Original Article

A Cross-Sectional Study Evaluating the Knowledge and Beliefs About, and the Use of Antibiotics Amongst Medical Students in Malaysia

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A Cross-Sectional Study Evaluating the Knowledge and Beliefs About, and the Use of Antibiotics amongst Medical Students in Malaysia

ABSTRACT

Background: The introduction of antibiotics into modern medicine has changed clinical care by saving millions of lives. However, antibiotics are not a panacea for everything and misuse of antibiotics has led to their many benefits being overshadowed by the development of antimicrobial resistance. **Aims of Study**: This study aimed to assess university students' knowledge and beliefs about and their use of antibiotics. **Methods**: This cross-sectional study was conducted among medical and non-medical students of the National Defence University of Malaysia. A universal and convenience sampling method was applied for medical students and non-medical students respectively. The data was collected using a validated questionnaire and analyzed using IBM SPSS Statistics version 24 (IBM Corporation, Armonk, NY, USA). Frequencies and percentages were used to describe the knowledge and beliefs about and use of antibiotics, and the MANOVA test and Logistic Regression were used to explore the associated factors. **Results**: A total of 674 students participated in this study who expressed a high level of trust in their doctors. More than half of the respondents' knowledge was low (58.2%) and their health beliefs were outdated (56.1%). Respondents' age, race and program were found to be significantly associated with up-to-date knowledge and beliefs about antibiotic use (p<0.001), while multiple logistic regression found factors associated with finishing a course of antibiotics were studying in a medical field (OR=3.370; p<0.001), perceived personal health (OR=0.467; p=0.009) and ethnic origin (OR=0.455; p=0.045). Using multiple logistic regression, the significant factors associated with antibiotic self-prescribing were beliefs (OR=0.756; p<0.001); had been prescribed antibiotics during the last 12 months (OR=2.445; p=0.001) and trusted the doctors who did not prescribe antibiotics. **Conclusion**: This study has identified a concerning low knowledge about antibiotics amongst some Malaysian university students, which is reflected in use of unprescribed antibiotics and a lack of adherence to treatment. University students will often be the future leaders of a country and will therefore act as role models in their communities. This study has identified a need for widespread educational interventions

for students regarding antibiotic usage and resistance issues so that their future behaviors do not undermine healthcare initiatives.

1. INTRODUCTION

Over the last three to four decades, tremendous changes have taken place in both the concepts and the understanding of pharmaceutical treatment strategies [1-2]. Current medical students will become doctors who will be prescribing independently throughout their careers, which are, on average, 40 years [3-7]. Learning, attaining and updating prescribing knowledge and skills is therefore an essential tool for every student and practicing doctor [8-11] however multiple studies report that many medical students do not adequately learn prescribing skills to effectively prescribe drugs during their undergraduate programs [12-15]. The World Health Organization (WHO) also reports that the prescribing of at least 50% of medicines is inappropriate [16], with a large proportion of these being antimicrobials or antibiotics [17, 18]. Overuse and misuse of antimicrobials is currently a global public health problem, particularly because this encourages antimicrobial resistance (AMR) [19-21].

The current study was therefore carried out to appraise the usage pattern, knowledge and beliefs about antimicrobial use among medical and non-medical students of the Universiti Pertahanan Nasional Malaysia [(UPNM) National Defence University of Malaysia]. Specifically, this study intended to seek the respondents' opinions on their trust in their doctors' behaviors and communication skills (as a proxy for exploring adherence to treatment with antibiotics) while prescribing antimicrobials; the factors associated with knowledge and beliefs about antibiotic use; finishing a course of prescribed antibiotics, and antibiotic self-prescribing.

2. MATERIALS and METHODS

2.1 **Study Design**: This was a snapshot cross-sectional study using a survey questionnaire as the method of data collection, with one data collection point.

2.2 **Study Population**: The study population comprised medical and non-medical students of the UPNM, Malaysia, Kem Perdana Sungai Besi, Kuala Lumpur, Malaysia, from all years of study.

The non-medical students were drawn from the faculties of Defence Studies and Management (FDSM), Engineering (FE), Defence Sciences and Technology (FDST), and Language Center (LC).

2.3 **Study Period**: The data were collected from 1st January to 30th April 2018.

2.3 **Sampling Method and Sample Size**: This research was conducted among the students of the 2017-2018 academic year. This is a military university where most students are cadet officers, although there are some territorial students and civil students. The students are extensively occupied with the military training programme, which is mandatory for all courses. This made access to the students difficult. For the medical students, a universal sampling method was adopted as the total population size was small (N=230), as only 50 students are admitted into the Medical Faculty of this university each year. Due to the difficulty in accessing the non-medical students, a convenience sampling method was applied for these cohorts. Any undergraduate students, both male and female, were eligible to participate in this study.

2.4 **Sample Size Calculation:** The Raosoft Sample Size Calculator [22] was utilized to calculate the sample size for non-medical students given that universal sampling was adopted for medical students. The calculated sample size was 316, added to by 32 of a 10% non-response, giving the sample size of 348. An error margin of 5%, a confidence level of 95%, response distribution of 50%, and a total population size of 1746 was used in the calculation [22].

2.5 **Techniques of Data Collection**: Following ethics approval and with permission from the faculty administration, students were invited to a meeting where the project was explained, consent was obtained, and the survey questionnaires given out and completed. Data were collected using a validated instrument regarding antibiotic use [23]. Permission was obtained from the corresponding and principal author of the original questionnaire. The self-administered questionnaire comprised four sections:

- **Section A** - Socio-demographic data, including age, gender, ethnicity/race, place and year of birth and programme and type of admission.
- **Section B** - Pattern of Antibiotic Use.
- **Section C** - Knowledge about Antibiotics.

- **Section D** – Beliefs about the use of Antibiotics.
- **Section E** - Doctors' behaviours and the Patient/Doctor Relationship.

Prior to undertaking the full survey, the questionnaire was pre-tested and validated in the local context, with 20 (10 medical and 10 non-medical) students who did not participate in the principal study. The sections of this questionnaire demonstrated acceptable Cronbach alpha results, with values between 0.672-0.882, which indicated that the instrument possessed good internal consistency and reliability. Evidence of convergent validity was shown by the significant correlations between the items of each section and the total mean in each part (r=0.332–0.718; p=0.05) [24, 25].

2.6 **Data Analysis**: The data collected were analyzed using IBM SPSS Statistics version 24 (IBM Corporation, Armonk, NY, USA). Descriptive statistics were used to describe the sample using frequency and percentage for categorical variables and mean with standard deviation for age as this was normally distributed. In the section on knowledge, attitude and perception of doctors' behaviours, "strongly disagree" was combined with "disagree" and "strongly agree" was combined with "agree" to simplify the results, using a scoring system where one mark was given for "strongly agree" and "agree," and 0 marks for "strongly disagree" and "disagree" for correct statements in the knowledge and attitude section, reversed for any inaccurate statements. Neutral responses ("neither agree nor disagree") were given a mark of zero.

The Multivariate Analysis of Variance (MANOVA) test was used to analyse the socio-demographic factors associated with knowledge and attitude regarding antibiotic usage. These were defined as the total knowledge and attitude scores, taking into consideration the numerical outcome variables used. The Bonferroni post-hoc test was used in a pairwise comparison to identify the different pairs of significant results relating to the independent variables with more than two groups. The Pearson correlation test was used to explore the association between the two numerical variables for age. Linearity and normality assumption was confirmed before any results were reported.

In exploring the associated factors for finishing prescribed antibiotics and the self-prescription of antibiotics, simple logistic regression followed by multiple logistic regression was carried out using the binomial outcome variables, where the "don't know/can't remember" answers were treated as missing values. The factors considered in the analysis were age, gender, race/ethnicity, programme, whether studying in medicine, perceived personal health status, trusting doctors to prescribe or not prescribe antibiotics, and the total knowledge and attitude scores. For variables with a *p*-value of less than 0.25, forward Likelihood Ratio (LR) and backward LR tests were carried out to identify the variables to be tested via multiple logistic regression. Before finalizing the results, each variable that had been taken out due to non-significance was recalculated to ensure their non-significance before being finally rejected. Model fitness was checked before the results were reported as an odds ratio (OR) with a 95% confidence interval (CI). An OR of more than one means that there is a higher probability for the outcome variable, while an OR of less than one means that there is less probability for the outcome variable, as compared to the reference group. The significance level was taken as 0.05 in all the statistical tests done.

2.7 **Ethical Considerations**: This research study was approved by the Institutional Ethical Clearance Committee, Centre for Research and Innovation Management, UPNM, Kem Sungai Besi, 57000 Kuala Lumpur, Malaysia, Code of Research: UPNM/2017/SF/SKK/07, Memo No: UPNM (PPPI) 16.01/02/027 (2), 12 December 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 for non-participation. Written consent was obtained before the survey questionnaires were distributed.

3. RESULTS

3.1 Socio-Demographic Characteristics

674 participants were recruited for this study. Their socio-demographic characteristics are displayed in Table 1. There were slightly more males (51.3%) than females (48.7%), with most of the participants being Malay (84.4%) and from the Medical Faculty (i.e. medical students)

(32.5%). In terms of marital status, there were two missing responses, otherwise all participants were single.

Table 1: Socio-demographic characteristics of participants (n=674).

Variable	Frequency	Percentage (%)
Age (years old)	21.5[a]	1.32[b]
Sex		
Male	346	51.3
Female	328	48.7
Race/Ethnicity		
Malay	566	84.0
Chinese	20	3.0
Indian	73	10.8
Others	12	1.8
Faculty		
Medical	215	31.9
Engineering	81	12.0
DSM [c]	199	29.5
Science	112	16.6
Language	55	8.2

[a] Mean; [b] Standard deviation; [c]Defence Studies and Management

The survey asked respondents about their perceived health status, see Figure 1. This shows that majority of the participants perceived themselves to be in either “very good” (38%) or “excellent” (31%) health.

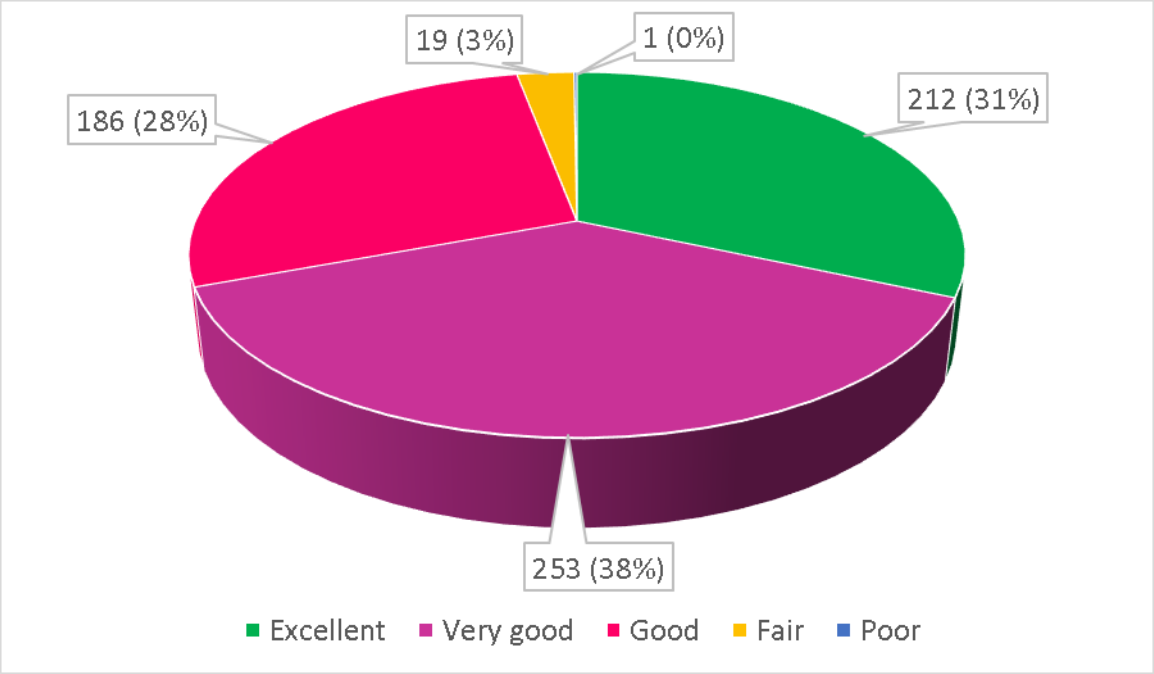

Figure 1: Perception of health status (n=671).

3.2 Knowledge and Beliefs about Antibiotics

Table 2 shows the comparison of the different levels of knowledge and beliefs regarding antibiotic usage between medical and non-medical faculties. The chi-square test shows significantly higher levels of knowledge and more up-to-date beliefs among medical compared to non-medical students with a p-value of < 0.001. Amongst the total of 674 students in the study, the results demonstrate that, only 22 (3.3%) had a high level of knowledge about antibiotics and that 296 (43.9%) held up-to-date beliefs regarding antibiotic usage. In Table 3, detailed responses are set out on knowledge and beliefs about antibiotics usage.

Table 2: Comparing levels of knowledge and beliefs regarding antibiotic usage between medical and non-medical faculties using chi-square test.

Categories	Indicated marks [a]	Medical No. (%) (n=215)	Non-medical [b] No. (%) (n=459)	Total No. (%) (n=674)	*p*-value
Knowledge:					
Low	0 – 6	58 (27.0)	334 (72.8)	392 (58.2)	< 0.001
Moderate	7 – 10	136 (63.3)	124 (27.0)	260 (38.6)	
High	11 – 13	21 (9.8)	1 (0.2)	22 (3.3)	
Beliefs:					
Negative [c]	0 – 3	59 (27.4)	319 (69.5)	378 (56.1)	< 0.001
Positive [d]	4 – 7	156 (72.6)	140 (30.5)	296 (43.9)	

[a] Awad AI, Aboud EA. Knowledge, Attitude and Practice towards Antibiotic Use among the Public in Kuwait. PLoS One. 2015; 10 (2): e0117910 [23].

[b] Combination of students from Defence Studies and Management, Engineering, Defence Sciences and Technology, and Language Center.

[c] Outdated health beliefs about antibiotic use

[d] Up to date and informed health beliefs about antibiotic use

Table 3: Detailed results about knowledge and beliefs about antibiotics (n=674)

Items	Frequency (%)		
	Disagree	Neutral	Agree
Knowledge:			
• Effective against bacteria	24 (3.6)	121 (18.0)	529 (78.5)
• Effective against viruses	199 (29.5)	188 (27.9)	287 (42.6)
• Work on most coughs and colds	109 (16.2)	228 (33.8)	337 (50.0)
• Speed up recovery from coughs and colds	102 (15.1)	240 (35.6)	332 (49.3)
• Different antibiotics cure different diseases	52 (7.7)	175 (26.0)	447 (66.3)
• Kill good normal bacteria on skin and gut	104 (15.4)	223 (33.1)	347 (51.5)
• Should not use antibiotics which gives skin reaction	58 (8.6)	158 (23.4)	458 (68.0)
• Cause imbalance in bacterial flora	69 (10.2)	304 (45.1)	301 (44.7)
• Should stop antibiotic if got side effects	52 (7.7)	149 (22.1)	473 (70.2)
• Human can be resistant to antibiotics	51 (7.6)	232 (34.4)	391 (58.0)
• Unnecessary antibiotics can increase bacteria's resistance	58 (8.6)	228 (33.8)	388 (57.6)
• Usage among animals reduce effect on humans	140 (20.8)	353 (52.4)	181 (26.9)
• Resistance to antibiotics is a worldwide problem	47 (7.0)	283 (42.0)	344 (51.0)
Beliefs:			
• Keep antibiotics at home in case in need later	199 (29.5)	181 (26.9)	294 (43.6)
• Get antibiotics from others without seeing a doctor	462 (68.5)	117 (17.4)	95 (14.1)
• Buy antibiotics from pharmacy without a	457 (67.8)	140 (20.8)	77 (11.4)

prescription			
• Prefer antibiotic for cough for more than a week	205 (30.4)	202 (30.0)	267 (39.6)
• Prefer antibiotic if have sore throat	266 (39.5)	247 (36.6)	161 (23.9)
• Always complete taking antibiotics even if feel better	149 (22.1)	182 (27.0)	343 (50.9)
• Stop taking antibiotics when feel better	260 (38.6)	162 (24.0)	252 (37.4)

3.3 Doctor's Behaviors and the Patient/Doctor Relationship

Table 4 illustrates the respondents' perception of their doctor's behaviors and the patient/doctor relationship. Most respondents demonstrated trust in their doctor's judgment about prescribing antibiotics.

Table 4: Respondents' perception of their doctor's behaviors and the patient/doctor relationship (n=674)

Items	Frequency (%)		
	Disagree	Neutral	Agree
• Doctors consider carefully the need of antibiotics	74 (11.0)	196 (29.1)	404 (59.9)
• Doctors prescribe antibiotics because patient expects it	153 (22.7)	229 (34.0)	292 (43.3)
• Trust doctor's decision on antibiotics' prescription	28 (4.2)	125 (18.5)	521 (77.3)
• Doctors explain the use of antibiotics	91 (13.5)	199 (29.5)	384 (57.0)
• Pharmacists explain the use of antibiotics	57 (8.5)	158 (23.4)	459 (68.1)
• Trust doctors if they did not prescribe an antibiotic	51 (7.6)	149 (22.1)	474 (70.3)

3.4 Patterns of Antibiotic Use

Not all respondents answered all questions in this survey section. From the 662 respondents to the questions asking whether they had been prescribed antibiotics within the last 12 months, 402 (60.7%) and 7 (1.0%) responded that they had been prescribed antibiotics (inside and outside Malaysia), respectively. Among those who had been prescribed antibiotics, 68 (16.6%) said they had only been prescribed antibiotics either once, 128 (31.3%) 2-5 times, 33 (8.1%) 6-10 times and 51 (12.5%) were prescribed antibiotics more than 10 times. 118 (28.9%) could not remember. On asking whether they finished the last prescribed course of antibiotics, from the 422 respondents who answered, 183 (43.4%) replied that they did, 154 (36.5%) did not, and

another 85 (20.1%) did not remember. When asked why they did not finish the course, the majority 425 (63.1%) gave no response to the question; 68 (10.1%) said they forgot to take them, 121 (18.0%) said they already felt better, 46 (6.8%) said it was because of the side effects or that antibiotics made them feel unwell, and 8 (1.2%) replied that they kept the antibiotics in case of future need. The students were then asked if they had used antibiotics without prescription within the last 12 months, to which 95 (14.1%) replied that they had, while the rest said "no." Among those who said "yes", 26 (27.4%) reported that they had used antibiotics without prescription once; 24 (25.3%) 2-5 times; 8 (8.4%) 6 or more timers. 34 (35.8%)could not remember and three (3.2%) did not respond. Among those who said "no" to the use of unprescribed antibiotics, 15 (16%) stated that they could not remember how many times they use antibiotics without prescription during the last 12 months.

104 respondents replied to the questions on the reasons for self-medicating antibiotics. The reasons stated were for common colds (33, 31.7%); coughs (35, 33.7%); genitourinary infections (6, 5.8%); sore throat (10, 1.5%); superficial wounds (10, 1.5%) and other (not stated) reasons (10, 1.5%). When asked whether they had ever given an antibiotic to someone else to use that had not been prescribed for them, 563 (83.5%) did not answer the question; 23 (3.4%) answered "yes", 69 (10.2%) answered "no" and 19 (2.8%) could not remember. Only 82 students responded to another question on self-medication with antibiotics, from these, 49 (59.8%) said they used antibiotics that were originally prescribed for an infection which reoccurred later; 8 (9.8%) said these were originally prescribed for another type of infection; 12 (14.6%) used antibiotics obtained from a pharmacy abroad without prescription; 3 (3.7%) used antibiotics originally prescribed for someone else; and 5 (6.1%) each used antibiotics obtained from a pharmacy within Malaysia without a prescription or used antibiotics originally prescribed for another family member.

3.5 **Knowledge and Beliefs about Antibiotics' Use**

A Pearson correlation test used to assess the association between age with total knowledge and beliefs scores found significant results for both, but with little correlation (r=0.266, p<0.001

and r=0.115, p=0.003, respectively) Knowledge increased and health beliefs became more aligned with scientific evidence with increasing age. The MANOVA test showed no significant results comparing knowledge and beliefs about antibiotics use between genders and perceived health status (p>0.05). However, the results comparing students from different races/ethnic groups and faculties (i.e. medical vs non medical programmes) demonstrated significance at the multivariate level ($F_{(6,\ 1334)}$=12.129, p<0.001 and $F_{(8,\ 1314)}$=29.122, p<0.001; respectively) and univariate level for both knowledge and attitudes (p<0.001 for the comparison of knowledge and attitudes between races/ethnic groups and faculties). The comparisons of knowledge and attitudes for the different races/ethnic groups and faculties (programmes of study), including results of the Bonferroni post-hoc test are illustrated in Figures 2 and 3, respectively.

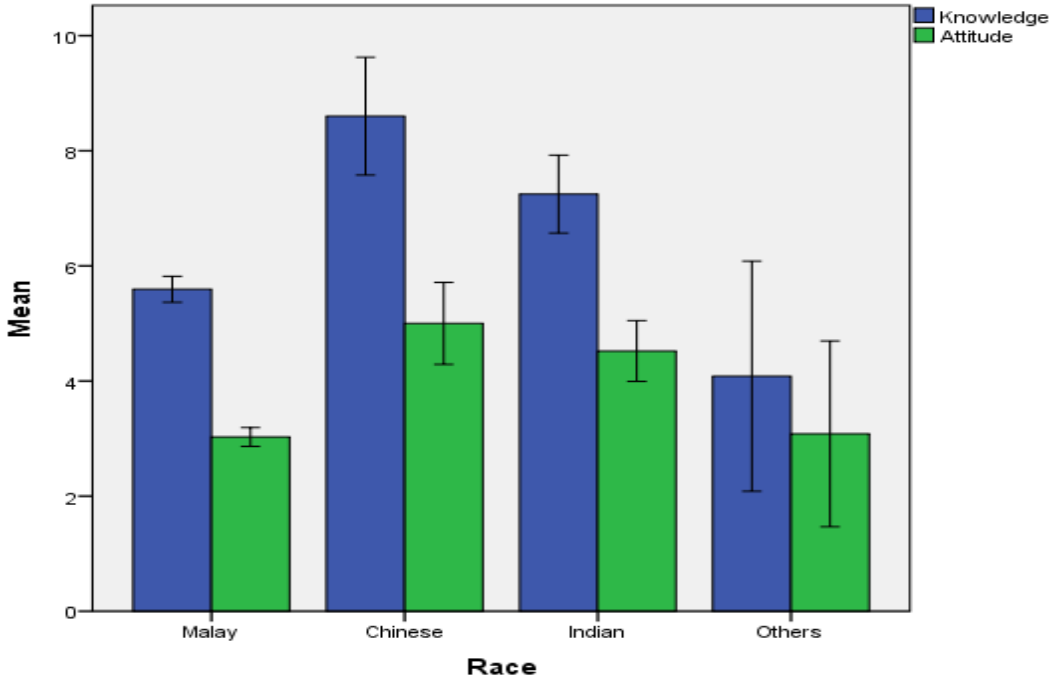

Figure 2: Comparing means of total knowledge and beliefs scores between races/ethnic groups.
*Bars represent 95% confidence interval of means.
**Bonferroni post-hoc test of MANOVA test showed significant differences for both knowledge and beliefs between Malay with Chinese and Indian (p<0.001 each), but for knowledge between Chinese and others (p<0.001) and between Indian and others (p=0.002).

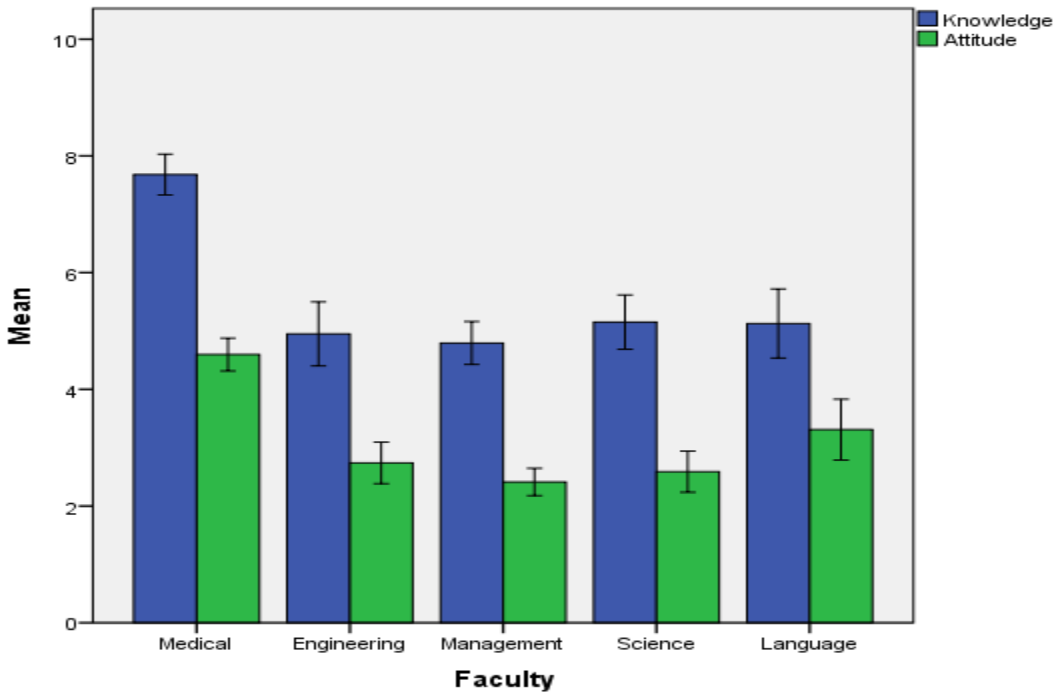

Figure 3: Comparing means of total knowledge and beliefs scores between faculties/programmes.
*Bars represent 95% confidence interval of means.
**Bonferroni post-hoc test of MANOVA test showed a significant difference for both knowledge and beliefs between Medicine and all other faculties (p<0.001 each), but for beliefs only between Management and Language faculties (p=0.017).

3.6 Factors Associated with Finishing a Prescribed Course of Antibiotics

Simple logistic regression was performed on the results relating to these factors. Those who answered "don't know/can't remember" were treated as missing values. Five significant factors were identified associated with finishing the course of antibiotics prescribed, similar to the factors relating to self-prescribing antibiotics. Those who were more likely to finish their antibiotic course had higher total beliefs scores (OR=1.187; p=0.002) (i.e. were more informed and up-to-date); had been prescribed antibiotics during the last 12 months (OR=3.368; p=0.034) and were more likely to be studying medicine (OR=3.009; p<0.001), compared with scores from students from other faculties i.e. FE (OR=0.475; p=0.048), FDSM (OR=0.250; p<0.001), FDST (OR=0.424; p=0.015) and LC (OR=0.355; p=0.017). The other significant variable associated with finishing prescribed antibiotics using simple logistic regression arose from comparing students with perceived "very good" with those reporting "excellent" personal health (OR=0.434;

p=0.003), finding that those reporting a "very good" perceived health status had a higher probability of finishing their antibiotics. The final stage of multiple logistic regression revealed three significant factors of finishing the prescribed antibiotics: studying medicine (OR=3.370; 95%CI=1.859-6.109; p<0.001), perceived personal health (OR=0.467; 95%CI=0.264-0.827; p=0.009) in comparison of "very good" with "excellent" perceived health, and race/ethnicity, specifically between Indian and Malay students (OR=0.455; 95%CI=0.210-0.982; p=0.045).

3.7 Factors Associated with Antibiotic Self-Prescribing

Simple logistic regression found five significant factors associated with a lower reported self-prescribing of antibiotics. These were: total beliefs scores (OR=0.752; p<0.001) i.e. those with a more informed health beliefs reported less antibiotic self-prescribing; respondents who reported having been prescribed antibiotics during the last 12 months (OR=0.356; p=0.008); studying medicine (OR=0.601; p=0.049) ; and faculty, specifically between the Medical Faculty and the FDSM (OR=2.138; p=0.008), meaning students from the FDSM were more likely to self-prescribe antibiotics than medical students; and trusting doctors when they did not prescribe antibiotics (OR=0.471; p=0.035), i.e. students report not self-prescribing if they trust their doctor's decision. Multiple logistic regression, however, only revealed three significant variables in the final stage, namely beliefs (OR=0.756; 95%CI=0.668-0.855; p<0.001); having been prescribed antibiotics during the last 12 months (OR=2.445; 95%CI=1.425-4.196; p=0.001), and trusting their doctors when they did not prescribe antibiotics, where "neither agree nor disagree" gave the OR of 0.424 (95%CI=0.185-0.973; p=0.043), while "agree" gave the OR of 0.437 (95%CI=0.210-0.909; p=0.027) compared to "disagree".

4. DISCUSSION

4.1 Response Rate and Socio-Demographic Characteristics

From the students who attended the information session, 97.73% of medical students and 100% of students from non-medical faculties responded, an average of 98.86%. The response rate was high because the students who were interested in participating attended the information session and the survey questionnaire was completed and submitted as part of the

session. The socio-demographic characteristics of this group were similar to those of earlier studies among medical students in the UPNM and other Malaysian universities [26-29].

4.2 Knowledge and Beliefs about Antibiotics

Research conducted in the United States of America (USA) amongst adults of all ethnic groups studying knowledge and beliefs about antibiotic use reported that certain ethnic groups held health beliefs that antibiotics are necessary for common infections, and they would be cured more quickly than without antimicrobial drugs [30]. Very frequently, such patients obtain antibiotics from their doctors through peer pressure; retain antibiotics from earlier bouts of sickness; purchase them from a pharmacy or use a relative's left-over antibiotics. Multiple studies report that consumers and communities need to be educated about the prudent use of antibiotics, prescribing, and resistance because antibiotic or antimicrobial resistance (AMR) is a high public health risk [17, 19, 30-34] and few new antimicrobials are in the pipeline for widespread public use [35, 36]. Like an earlier study [23], this study found most of these university students had a low level of knowledge about antibiotic usage, despite their high level of education. In contrast, a Swedish study, in which most respondents had a university level or upper secondary school equivalent education, found that most respondents demonstrated a high level of knowledge about antibiotics [37]. However, regarding health beliefs, the current study reflected findings from an earlier Malaysian study [38] and another from Europe [32], in that most respondents were found to have outdated or misinformed health beliefs about antibiotic usage.

The low level of knowledge about antibiotics might be explained because the majority (72%) of the research participants were non-medical students and, of the 32% medical students, these would not be yet prescribing and therefore might not feel they need to know this information yet. This cognitive dissonance may be exacerbated because in Malaysia, medical graduates do not obtain their full license to practice until after another two years internship and so the motivation to learn about prescribing practice may feel a long way off. In addition, a large proportion of medical students had not completed their three clinical years and, although the

372 medical students had received some pharmacology and clinical pharmacology theoretical
373 classes in the pre-clinical part of the course, they had received no practical hands-on training
374 about good prescribing practice. Regarding health beliefs, there may be psychological leakage
375 from health beliefs (which may arise from one's own cultural practices) into both knowledge
376 and putting this into practice [39]. This could work in three ways. First, the students in this
377 study may well have expectations about whether they should be prescribed antibiotics which
378 could affect the prescribing practice of the doctors they saw, leading to an increase in antibiotic
379 prescribing [39]. Secondly, if the students were not prescribed antibiotics, even if their
380 knowledge gained through the courses told them that they probably did not need them, the
381 health beliefs of the students might override this, leading them to use other people's antibiotics
382 or antibiotics from a previous infection. Finally, whilst students may hear doctors saying one
383 thing about prescribing antibiotics (based on scientific evidence), their actual practice might
384 differ due to patient pressure or expectations and students will copy what they see in practice.
385 Ensuring that teaching about antibiotics includes psychological as well as pharmacological and
386 physiological principles is therefore essential.

387 Like the current study, previous studies conducted in China showed significantly higher level of
388 knowledge regarding the proper use of antibiotics, but also a higher reliance on antibiotics
389 among medical compared to non-medical students [40, 41]. Another study involving 731
390 university students in Western China also found significantly better knowledge regarding
391 antibiotics among intern students who worked in hospitals compared to other students which
392 echoes the findings of the current study as the medical students were primarily from the earlier
393 years of the course and we found that knowledge improved with age [42]. Furthermore, the
394 current findings on the lack of knowledge regarding antibiotics among non-medical students
395 was also reported by other studies carried out in Nigeria [43], Western China [42] and Jordan
396 [44]. A theoretical understanding of antibiotics is offered by most medical curricula; however,
397 this often focuses (in the early stages) on pharmacology and mechanisms of disease and
398 infection. The relatively low percentage of medical students with a good level of knowledge in
399 the current study was similar to the results of a survey carried out in 35 medical schools in 13
400 European countries [45]. This study concluded that the teaching on key principles and the

prudent prescribing of antibiotics should be improved, due to the existing wide variation in exposure, lack of time and prioritization towards the teaching of antibiotics [45]. As reported by a systematic literature review, this less than comprehensive teaching about antibiotics could lead to insufficient antibiotic prescribing competencies among medical students. It should be noted that the authors cautioned on the findings due to the methodological weaknesses and heterogeneity of the few studies included in the review [45].

4.3 Doctor's Behaviors and the Patient/Doctor Relationship

"Medicine is an art whose magic and creative ability have long been recognized as residing in the interpersonal aspects of the patient-physician relationship [47]." The success of healthcare, treatment, and patient satisfaction largely depends on the development of a good rapport between doctor and patient [48, 49]. Doctors' interpersonal and communication skills enable them to elicit the information essential to diagnose illness and conditions appropriately from their patients, and provide the necessary counseling and therapeutic instructions, promote lifestyle changes, and better ensure adherence to treatment [50-53]. The trust a patient has in their physician is the principal component of a positive doctor-patient relationship which optimizes care and success of treatment [54, 55]. Most of the current study respondents had full trust in their doctors, which should have promoted adherence to treatment regarding the prescribing of antibiotics or not.

4.4 Pattern of Antibiotic Use

The development of AMR is a global public health concern which causes tremendous human misery [19, 34, 56]. Multiple studies find that the inappropriate use of antibiotics in both community and hospital acquired infections (especially in respiratory and urinary tract infections (UTIs)) contribute most to the evolution of AMR [57, 58]. Around 63% of the current study participants reported that they had used antibiotics in the last year, similar to results from a British study where 63% of the patients had used antibiotics in primary care settings in the last 12 months [59]. This British study (with unadjusted regression analysis) found that antibiotics were prescribed because of a UTI in the last year, which was followed by the

development of AMR [59]. Such high prescribing rates are echoed in many other countries, including low resource settings. For example, in Nigeria, although one study found an antibiotic prescribing rate of 49.5-63% [60], another study reported a prescribing rate of 63.3-86.6%, and among pediatric cases, 80-86% [61].

AMR has become an alarming public health issue with "700,000 deaths annually (and rising)" [62], especially because of the misuse or overuse of antibiotics which has led to the prevalence of multidrug resistant (MDR) microbial [63]. Whilst the ideal length of antimicrobial treatment for conditions such as ventilator-associated pneumonia (VAP) is not certain, limiting a course of antibiotics to 7-8 days can reduce the problems of overuse in critical care, including AMR, adverse effects or adverse drug reactions (ADR), ADR related impairment and increase healthcare costs [63]. Another study found that short-term antimicrobial courses were as safe and effective for life-threatening infections as long-term courses [64]. Until relatively recently, patients were frequently advised to finish each course of antibiotic treatment, even they felt better [65], however, a recent study reported that completing the full course of antibiotics is ineffective if the patient feels well and should not be part of an antibiotic stewardship program [66]. Among the current study respondents, a small group stated that they had taken antibiotics without prescription between 2-6 times in the last year. Their reasons for self-prescribing antibiotics (because of common colds, cough, genitourinary infections, sore throat, and superficial wounds, etc.) were similar to those cited in other studies [23, 67-71]. Some respondents reported that the antimicrobials they used were left over from those previously prescribed to colleagues or family members, again in line with an earlier study [23]. The reasons for self-prescribing were not explored in this study, however in Malaysia people can obtain antibiotics from local pharmacies, thus avoiding the need to get a doctor's prescription, which may save individuals both money and time.

4.5 **Factors Associated with Knowledge and Beliefs about Antibiotic Use**

A significant association exists between the respondents' total knowledge and beliefs scores with age, with increasing age correlating with an improved knowledge and more appropriate

and informed heath beliefs about antibiotic use, this corroborates the findings of other studies [72, 73]. No significant correlation was found when comparing knowledge and beliefs about antibiotic use between different sexes and perceived health status. A Jordanian study also reported no significant difference between sexes [74]. The current study, however found significant differences among races/ethnic groups and students from different faculties, consistent with the findings from another study in Malaysia [38]. Some of the explanations for this could lie in cultural perceptions and health beliefs as discussed above. Finally, this study found that (as anticipated) knowledge about antibiotic usage was significantly higher in the medical students as compared to non-medical students, probably because it is included in the medical curriculum and medical students have a keener interest in understanding about infections and treatment as they are training to be doctors.

4.6 Factors Associated with Finishing the Course of Antibiotics Prescribed

Five factors were significantly associated with finishing the course of prescribed antibiotics using simple logistic regression: total beliefs scores; had been prescribed antibiotics during the last 12 months; studying medicine; faculty (course of study), and perceived "very good" personal health. Multiple logistic regression found only three significant factors, namely: studying medicine, perceived "very good" personal health, and race/ethnicity, specifically in the comparison of Indian with Malay students. These results mean that those studying medicine were more at odds (more likely) to finish the course of their prescribed antibiotics. Medical students might know more about the risks of AMR due to not finishing their antibiotics as prescribed, and therefore might be more likely to follow the doctor's advice. On the other hand, those who perceive their personal health as "very good" were less likely to finish their course of prescribed antibiotics as compared to those with perceived "excellent" personal health, and those of Indian ethnic origin were less likely to finish their antibiotics as compared to those who identified as Malay.

4.7 Factors Associated with Antibiotic Self-Prescribing

Simple logistic regression study found five significant factors associated with self-prescribing antibiotics: total belief scores; studying medicine; having been prescribed antibiotics in the last 12 months; faculty/program of study (specifically between the Medicine and Management programs) and trusting the doctors when they did not prescribe antibiotics. Conversely, multiple logistic regression only revealed three significant variables in the final stage, namely: beliefs, had been prescribed antibiotics during the last 12 months, and trusting their doctors when they did not prescribe antibiotics. With an OR of less than one, those with more informed health beliefs were at lower odds (less likely) to self-prescribe antibiotics, and those who either "trusted" or "neither trusted nor not trusted" the doctors when they did not prescribe antibiotics were less likely to use antibiotics without a doctors' or dentists' prescription, as compared to those who did not trust the doctors' judgment. On the other hand, those who had been prescribed antibiotics during the last 12 months were more than twice at odds (more likely) of self-prescribing antibiotics as compared to those who were not. This might be because they think they already know what kind of antibiotics they need; however, this might not be correct and could lead to the development of AMR.

5. Limitations of the Study

This was a cross-sectional study conducted only in one university in Malaysia. Further studies would need to track cohorts, possibly include random sampling and inclusion of other universities, stage of education or countries to explore more deeply into people's health beliefs and knowledge and whether the findings from this study are generalizable or whether the findings are more culturally specific.

6. CONCLUSIONS

This was a cross-sectional study conducted amongst UPNM students about their antibiotic knowledge, beliefs and usage. Slightly more male students responded than females and most of the respondents were Malay. The knowledge of over half of the respondents about antibiotic usage was low and their health beliefs were outdated. This is a key finding from the study. Over 60% of the study population had taken antibiotics between 2-10 times in the last year, and self-medication was quite common for a sore throat, common cold, cough or superficial infection.

Age, race and course of study were found to be significantly associated with knowledge and beliefs regarding antibiotic use, with medical students (as anticipated) being more knowledgeable and up-to-date than non-medical students. The factors associated with finishing a course of antibiotics were studying medicine, good perceived personal health status, and race/ethnicity. The significant factors associated with antibiotic self-prescribing were outmoded health beliefs, having been prescribed antibiotics during the last 12 months, and not trusting their doctors when they did not prescribe antibiotics. Finally, this study reveals the importance of providing educational interventions which includes education on the psychological aspects of prescribing antibiotics, health beliefs and patient expectations, and an antibiotic stewardship program to combat the inappropriate use of antibiotics and to help prevent AMR.

Key Issues

- This study explored medical and other students' knowledge and beliefs about, and their use of, antibiotics from a Malaysian University
- The study found that, whilst medical students' knowledge and beliefs about the use of antibiotics was higher than those of other students, over half of students had outdated beliefs and poor knowledge
- Over 60% of the study population had taken antibiotics between 2-10 times in the last year, and over 25% of students had self-medicated over the last year for a sore throat, common cold, cough or superficial infection
- The study concluded that educational and community interventions on how antibiotics should be used are needed to help raise awareness of antibiotic resistance and change the practice of these future leaders and role models
- Such training should include the psychological aspects of antibiotics prescribing around patient expectations and health beliefs

Author Contributions

The authors contributed equally.

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Conflict of Interest

The authors declare no conflicts of interest.

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