threat”²⁶ and an “apocalyptic threat”²⁷ which does not follow geopolitical borders.^{12,28} Tuberculosis, pneumonia, and gastroenteritis were three major killer diseases in the USA before the era of penicillins, responsible for 30% of all deaths and (because of AMR) these infections are reappearing with potentially devastating consequences.²⁹ “Methicillin-Resistant *Staphylococcus aureus* (MRSA)”, alone kills more people globally every year than many other diseases in combination.³⁰ Of all bacteria, *S. aureus* has the largest potential to cause widespread microbial infections³¹ and, as an opportunistic pathogenic microorganism causes superficial skin and soft tissue invasive infections including pneumonia, bloodstream infections, bone, and joint infections.^{32–34} *S. aureus* and MRSA are “one of the most frequent reasons for health care-associated infections”.³⁵ Asia, as the most populous continent, has the highest “rates of health care-associated methicillin-resistant *Staphylococcus aureus* and community-associated methicillin-resistant *Staphylococcus aureus*”^{36,37} and in many Asian hospitals MRSA is becoming multidrug-resistant (MDR).^{38–40}

In the US, the Center for Disease Control and Prevention (CDC) documented the first “18 drug-resistant microorganisms” as threats to the public health care system, categorized based on their potential to cause life-threatening disease at three levels: “urgent, serious, and concerning.”⁴¹ Threats allocated to the “urgent and serious” types necessitate more intensive care and precautionary measures. The CDC line of action is customized based on the epidemiology of the infectious microbial diseases, finding loopholes that might promote resistance and preventing resistance.

AMR in Malaysia

In Malaysia, Ampicillin is widely used to treat *Escherichia coli* induced urinary tract infection, and Erythromycin is widely used to treat *Streptococcus pneumoniae* induced pneumonia but at least 50% of *E. coli* infections and 25% of *S. pneumoniae* infections are resistant.⁴² Furthermore, in 2014 the hospital variety of *S. pneumoniae* shows an increase resistance up to 35.7% from an earlier year to Erythromycin and *Enterococcus faecium*

an increase of 9.3% to Vancomycin.⁴² A principal source of amplified AMR is the “overuse or inappropriate use of antibiotics that will lead to difficulties in treating common bacterial infections and increased health care costs.”⁴³ In Malaysia, the use of antimicrobials, both prescribed and purchased over-the-counter has increased by 16% annually, although it has decreased in some neighboring countries.^{44,45} In 2015, 39 hospital microbiology laboratories were tracked by the National Surveillance of Antibiotic Resistance group which reported that almost every variety of pathogenic microorganisms was resistant to some extent and that the gene *mcr-1* had been isolated in a Malaysian patient.⁴⁶ This new gene can make bacteria resistant to colistin (a last-resort drug for some MDR infections) was first reported in China in November 2015 and in the United States in May 2016.⁴⁷ The high economic growth in Southeast Asia (including Malaysia) has led to increased consumption of antimicrobials, especially with over the counter antibiotics, and it is anticipated that the region will see more widespread AMR emergence and spread.⁴⁸

Antibiotic resistance and health care costs

Although increasing numbers of microbial infections are resistant to antimicrobial drugs,⁴⁹ prior to 2000, no different types of antibiotics had been released for public sale for over 25 years and since then, only three new types of antibiotics for human treatment purpose have been made available for public purchase^{50,51} This lack of new antibiotics has come about because of increasing competition between pharmaceutical companies, lowering profit margins, and stringent policy issues.^{52–59} This increase in AMR comes at a high financial cost, with treatment costs for patients infected with antibiotic-resistant microorganisms being US\$6,000–30,000 higher than those infected with antimicrobial-susceptible organisms.^{60,61} To highlight the scale of AMR, a recent US study reported that resistant microorganisms infected around 2,000,000 patients, causing 23,000 deaths, and increasing health care costs around US\$55–70 billion annually.⁶² Specifically, “extended-spectrum β -lactamase *Enterobacteriaceae*, *MRSA*, *vancomycin-resistant Enterococcus* (VSE), MDR *Acinetobacter* or *Pseudomonas* spp. are reported by many studies to increase treatment costs by US\$7,212–98,575 per patient”.^{63–71}

Self-medication reports and hazards

One recent systematic review reported that SMA was common among people in the Middle East and contributed to using antibiotics wrongly.² This study also revealed that better, more widespread health education by health care professionals and strict policy implementation regarding “over the counter sales of antibiotics” would help reduce SMA.² Similarly, an Indian study reported an urgent need to develop health education programs for the public regarding self-medication, especially of antimicrobials, to improve knowledge, promote the rational use of drugs and help prevent adverse effects, including AMR.¹⁸ Cultural health beliefs and the level of education both greatly affect the nature and type of self-medication. For example, a Nigerian study reported that “41.9%, 9.1%, 4.0%, 3.5%, and 1.3%” of pregnant women self-medicate for “fever/pain; herbs and other drugs; sedatives; alcohol; and kola nuts” respectively to protect themselves from “witches and witchcrafts, abortion, bleeding; insomnia, fever, vomiting, and infections.”⁷² This study also found statistically “significant ($p=0.001$)” differences between pregnant educated and uneducated women regarding the self-medication of analgesics and antibiotics, with the former self-medicating much less.⁷²

A study in Saudi Arabia found a 78.7% self-medication rate of antimicrobials, with amoxicillin, ciprofloxacin, and penicillin being the antibiotics most self-consumed.⁷³ One recent cross-sectional study in Pakistan reported a self-medication rate for antimicrobials of 15.2% which was considered a huge public health issue.⁷⁴ Additional studies in Pakistan found that self-prescribed antibiotics were principally taken for “colds, coughs, diarrhea, flu, fever, and sore throats”^{75,76} and most of them were university students.⁷⁷ These trends are replicated throughout the world, for example, in Mongolia (71%),³ Spain (54.1%),⁷⁸ Zambia (97%),⁷⁹ Indonesia (64%),⁸⁰ Pakistan, (81.25%),⁸¹ India (39.3%),⁸² Peru (65.4%),⁸³ Malaysia (9%),⁸⁴ Bangladesh (26.69%),⁸⁵ and Haiti (45.5%).⁸⁶ Globally, self-medication with antibiotics is a huge public health issue because of ever-increasing antibiotic-resistance.^{87–93}

Whilst the practice of SMA and other drugs is more common among the public than more educated people and health professionals, it is still common among health care professionals and university students from Malaysia and other countries.^{94–97} This research was specifically concentrated among students of the Universiti Pertahanan Nasional Malaysia [(UPNM) National Defence

University of Malaysia], with participants being military medical and non-medical students, mainly cadet officers. Whilst this was an opportunistic sample as the lead researcher works at the University, no research had been carried out on military students before.

Materials and methods

Study design

This was a cross-sectional study. This article reports on findings from one part of the study.

Study population

The study population comprised medical and non-medical students of the National Defence University of Malaysia [UPNM].

Study period

Data were collected between 1 January and 30 April 2018.

Sampling method and Sample size

UPNM is a military University, most students are cadet officers, although there are some territorial and civil students. Students are extensively occupied with mandatory military training included within each program and access to students for research is difficult. The researchers used random sampling for the non-medical students from the faculties of i. Defence Studies and Management (FDSM), ii. Engineering (FE), iii. Defence Sciences and Technology (FDST), and iv. Language Center (LC). In the 2017–2018 academic year, there was a total of 1,746 student in these faculties and center. The Raosoft Sample Size Calculator was used to calculate the sample size.⁹⁸ The calculated sample size was $316+32$ (10% non-response) = 348 “(Error Margin=5%, Confidence Level=95%, Response distribution=50%, and Total Sample size=1746)”.⁹⁸ All 1,746 students were invited to participate in the study and, from these, 445 students volunteered and consented to participate through completion of a survey questionnaire. The population size of medical students was small ($N=230$), as only 50 students are admitted each year, and universal sampling was used for this group.

Techniques of data collection

Data were collected using a previously validated instrument regarding antibiotic use with permission (Appendix I).⁹⁹ All research participants were given details about the objectives

of the research, and (especially for non-medical research participants) information clarifying which medications were antibiotics. The self-administered questionnaire comprised three sections:

- Section A - socio-demographic data, including age, gender, place, and year of birth and program;
- Section B - Self-medication behaviors;
- Section C - Knowledge about antibiotics.

Prior to the full survey, the questionnaire was pre-tested and validated in the local context involving 45 (5 from each year) medical ($5 \times 5 = 25$) and non-medical ($5 \times 4 = 20$) students. These students did not participate in the subsequent primary study. The questionnaire sections demonstrated acceptable values, with a range between 0.672 and 0.882, which indicated that both instruments possessed good internal consistency and reliability. Convergent validity was shown by the significant correlations between the items of each section and the total mean in each part ($r_s = 0.332-0.718$; $p = 0.05$). The study pretested result corresponds with earlier studies.^{100,101}

Data analysis and interpretation

The data collected from this study were entered and analyzed using SPSS Version 21 (IBM Corporation, Armonk, NY, USA). The socio-demographic characteristics of the participants were described using frequency and percentages, since they are categorical variables, and compared between medical and non-medical students using the Chi-square test. The use and frequencies of SMA; reasons, diseases, basis and when to stop antibiotics during SMA and the practices and use of antibiotics during SMA were also described using frequency and percentages and compared between medical and non-medical students using Chi-square test. In the logistic regression, forward and backward LR test were used to select the variables to be included in the final model of multiple logistic regression. Each variable was also entered back into the model one by one and removed again if it was not significant, until the final model was achieved. The final model was checked to ensure that the model fitness is good. Some missing values were noted during data analysis as not all participants answered all questions fully. These were automatically excluded from the analysis as per the default setting of analysis using SPSS. The significance level was set at $\alpha = 0.05$.

Table 1 Socio-demographic characteristics of medical and non-medical students (n=649)

Variables	Total ^a No. (%)	Medical No. (%)	Non-medical ^b No. (%)	p-value ^c
Gender:		No. (%)	No. (%)	0.298
Male	314 (48.5)	105 (51.5)	209 (47.1)	
Female	334 (51.5)	99 (48.5)	235 (52.9)	
Marital status:				0.023
Single	636 (98.3)	204 (100.0)	432 (97.5)	
Married	11 (1.7)	0 (0)	11 (2.5)	
Family in health care:				0.001
Yes	124 (19.2)	54 (26.5)	70 (15.9)	
No	521 (80.8)	150 (73.5)	371 (84.1)	
Year of study:				<0.001
1	272 (42.1)	56 (27.5)	217 (48.8)	
2	146 (22.5)	38 (18.6)	108 (24.3)	
3	157 (24.2)	39 (19.1)	118 (26.5)	
4	35 (5.4)	33 (16.2)	2 (0.4)	
5	38 (5.9)	38 (18.6)	0 (0)	
Examination grade:				<0.001
1 or A	98 (19.8)	11 (5.4)	87 (29.9)	
2 or B	246 (49.7)	107 (52.5)	139 (47.8)	
3 or C	138 (27.9)	86 (42.2)	52 (17.9)	
4	13 (2.6)	0 (0)	13 (4.5)	
Admission type:				<0.001
Cadet Officer	117 (18.5)	110 (53.9)	7 (1.6)	
Territorial Army	371 (58.7)	26 (12.7)	345 (80.6)	
Civil	144 (22.8)	68 (33.3)	76 (17.8)	
Allowance:				<0.001
<RM500	327 (65.0)	73 (35.8)	254 (84.9)	
RM500–RM1,000	52 (10.3)	10 (4.9)	42 (14.0)	
RM1,001–RM2,000	105 (20.9)	102 (50.0)	3 (1.0)	
>RM2,000	6 (1.2)	6 (2.9)	0 (0)	
Others	13 (2.6)	13 (6.4)	0 (0)	
Health insurance:				<0.001
None	110 (30.0)	80 (39.2)	30 (18.4)	
Free medical care	84 (22.9)	44 (21.6)	40 (24.5)	
Various type	173 (47.1)	80 (39.2)	93 (57.1)	

^aWith some missing values. ^bFDSM, FE, FDST, and LC. ^cChi-square test between medical and non-medical faculties ([†]).

Abbreviations: FDSM, Faculty of Defence Studies and Management; FE, Faculty of Engineering; FDST, Faculty of Defence Sciences and Technology; LC, Language Center; RM, Malaysian Ringgit.

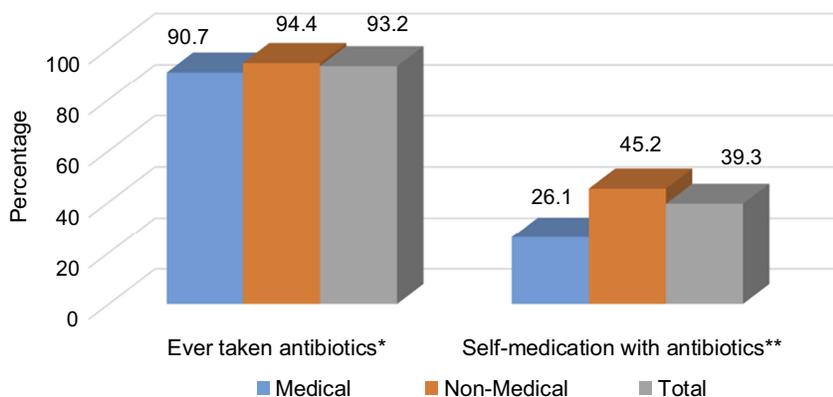


Figure 1 Percentages use of antibiotics among medical (n=204) and non-medical (n=445) students (Total n=649). *No significant difference between medical and non-medical students, Chi-square $p=0.082$. **Significant difference between medical and non-medical students, Chi-square $p<0.001$.

Ethical considerations

This research study was approved by the Institutional Ethical Clearance Committee, Centre for Research and Innovation Management, UPM, Kem Sungai Besi, 57,000 Kuala Lumpur, Malaysia, Code of Research: UPM/2017/SF/SKK/03, Memo No: UPM (PPPI) 16.01/06/023 (2), 23 August 2017. The study population was informed about the objectives and process of the study that the data gathered would be anonymized and used for publication, and that study participation was entirely voluntary with no penalty should they choose not to participate. Written consent was obtained before the questionnaires were distributed.

Reasons for focusing defence university

The Principal Investigator works in the National Defence University of Malaysia and therefore had access to the study participants, which are a unique group in Malaysia. This leads to some limitations of the study as it is an opportunistic sample but it was not possible to carry out a multi-center study within the resource constraints.

Results

Sociodemographic variables between medical and non-medical respondents

The distribution of sociodemographic characteristics of the participants' is set out in Table 1, including the comparison between medical and non-medical students (using Chi-square test). Respondents included slightly more females (n=334; 51.5%), the majority were unmarried (n=636; 98.3%) and did not have any family members working in health care services (n=521; 80.8%). Most participants described themselves as Malay in terms of

race (563, 88.52%), the others being Chinese, Indian, and others. The median age of the participants was 21 years old with an inter-quartile range of 2. The independent *t*-test results indicated that the medical students were slightly (but significantly) older (n=204; mean=21.8 years old; standard deviation [SD] =1.46) than the non-medical students (n=445; mean=21.4 years old; SD=1.18) with a *p*-value of <0.001. More than half of the participants received a monthly allowance of less than RM500 (n=327; 65.0%). Table 1 highlights that the socio-demographic characteristics between medical and non-medical students showed significant differences ($p<0.05$), except for gender ($p=0.298$). Medical students had a higher percentage of participants with family members working in health care services; were in Year 4 and 5 of their studies; had obtained Grades B and C in their examinations; were admitted as Cadet Officers; had a higher allowance and free medical care compared to those from non-medical faculties.

Students' self-medication with antibiotics within the last year

Most respondents had taken antibiotics (n=605; 93.2%) in the last year, and 39.3% (n=239) had practiced SMA (Figure 1). Antimicrobials were principally consumed for a runny nose, nasal congestion, cough, sore throat, fever, aches and pains, vomiting, diarrhea, and skin wounds (Table 2). The Chi-square test showed no significant difference between the medical or non-medical students regarding whether they had ever taken antibiotics ($p=0.082$) but a significantly higher percentage of non-medical students had self-medicated with antibiotics compared to medical students ($p<0.001$). Figure 2 shows the

Table 2 Reasons, diseases, basis and when to stop antibiotics during self-medication of antibiotics (SMA) among medical and non-medical students (n=239)

Variables	Total ^a No. (%)	Medical No. (%)	Non-medical ^b No. (%)	p-Value ^c
Reasons for SMA:				0.005
Cost saving	81 (35.7)	18 (37.5)	63 (35.2)	
Convenience	96 (42.3)	20 (41.7)	76 (42.5)	
Lack of trust in prescribing doctors	16 (7.0)	0 (0)	16 (8.9)	
Other reasons	19 (8.4)	2 (4.2)	17 (9.5)	
Multiple answers ^d	15 (6.6)	8 (16.7)	7 (3.9)	
Diseases for SMA:				0.052
Running nose	5 (2.3)	0 (0)	5 (2.9)	
Nasal congestion	5 (2.3)	1 (2.1)	4 (2.3)	
Cough	9 (4.1)	3 (6.3)	6 (3.5)	
Sore throat	8 (3.6)	1 (2.1)	7 (4.1)	
Fever	56 (25.5)	8 (16.7)	48 (27.9)	
Ache and pain	9 (4.1)	1 (2.1)	8 (4.7)	
Vomiting	4 (1.8)	0 (0)	4 (2.3)	
Diarrhea	3 (1.4)	2 (4.2)	1 (0.6)	
Skin wounds	8 (3.6)	0 (0)	8 (4.7)	
Other diseases	7 (4.1)	0 (0)	7 (4.1)	
Multiple answers ^d	106 (48.2)	32 (66.7)	74 (43.0)	
Basis for SMA:				0.428
Recommendation by pharmacist	58 (24.5)	7 (14.6)	51 (27.0)	
Opinion by family members	10 (4.2)	1 (2.1)	9 (4.8)	
Opinion by friends	2 (0.8)	1 (2.1)	1 (0.5)	
Own experience	11 (4.6)	2 (4.2)	9 (4.8)	
Previous doctor's prescription	85 (35.9)	19 (39.6)	66 (34.9)	
Advertisement	1 (0.4)	0 (0)	1 (0.5)	
Multiple answers ^d	70 (29.5)	18 (37.5)	52 (27.5)	
When to stop antibiotics:				0.684
After a few days, regardless of the outcome	20 (8.7)	5 (10.6)	15 (8.2)	
After symptoms disappeared	72 (31.2)	17 (36.2)	55 (29.9)	
Few days after recovery	27 (11.7)	2 (4.3)	25 (13.6)	
After antibiotics ran out	37 (16.0)	8 (17.0)	29 (15.8)	
After completed antibiotic course	14 (6.1)	4 (8.5)	10 (5.4)	
After consulting doctor/pharmacist	12 (5.2)	2 (4.3)	10 (5.4)	
Others	2 (0.9)	0 (0)	2 (1.1)	
Multiple answers ^d	47 (20.3)	9 (19.1)	38 (20.7)	

Notes: ^aWith some missing values. ^bFaculty of Management, Engineering, Science and Language. ^cChi-square test between medical and non-medical students (^b) (Expected frequencies <5 is >20% of the cells). ^dParticipants giving >1 answer.

frequency of SMA and illustrates that the medical students have a significantly lower SMA than the non-medical students with a Chi-square of $p < 0.001$. The other details regarding SMA are shown in Tables 2–4.

Table 2 shows the significant differences regarding reasons for SMA between medical and non-medical students. Most practiced SMA because of its convenience (n=96; 42.3%) [Medical (n=20; 41.7%) and non-medical students (n=76; 42.5%)] or cost savings [Medical (n=18; 37.5%) and non-medical students (n=63; 35.2%), though

not much difference was seen between both groups. Differences were found relating to lack of trust in the prescribing doctors as one of the reasons for SMA, where none of the medical students had lack of trust in their prescribing doctors as compared to non-medical students (n=16; 8.9%). Furthermore, more non-medical students gave “other reasons” as their reason (n=17; 9.5%) while more medical students gave multiple answers to these questions (n=8; 16.7%). However, there was no significant difference between the medical and non-

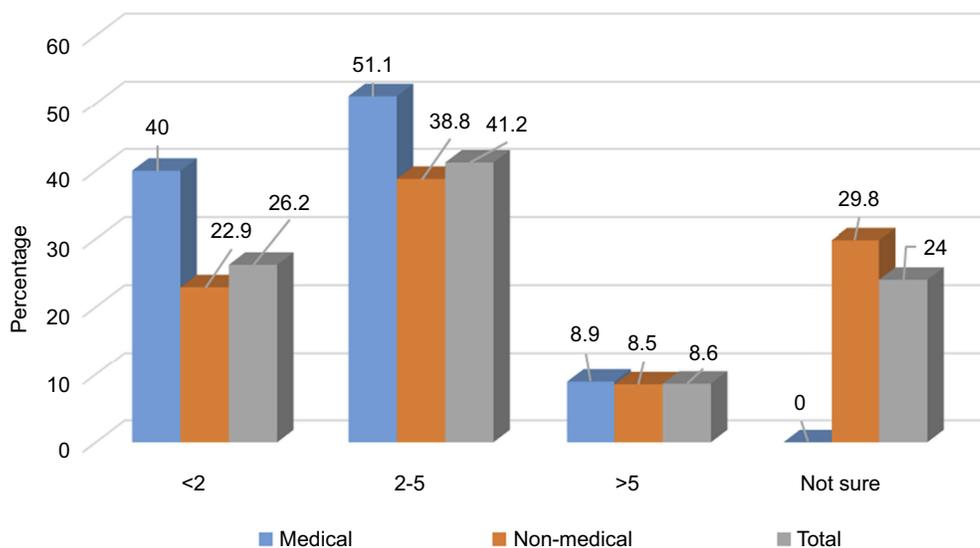


Figure 2 Percentages of frequencies of self-medication of antibiotics (SMA) among medical (n=49) and non-medical (n=190) students (Total n=239). *Significant difference between medical and non-medical students, Chi-square $p<0.001$.

medical students regarding the diseases, the basis for SMA, nor the reasons they stopped antibiotics during SMA ($p=0.052$, 0.428 and 0.684, respectively). Amongst all respondents, the main disease or condition for SMA was due to fever (n=56; 25.5%); SMA was mainly practiced based on a previous doctor's prescription (n=85; 35.9%) and the majority stopped the antibiotics once their symptoms disappeared (n=72; 31.2%). No medical students cited a lack of trust in prescribing doctors, whereas 16 (8.9%) non-medical students stated that was a reason for SMA (Chi-square $p=0.005$).

Table 3 shows that most respondents described the main considerations in choosing antibiotics during SMA as the type of antibiotics (n=88; 37.1%); obtaining their antibiotics from community pharmacies (n=155; 66.0%); knowing the dosage after consulting a doctor (n=65; 27.8%) and taking only one type of antibiotic during an illness (n=98; 55.1%). There was no significant difference between medical and non-medical students regarding the dosage and the maximum number of antibiotics taken during an illness. However, significant differences were observed between the two groups regarding the consideration for SMA and where they obtained the antibiotics for SMA. A higher percentage of medical students gave either multiple answers or the brand and price of the antibiotics as their main consideration compared to non-medical students, who were more concerned about the type or an adverse reaction from the antibiotics.

The practices regarding the use of antibiotics during SMA are shown in Table 4. Very few participants "always" change dosage or switch antibiotics during SMA (n=19; 8.1% and n=19; 8.2%, respectively), though quite a number "sometimes" did that (n=97; 41.3% and n=82; 35.3%, respectively). The majority did not fully understand the instruction on the antibiotic package however (n=136, 60.2%), were somewhat concerned about taking counterfeit antibiotics (n=108; 46.4%), did not experience any adverse effects during SMA (n=164; 71.3%), thought that SMA was an acceptable practice (n=144; 61.3%) but were not sure whether they could successfully treat the infection on their own (n=151; 64.3%). Less than half of the participants had taken the same antibiotics with different names during a course of antibiotics (n=93; 40.1%).

The comparison between medical and non-medical students regarding the use of antibiotics during SMA (Table 4) showed a significant difference for understanding the instruction on the antibiotics package, where as might be expected, a higher percentage of medical students understood the instruction fully ($p=0.015$). In addition, a higher percentage of medical students switched antibiotics during SMA ($p=0.004$) and did not think that they could successfully treat themselves ($p=0.011$). A higher percentage of non-medical students were more concerned about taking counterfeit antibiotics ($p=0.011$) and thinking that SMA is a good or acceptable practice ($p=0.002$).

Table 3 Practices regarding self-medication of antibiotics (SMA) among medical and non-medical students (n=239)

Variables	Total ^a No. (%)	Medical No. (%)	Non-medical ^b No. (%)	p-Value ^c
Consideration for SMA:				0.007
Type of antibiotics (AB)	88 (37.1)	14 (29.2)	74 (39.2)	
Brand of AB	11 (4.6)	5 (10.4)	6 (3.2)	
Price of AB	9 (3.8)	3 (6.3)	6 (3.2)	
Indication of use	39 (16.5)	6 (12.5)	33 (17.5)	
Adverse reaction	26 (11.0)	1 (2.1)	25 (13.2)	
Other considerations	5 (2.1)	0 (0)	5 (2.6)	
Multiple answers ^d	59 (24.9)	19 (39.6)	40 (21.2)	
Place to get AB:				0.001
Community pharmacies	155 (66.0)	20 (41.7)	135 (72.2)	
TCM practitioners	7 (3.0)	1 (2.1)	6 (3.2)	
Leftovers	28 (11.9)	12 (25.0)	16 (8.6)	
Online shopping/E-Pharmacies	2 (0.9)	0 (0)	2 (1.1)	
Other places	16 (6.8)	5 (10.4)	11 (5.9)	
Multiple answers ^d	27 (11.5)	10 (20.8)	17 (9.1)	
How to know the dosage:				0.136
Checking inside package	39 (16.7)	10 (20.8)	29 (15.6)	
Consulting a doctor	65 (27.8)	11 (22.9)	54 (29.0)	
Consulting a pharmacist	25 (10.7)	2 (4.2)	23 (12.4)	
Consulting family member/friend	4 (1.7)	1 (2.1)	3 (1.6)	
From newspapers/magazines/books/TV programs	1 (0.4)	0 (0)	1 (0.5)	
From internet	2 (0.9)	2 (4.2)	0 (0)	
Previous experience	3 (1.3)	1 (2.1)	2 (1.1)	
Guessing the dose	1 (0.4)	0 (0)	1 (0.5)	
Multiple answers ^d	94 (40.2)	21 (43.8)	73 (39.2)	
Max. no. of AB taken during an illness:				0.606
1	98 (55.1)	26 (59.1)	72 (53.7)	
2	62 (34.8)	15 (34.1)	47 (35.1)	
>2	13 (7.3)	3 (6.8)	10 (7.5)	
Not sure	5 (2.8)	0 (0)	5 (3.7)	

Notes: ^aWith some missing values. ^bFaculty of Management, Engineering, Science and Language. ^cChi-square test between medical and non-medical students (^b) (Expected frequencies <5 is >20% of the cells). ^dParticipants giving >1 answer.

Abbreviation: TCM, Traditional Chinese Medicine.

Self-medication with antibiotics association with knowledge

Scores from the knowledge section were collated to calculate total knowledge scores, which were then compared between the medical and non-medical students. The mean total scores of the participants were 5.4 (SD=1.49) with a range of between 2 and 9 out of a possible maximum score of 9. The result of comparison using MANCOVA (by taking into consideration the possible confounding effect of age, gender, year of study, examination grade and SMA practice) is shown in Figure 3. As might be expected, the results showed independently significantly higher total scores

of knowledge about antibiotics among medical students (estimated marginal mean (EMM) =5.9; 95% confidence interval (CI)=5.57, 6.18) compared to non-medical students (EMM=4.7; 95% CI=4.44, 4.95) with the *p*-value of 0.002.

Factors associated with self-medication with antibiotics

Simple logistic regression was carried out, followed by multiple logistic regression to identify the independently associated factors for SMA. An OR of more than 1 means there is a higher risk of practicing SMA whilst an OR of less than 1 means there is a lower risk of practicing SMA.

Table 4 Practices regarding the use of antibiotics during self-medication of antibiotics (SMA) among medical and non-medical students (n=239)

Variables	Total ^a No. (%)	Medical No. (%)	Non-medical ^b No. (%)	p-Value ^c
Understand the instruction on package:				0.015
Fully understood	90 (39.8)	26 (55.3)	64 (35.8)	
Partly or did not understand	136 (60.2)	21 (44.7)	115 (64.2)	
Change dosage during SMA:				0.192
Yes, always	19 (8.1)	6 (12.5)	13 (7.0)	
Yes, sometimes	97 (41.3)	15 (31.3)	82 (43.9)	
Never	119 (50.6)	27 (56.3)	92 (49.2)	
Switch antibiotics (AB) during SMA:				0.004
Yes, always	19 (8.2)	9 (18.8)	10 (5.4)	
Yes, sometimes	82 (35.3)	11 (22.9)	71 (38.6)	
Never	131 (56.5)	28 (58.3)	103 (56.0)	
Concern about taking counterfeit AB:				0.011
Yes, very much	59 (25.3)	14 (29.8)	45 (24.2)	
Yes, somewhat	108 (46.4)	13 (27.7)	95 (51.1)	
No	66 (28.3)	20 (42.6)	46 (24.7)	
Taken same AB with different names:				0.629
Yes	93 (40.1)	17 (37.0)	76 (40.9)	
No	139 (59.9)	29 (63.0)	110 (59.1)	
Adverse reactions during SMA:				0.105
Yes	66 (28.7)	9 (19.1)	57 (31.1)	
No	164 (71.3)	38 (80.9)	126 (68.0)	
SMA for self-health care:				0.002
Good practice	65 (27.7)	11 (23.4)	54 (28.7)	
Acceptable practice	144 (61.3)	24 (51.1)	120 (63.8)	
Not acceptable practice	26 (11.1)	12 (25.5)	14 (7.4)	
Successful treatment by SMA:				0.011
Yes, I can	58 (24.7)	10 (21.3)	48 (25.5)	
Not sure	151 (64.3)	26 (55.3)	125 (66.5)	
No, I cannot	26 (11.1)	11 (23.4)	15 (8.0)	

Notes: ^aWith some missing values. ^bFDSM, FE, FDST, and LC. ^cChi-square test between medical and non-medical students (^b).

Simple logistic regression found SMA was significantly associated with year of study, namely less SMA in Year 5 compared to Year 1 (OR=0.084; 95% CI of OR=0.020, 0.359; $p=0.001$); admission type, namely Territorial Army compared to Cadet Officer (OR=2.423; 95% CI of OR=1.473, 3.987; $p<0.001$); medical compared to non-medical students (OR=0.427; 95% CI of OR=0.292, 0.623; $p<0.001$); total scores of knowledge (OR=0.782, 95% CI of OR=0.695, 0.881, $p<0.001$), and monthly allowance, namely between allowance of RM1,001–RM2,000 compared to <RM500 (OR=0.530; 95% CI of OR=0.315, 0.890; $p=0.016$). After finalizing the multiple logistic regression, only three variables were found to be

independently significantly associated with SMA: year of study, medical faculty, and total knowledge scores. Students reporting lower SMA were in Year 5 (compared to Year 1), a medical student (rather than a non-medical student) and having a higher total score of knowledge regarding antibiotics. The full results of the multiple logistic regression are shown in Table 5.

Discussion

Prescription-only drugs (including antibiotics) are often self-administered as patients feel that they will save money and time, but this can lead to substantial adverse drug reactions, antibiotic resistance, treatment failure, and

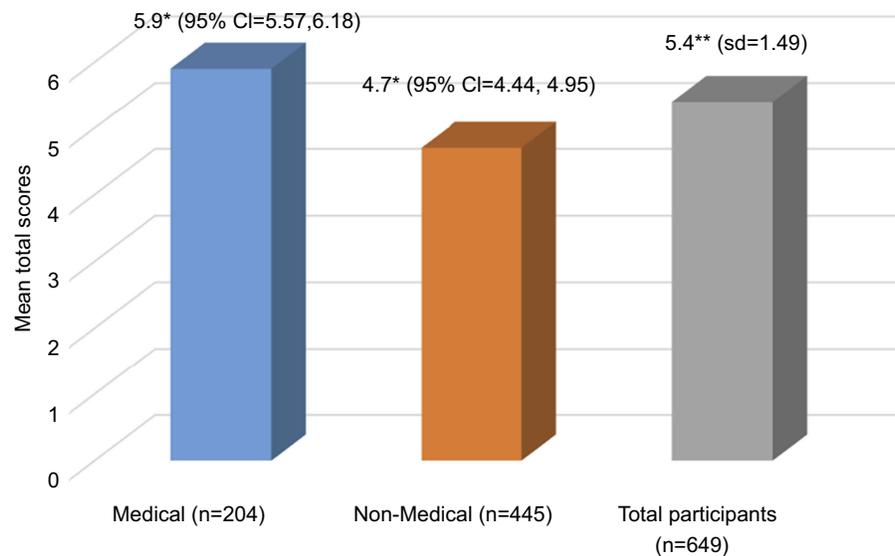


Figure 3 The mean total scores of knowledge about antibiotics among medical and non-medical students. ** Mean; * Estimated marginal mean adjusted by age, gender, year of study, examination grade and practicing self-medication of antibiotics (SMA). A MANCOVA test showed a significant difference between medical and non-medical students adjusted estimated marginal means with $p=0.002$.

drug-related toxicity: all of which lead to costs for both individuals and health services^{18,102} With the development of MDR and extremely drug-resistance microbial-strains, treatment options are increasingly limited, and this leads to more visits to doctors; prolonged hospital stays; more expensive proprietary drugs; higher health care costs; poorer quality of life for individuals; increased mortality, and loss of potential work hours.¹⁰³

Study respondents' demographics

Respondents in the study had similarities with those in other studies involving students. Earlier studies at UPNM reported more male respondents than female.^{104,105} However, although in the current study there were more

female respondents than males, there was no statistically significant difference between genders. Most of the current study respondents were unmarried reflecting that cadet officers cannot marry whilst a student, but also that most Malaysian university students are unmarried with the average age of marriage being 26–28 years.^{106,107} Although Malaysia is a multi-ethnic country, Malays are the largest race¹⁰⁸ and, reflecting that, the respondents were mostly Malay.

Behaviors regarding self-medication with antibiotics

“The skyrocketing rates of antibiotic prescriptions now suggest that as many as four out of five Americans may

Table 5 Factors associated with self-medication of antibiotics (SMA) using multiple logistic regression (n=649)

Variables	n	Odds ratio (OR)	95% confidence interval of OR	p-Value
Year of study:				
Year 1*	272	1	–	1.000
Year 2	146	0.758	(0.484, 1.188)	0.227
Year 3	157	1.097	(0.706, 1.704)	0.682
Year 4	35	0.804	(0.335, 1.930)	0.625
Year 5	38	0.163	(0.036, 0.733)	0.018
Students:				
Medical*	204	1	–	1.000
Non-medical	445	0.599	(0.387, 0.926)	0.021
Total scores of knowledge regarding antibiotics	649	0.863	(0.760, 0.980)	0.023

Notes: *Reference group

be getting antibiotics annually, according to a new study by the CDC.”¹⁰⁹ Internationally between 2000 and 2015 the use of antimicrobials increased to 65%¹¹⁰ which is reflected in the findings of this study. The SMA rate in this study (40% overall) is lower than of Peru (70%)⁸³ and Asian studies [Pakistan (50.1%, 58.3%), India (78.18%)].^{19,97,111} However, it is higher than in other Asian studies [Bangladesh (26.69%, 15.6%), Bhutan (23.6%)].^{85,112,113} In Peru, 70% of the study respondents treated themselves with antimicrobials two or more times annually.⁸³ Similarly, another European study found that respondents reported SMA 2–3 times a year for upper respiratory tract infections.¹¹⁴ This study’s findings regarding SMA annually were similar. The current study also found that medical students had a lower rate of SMA per year than non-medical students. This could have been anticipated and explained because medical students learn about the correct use of antibiotics and the dangers of misuse during their degree program. Moreover, many of the medical students had family members who were health professionals. A similar positive awareness regarding SMA among medical students was also observed in an earlier study.¹¹⁵

Multiple studies report that the high rate of SMA can be explained by poor or lacking drug control measures, regulatory policy, and planning and, whilst antimicrobials are generally prescription-only drugs, patients can buy them over the counter because of the poor practice of regulatory agencies and individuals acquiring antibiotics to sell on the black market.^{19,116,117,118} In addition, the public might have poor knowledge about antimicrobials acquired from “advertisements on television, radio and print media in addition to advice from friends and family.”¹¹⁷ Cost and convenience are other factors, patients in an “expensive health care system cannot afford to pay the consultation fees of the doctor, (and) going to a doctor’s clinic or to the hospital is too much of a hassle.”¹¹⁹ In the light of financial and workforce constraints, governments are increasingly encouraging people to treat minor health ailments themselves and if people do not understand the consequences of SMA they will see taking antibiotics as the same as (for example) taking analgesics.¹¹⁹ The health issue reasons for SMA stated by the current study respondents are similar to other Asian studies.^{85,120} The selection of antibiotic based on presenting symptoms was also consistent with earlier studies, principally: pharmacist’s recommendation; friends and family members suggestions; previous personal experience and having previously been recommended antibiotics

by a registered health professional.^{2,18,121} The source of antibiotics (pharmacists or leftover medicines) also reflected other studies.² Although SMA is considered a potential health hazard especially because of misuse and development of resistant microbes, many respondents reported that they always read and understood medication instructions. Whilst this is a positive finding, almost half of the respondents changed the dosage of antimicrobials (as in another study⁹⁹) or changed to another antibiotic because they felt they were not improving, their stock had run out, or they wanted a cheaper alternative. These attitudes reflect an irrational use of antimicrobials which has the potential to promote AMR. Respondents also reported that they suspected they were taking counterfeit drugs and it has been reported that “counterfeit drugs are widely available within the Asia Pacific region, including Malaysia.”¹²² These study respondents were often taking the same molecule of antibiotic with a different trade name, also found among Chinese University students.⁹⁹ Respondents also frequently stopped taking the antibiotics when their symptom went and they felt better, which conflicts with the WHO campaign regarding AMR.¹²³ Penicillin, doxycycline, clarithromycin were the most commonly used antibiotics, and the majority did not report any adverse drug reactions. Multiple studies also report that penicillin is the most commonly abused antibiotic for SMA.^{20,99} However, the most alarming issue highlighted in the study is that, despite antibiotics being prescription-only drugs, most of both groups of respondents think SMA is a good/acceptable practice and one-quarter of them think they can treat and manage infectious diseases themselves. These (relatively privileged) students cite cost-saving and convenience as the reasons for SMA. Across low and middle-income countries multiple other studies identify poverty; poor access to health care; scarcity of graduate physicians and other health professionals; a low standard of health care; over the counter availability of antimicrobials, and patients’ misapprehensions about medical doctors, as the reasons for SMA.^{90,124,125}

Self-medication with antibiotics: association with knowledge

SMA can lead to adverse drug reactions and interactions, mask signs and symptoms which makes it harder to reach the correct diagnosis, and can promote the development of additional infectious diseases. Additionally, the wrong antibiotic or wrong dosage (often seen in SMA) can lead to microbial resistance, treatment failure, and increased cost.^{114,126,127}

The results of the current study revealed that medical students had significantly higher total scores of knowledge about antibiotics compared to non-medical students and reported less SMA. This is confirmed by multiple other studies which also report that when medical students have a good knowledge about SMA, subsequently more responsible self-medication practice was observed.^{128,129,130} In order to increase widespread knowledge of the risks of SMA and minimize unnecessary antibiotic use, several studies suggest that national and local educational interventions, antibiotic stewardship, and other activities among all stakeholders regarding antibiotic use are required.^{131–135}

Factors associated with self-medication with antibiotics

One earlier Ethiopian study utilizing bivariate and multivariable analysis found that multiple factors were independently associated with non-prescribed antimicrobial use.¹³⁶ Another study from Serbia using Multivariate logistic regression analysis identified the independent risk factors for self-medication among medical students as possession of home-pharmacy/left-over antibiotics; being female; senior students; lower level of father's education; alcoholic drink intake; a higher Physical Health Questionnaire – 9 score, and minimum physical activity.¹³⁷

In the current study, simple logistic and multiple logistic regression found SMA was significantly associated with several factors. Regarding year of study, it was lower in Year 5 compared to Year 1 students, probably due to the higher level of knowledge about antibiotics and greater maturity of the Year 5 clinical students than their biomedical science peers. The Territorial Army students had a lower reported SMA than the Cadet Officers, which might be explained by the Cadet Officers having much less time available to attend clinics. As expected SMA was lower in medical students than non-medical students; lower with a higher total score of knowledge about antibiotics, and lower in students with a higher monthly allowance (RM1,001-RM2,000 compared to <RM500). The latter can be explained by students with lower incomes looking to save money so buying cheaper over the counter antibiotics than by going to a doctor which costs more.

A recent review revealed substantial overuse and misuse of antibiotics among US physicians.¹³⁸ Moreover, 30% of these prescriptions were irrational, and 50% were for acute respiratory diseases, many of which are self-limiting and do

not require antimicrobials.^{139,140} This is a global issue.¹⁴¹ Resistance of microbes is a natural phenomenon and so even if antibiotic use is rational, AMR will still increase, this is, of course, exacerbated with over-prescribing, and even further by SMA.¹⁴² Overprescribing is especially predominant (around 40% being unnecessary) in acute respiratory tract infections.^{141,143,144,145} To improve antibiotics' use and prevent AMR, educational and community awareness-raising interventions are required for all stakeholders including health professionals and consumers.¹⁴⁶

Limitations of the study

There are several limitations to this study. First, the study was carried out in a specific context, a military college in Malaysia and therefore the study participants may not be representative of other university students around the world and the findings may not be generalizable to other contexts (eg, where antibiotics cannot be bought over the counter). The students were self-selecting as they could opt out of the study, and they also self-reported on their behaviors, therefore there could be some recall bias leading to respondents either over- or under-reporting SMA. The study sample was also relatively low and therefore more studies in different contexts with larger numbers and measuring actually observed behaviors would help to validate or refute the findings from this study. Furthermore, some participants did not complete all survey questions, hence the missing data in the results presentation. The cross-sectional study design used did not allow for the causal-effect relationship to be inferred or concluded from the results of this study. Finally, it was unclear what and how any educational interventions might have impacted on the findings; therefore, action research studies would also be useful to examine the impact on antibiotic usage of education on antibiotic resistance and appropriate use of antibiotics.

Conclusions

Currently, AMR is a global public health crisis which has often been ascribed to the indiscriminate, irrational use of antimicrobials by registered health practitioners and SMA. These study respondents are medical and non-medical military students of the public university, who should be relatively informed and educated about the risks of SMA and will probably be future leaders in the country. However, even amongst this group, almost 40% (39.3%) of respondents reported self-medicating with antibiotics. The most concerning finding was that 89% of the research

participants felt that practicing SMA was a good or acceptable practice. Whilst these Malaysian students might not be representative of those in other contexts, the study highlights that more multi-center, well-designed prospective research studies are urgently required to confirm the issue and inform new health care and educational policies and strategies, which must include strict regulation of purchasing antibiotics over the counter.

Key issues or findings

- Self-medication of antibiotics (SMA) is a common problem, especially in low and middle-income countries
- It helps contribute to antimicrobial resistance and leads to a range of other health issues for individuals and health economies
- Medical students, particularly more senior students, are less likely to practice SMA than non-medical students, reflecting their deeper knowledge of antibiotic use and misuse
- Whilst multiple factors contribute to SMA, cost and convenience are common reasons, reflected in the findings from this study
- However, despite medical students being less likely to report SMA, 89% of all the students in the study felt SMA was a good or acceptable practice
- More educational, policy and regulatory interventions are required to increase knowledge about antibiotic use and prevent the purchase of antibiotics without prescription

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