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Original Article

A cross-sectional study on public belief, knowledge and practice towards antibiotic use in the state of Perak, Malaysia

Shea Jiun Choo[1], Chee Tao Chang[2], Jason Choong Yin Lee[3], Valli Munisamy[1], Chin Khai Tan[1], Jasmine Daryl Raj[1], Rosma Izzaty Mat Taib[1], Kah Shuen Thong[4], Asrul Akmal Shafie[5]

[1] *Department of Pharmacy, Hospital Taiping, Taiping, Malaysia*
[2] *Clinical Research Centre, Hospital Raja Permaisuri Bainun, Ipoh, Malaysia*
[3] *Pharmaceutical Services Division, Perak State Health Department, Ipoh, Perak*
[4] *Department of Pharmacy, Hospital Raja Permaisuri Bainun, Ipoh, Malaysia*
[5] *School of Pharmaceutical Sciences, Universiti Sains Malaysia, Minden, Malaysia*

Abstract

Introduction: Inappropriate use of antibiotics has led to antimicrobial resistance, a major public health challenge worldwide. This study aimed to explore beliefs, knowledge, and practice on antibiotic use among general public.

Methodology: Cross-sectional study was conducted at 13 hospitals and 44 primary health clinics in Perak from May to July 2017. Adults above 18 years, literate, and had experience in antibiotics consumption were selected through sequential sampling method. Data was collected using a self-administered questionnaire which included the three study domains i.e. belief, knowledge and practice. The questionnaire was pilot on 30 subjects.

Results: Out of 2850 distributed questionnaires, 2773 returned and 2632 were included for analysis. Mean age of the respondents was 39.7 ± 14.5 years old. Most respondents were female (58.6%), Malay (74.7%) and underwent upper secondary school (45.6%). Mean score were generated for each domain with belief: 5.87 ± 3.00 (total score: 12), knowledge: 15.82 ± 3.85 (total score: 24), practice: 6.91 ± 2.07 (total score: 12). In the belief domain, 63.2% of respondents believed that antibiotics would help them to recover faster. In the knowledge domain, 52.7% of respondents inappropriately thought that antibiotics could work on viral infections. In the practice domain, 70% of respondents expected doctors to prescribe antibiotics if suffered from symptoms.

Conclusion: Majority of the respondents expect doctors to prescribe antibiotics for their illness, and most believes that antibiotics can speed up recovery of illness. Lack of awareness on antibiotic resistance was found to be a significant factor associated with inappropriate antibiotic use.

Key words: Belief; practice; knowledge; antibiotic; public; antibiotic resistance.

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Introduction

Antibiotic resistance has been a growing threat and a major issue worldwide. There has been an inexorable rise in superbugs such as methicillin-resistant *Staphylococcus aureus* (MRSA), extended spectrum beta-lactamase bacteria (ESBL-bacteria), and carbapenem-resistant *Enterobacteriaceae* (CRE) which increase hospitalisation and mortality rate. Moreover, there is a dearth of new antibiotics with the antibiotic development pipeline running dry over the past few decades [1-3].

There are many reasons attributed to the misuse of antibiotics such as the high prevalence of inappropriate antibiotic prescription [4-5]. The irrational use of antibiotics is prominent in cases of upper respiratory tract infections (URTI) in which most of these infections are caused by viruses whereby the role of antibiotics is not justified as they have no efficacy against viral infections [6].

The beliefs and knowledge among the public towards the power of antibiotics also contribute significantly towards the emergence of antibiotic resistance [7]. A study has reported that Malaysians have inadequate knowledge about antimicrobials, which ultimately increases the likelihood of incorrect practice and use of antimicrobials [8]. Many people are under the impression that antibiotics are a cure for every form of ailment. Some fail to understand the importance of completing the full course of antibiotics and thus cease taking their medications upon the first signs of recovery [9].

In the 68th World Health Assembly in May 2015, a global action plan on antimicrobial resistance was endorsed in order to tackle this crisis. One of the strategic objectives was to improve public awareness and understanding about antimicrobial resistance. In the course of implementing the objective, WHO launched its first awareness campaign in year 2015 [10]. Malaysia echoed the call and started organizing antibiotic awareness campaign nationwide since then annually. However, to the best of our knowledge there was no study evaluating the efficacy of the campaigns conducted in improving the knowledge and practice of antibiotic use among the general public.

Therefore, this study aimed to explore the current belief, knowledge and practice towards antibiotic use and to determine the population characteristics associated with inappropriate use of antibiotics. This study was particularly designed in view of the high usage of antibiotics in Malaysia and the lack of such study being carried out especially in the state of Perak, situated in the northwest of peninsular Malaysia. The findings from this study will guide the development of optimum strategies to curb irrational use of antibiotics.

Methodology

Study design and administration of questionnaire

A cross-sectional study was conducted for a period of three months from May to July 2017 involving 13 hospitals and 44 primary health clinics in Perak using a self-administered questionnaire. Study subjects were attendees of the participating hospitals and primary health clinics. A minimum sample size of 2208 was needed in this study based on the calculation using Epicalc, with a precision of 4% and at confidence interval of 95%.

Study subjects were selected using sequential sampling method whereby every fifth attendees at each study site was approached to participate in this study. The inclusion criteria were: (i) adult (above 18 years old) (ii) able to read and understand Malay or English language (iii) have taken antibiotics at least once in their life. Written informed consent was obtained from all the respondents after explaining the nature and objectives of this study. Respondents were excluded from this study if they are not willing to participate or they have no experience in consuming antibiotics. All the information was collected anonymously and the confidentiality was maintained.

Questionnaire development and structure

A self-administered questionnaire with five sections was adapted and modified from previous studies [4,6-8]. Section I contained six questions which captured the demographic information of the respondents while Section II captured the history of their antibiotics use. Section III consisted of 11 items with a dichotomous scale of 'Yes' or 'No' which assessed the practice of respondents towards antibiotic use. Last but not least, respondents' belief and knowledge towards antibiotic use were assessed using a 5-point Likert-scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree) in section IV and section V respectively.

The self-administered questionnaire was developed in English language, and translated into Malay language. Face and content validation of the questionnaire were carried out by a panel of academics and hospital pharmacists. The feedback gathered from the panel was used to modify the questionnaire before conducting the pilot study among 30 study subjects. Reliability was assessed using Cronbach's alpha coefficient in section III (practice), IV (belief) and V (knowledge). The reliability was supported with all items in section III, IV and V showing acceptable correlation coefficient (i.e. $\alpha > 0.7$).

Statistical analysis

Only questionnaires that were more than 80% complete were included in the analysis to prevent statistical bias. This meant that questionnaires with a total of 7 or more questions unanswered from Section III to Section V were excluded from the analysis. Numerical data were expressed as mean ± standard deviation. "Inappropriate responses" were defined as incorrect practice for Section III, incorrect belief in Section IV and incorrect knowledge in Section V.

All the data collected was entered into Microsoft Excel 2013 (Microsoft Corporation, Redmond, Washington, United States). Responses were coded and analysed using IBM SPSS statistical software version 20.0 (SPSS Inc, Chicago, Illinois). Demographic characteristics, background use of antibiotics, practice, belief, and knowledge scores were descriptively reported. The differences between mean scores were explored using t-test or ANOVA where appropriate. Demographic characteristics which contributed to inappropriate practice, belief, and knowledge were identified using multivariate logistic regression. The relationship between belief, knowledge, and practice towards antibiotic use was determined using Pearson's correlation while the correlation between related statements was examined using the Chi-square test. The level of statistical significance was set at $p < 0.05$.

Results

Out of 2850 questionnaires distributed, 2773 responses were returned. However, 141 were incomplete and thus 2632 responses were included into final analysis (94.9% usable response). The demographic characteristics of the respondents were presented in Table 1. The mean age of the respondents was 39.7 ± 14.5 years, with 34% of the respondents were between 18 to 30 years old. Most respondents were female (1542, 58.6%), Malay (1966, 74.7%), and underwent upper secondary school (1200, 45.6%). A total of 1092 (41.5%) respondents or their family members worked in health-related sectors.

One-way ANOVA was performed to determine the association between various characteristics with mean scores (Table 1). Respondents' gender, highest academic level, healthcare related occupation, and knowledge on antibiotic resistance had significant association with mean belief, knowledge and practice score ($p < 0.05$). Besides, respondents' age had significant association with mean knowledge score ($p = 0.007$) and practice score ($p < 0.001$). Lastly, race was found to be associated with knowledge score ($p = 0.002$).

Figure 1. Most recent antibiotic use by respondents.

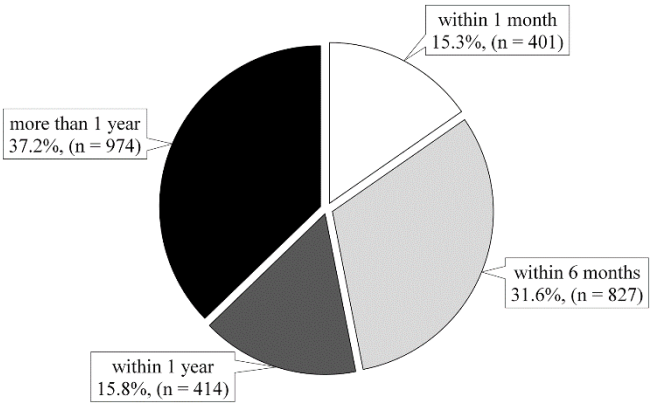


Table 1. Respondents' demographic characteristics.

Characteristics		Number, N	Mean belief score (total score = 12)	P value	Mean knowledge score (total score = 24)	P value	Mean practice score (total score = 12)	P value
Gender	Female	1540	5.98 ± 3.00	0.021	16.16 ± 3.74	< 0.001	7.12 ± 1.99	< 0.001
	Male	1086	5.7 ± 2.98		15.35 ± 3.94		6.61 ± 2.16	
Age	> 60	337	5.64 ± 2.96	0.056	15.84 ± 3.85	0.007	7.14 ± 2.07	< 0.001
	46 - 60	565	5.69 ± 3.19		15.51 ± 3.71		6.76 ± 2.13	
	31 - 45	841	6.07 ± 3.02		16.18 ± 3.57		7.14 ± 1.93	
	18 - 30	889	5.87 ± 2.85		15.66 ± 4.14		6.70 ± 2.15	
Race	Malay	1961	5.83 ± 2.96	0.055	15.68 ± 3.75	0.002	6.86 ± 2.03	0.113
	Chinese	303	6.13 ± 3.10		16.55 ± 4.14		7.09 ± 2.39	
	Indian	318	5.98 ± 3.12		16.09 ± 3.99		7.09 ± 2.05	
	Others	43	4.88 ± 2.97		15.55 ± 4.12		6.75 ± 2.18	
Highest academic level	College / University	955	6.58 ± 2.89	< 0.001	17.02 ± 4.03	< 0.001	7.26 ± 2.05	< 0.001
	Higher secondary school	1191	5.62 ± 2.97		15.19 ± 3.57		6.72 ± 2.03	
	Lower secondary school	240	5.03 ± 2.99		5.07 ± 3.72		6.71 ± 2.13	
	Primary school	223	5.01 ± 2.98		14.83 ± 3.33		6.64 ± 2.19	
Is your or your family's occupation related to health care?	Yes	1092	6.40 ± 3.03	< 0.001	16.78 ± 3.91	< 0.001	7.21 ± 2.04	< 0.001
	No	1518	5.50 ± 2.92		15.13 ± 3.66		6.70 ± 2.08	
Most recent use of antibiotics	Within 1 month	401	5.58 ± 2.93	0.001	15.46 ± 3.73	0.248	6.49 ± 2.18	< 0.001
	Within 6 month	827	5.65 ± 2.90		15.89 ± 3.87		6.80 ± 2.03	
	Within 1 year	414	6.04 ± 3.15		15.94 ± 3.82		6.98 ± 2.03	
	More than 1 year	974	6.10 ± 3.02		15.86 ± 3.90		7.16 ± 2.06	
Most common location seeking antibiotics	Own balance	75	4.96 ± 2.99	< 0.001	13.89 ± 4.37	< 0.001	4.51 ± 2.79	< 0.001
	Doctors' prescription	2421	5.89 ± 2.98		15.99 ± 3.81		7.04 ± 1.98	
	Retail pharmacy	292	5.04 ± 2.96		14.37 ± 4.19		5.60 ± 2.36	
	Buy from private clinic without consulting doctor	130	5.47 ± 3.04		14.42 ± 3.61		5.81 ± 2.36	
	Others	12	6.42 ± 2.64		14.27 ± 4.00		5.42 ± 3.34	
Have you self-medicated with antibiotics before?	Yes	264	5.42 ± 3.24	0.017	15.09 ± 4.44	0.006	5.72 ± 2.56	< 0.001
	No	2361	5.92 ± 2.97		15.90 ± 3.77		7.04 ± 1.97	
Knowledge on antibiotic resistance	Yes	862	6.72 ± 3.14	< 0.001	17.60 ± 4.05	< 0.001	7.45 ± 2.08	< 0.001
	No	1751	5.45 ± 2.83		14.94 ± 3.42		6.65 ± 2.02	

Background of antibiotic use

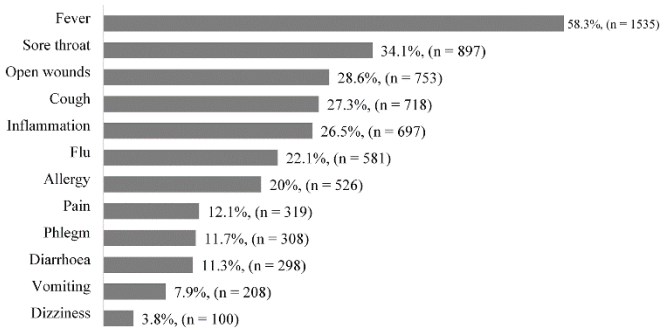
Figure 1 showed the last antibiotic consumption date of the respondents. Most of the respondents (974, 37%) reported that they had not taken any antibiotic for more than one year, while only 15.3% of the respondents (n = 401) reported that they had taken antibiotics within one month prior to this study.

More than one quarter of the respondents (764, 29%) reported taking antibiotics at least once in the past one year. Almost all (2421, 92%) of the respondents obtained antibiotics through doctor's prescription, while the remaining 10% of the respondents admitted that they self-medicated with antibiotics without consulting a doctor. A total of 51% (1342) respondents self-evaluated their knowledge in antibiotics usage as good. However, 67% of these respondents (1763) have not heard about antibiotic resistance. The common reasons for taking antibiotics were fever (1535, 58.3%), sore throat (897, 34.1%), open wound (753, 28.6%), cough (719, 27.3%), inflammation (698, 26.5%) and flu (582, 22.1%) (Figure 2).

Public belief in antibiotic use

The belief score ranged from 0 to 12 points, with a mean score of 5.87 ± 2.99. The highest inappropriate response was believing that taking antibiotics can help to recover faster (1659, 63.2%), followed by antibiotics can protect one's condition from becoming worse (1480, 56.4%) (Table 2).

Figure 2. Conditions in which respondents think antibiotic is needed.



Public knowledge in antibiotic use

The knowledge score ranged from 0 to 24 points, with a mean score of 15.82 ± 3.84. The percentage of inappropriate responses for 12 knowledge statements was summarised in Table 3.

Table 2. Proportion of inappropriate responses for belief statements.

No.	Statement	Inappropriate Response (%)
1	Without antibiotic, I would be very ill from infection.	36.9
2	If I suffer from any of the symptoms as stated above in this current moment, my health at present depends on antibiotics	28.3
3	Taking antibiotic can help to recover faster compared to not taking any antibiotic.	63.2
4	My antibiotic medication protects me from becoming worse.	56.4
5	People who take antibiotics should stop their treatment when symptoms improve.	35.8
6	My health in the future will depend on antibiotics	17.2

Table 3. Proportion of inappropriate responses for knowledge statements.

No.	Statement	Current study (%)	Oh et al (2011)	Lim et al (2012)
1	Antibiotic is used to treat bacterial infection.	7.1	23.3	21.7
2	Viral infection can be cured by taking antibiotic.	52.7	86.6	83
3	Antibiotic can be obtained without doctor's prescription.	14.4	-	-
4	Taking low dose of antibiotic is better than not taking any dose.	35.8	-	33.2
5	Antibiotic can be stopped once symptoms of illness improve.	37.8	-	-
6	Antibiotic resistance refers to the ability of body to resist against bacterial infection after taking antibiotic.	55.2	-	-
7	Antibiotic resistance happens when the antibiotic lost its ability to cure bacterial infection.	9.9	-	-
8	Overuse of antibiotics can cause the antibiotics to lose effectiveness in long term.	13.8	40.9	32.2
9	Sharing of antibiotics for the same illnesses/symptoms is appropriate	10.8	-	-
10	Stop the course of antibiotics when the symptoms have resolved is appropriate	37.0	28.9	41.9
11	Take leftover antibiotics for the same symptoms as consulted by doctor before is appropriate	11.9	-	-
12	Self-medicate with antibiotics without consulting doctor is appropriate	3.8	-	-

Table 4. Proportion of inappropriate responses for practice statements.

No.	Statement	Current study (%)	Oh et al (2011)	Lim et al (2012)
1	I expect my doctor to prescribe antibiotics if I suffer from any of the symptoms above.	70.1	57.8	73.8
2	I will take antibiotics early to prevent my illness from getting worse.	66.0	-	-
3	I will take antibiotics if my illness/symptom does not resolve after a few days without consulting doctor.	27.9	-	-
4	I sometimes take antibiotic with lower dosage/frequency than recommended.	19.9	-	-
5	I will stop taking my antibiotics once illness/symptom improves	48.0	40.2	45.6
6	I will use the leftover antibiotics when I have similar symptoms next time.	14.9	11.5	14.7
7	I sometimes share my antibiotics with my family members when we have the similar symptoms/illnesses.	12.9	11.8	17
8	I will normally keep extra antibiotics at home as stock for emergency use.	18.0	19.9	17
9	I will purchase antibiotics at private clinic or retail pharmacy without seeing a doctor.	12.1	-	-
10	If I have the knowledge on the appropriate use of antibiotics, I will still ignore the knowledge and follow the practice that eases me the most.	19.6	-	-

Table 5. Factors associated with inappropriate response for each practice statement.

Characteristics		1	2	3	4	5	6	7	8	9	10
Gender	Male	1	1	1	1	1	1	1	1	1	1
	Female	0.937	0.838	**0.817**	0.826	**0.702**	**0.691**	0.937	**0.747**	**0.760**	**0.788**
Age	> 60	1	1	1	1	1	1	1	1	1	1
	46 - 60	1.043	0.994	**1.885**	0.954	**1.432**	1.313	**1.700**	1.279	1.563	0.941
	31 - 45	1.150	0.949	**1.634**	0.887	**1.563**	0.936	1.300	0.973	1.367	**0.681**
	18 - 30	1.253	1.263	**1.880**	0.934	**2.111**	**2.101**	**3.277**	**2.339**	1.556	**0.668**
Race	Malay	1	1	1	1	1	1	1	1	1	1
	Chinese	**0.535**	**0.472**	1.246	1.304	0.858	1.299	0.941	0.845	1.403	1.266
	Indian	**0.722**	**0.680**	**0.533**	0.896	**0.641**	0.913	0.893	0.816	0.879	**1.872**
	Others	1.318	1.289	1.427	0.587	0.989	1.385	2.080	0.524	0.532	1.356
Highest academic level	College / University	1	1	1	1	1	1	1	1	1	1
	Higher secondary school	**1.496**	1.425	**1.272**	0.941	**1.592**	**1.377**	1.016	1.207	0.955	**1.464**
	Lower secondary school	1.095	1.260	0.916	1.170	**1.646**	**1.703**	0.982	1.284	1.187	**1.935**
	Primary school	0.947	1.055	1.257	1.201	**1.719**	**2.394**	**1.715**	**2.141**	1.025	1.372
Is your or your family's occupation related to health care?	Yes	1	1	1	1	1	1	1	1	1	1
	No	0.972	**1.245**	0.955	1.052	**1.366**	1.126	1.040	**1.446**	**1.363**	1.212
Recent antibiotic use	Within 1 month	1	1	1	1	1	1	1	1	1	1
	Within 6 month	0.897	0.811	1.024	1.077	1.029	0.868	1.347	0.982	1.270	0.870
	Within 1 year	0.976	0.594	1.098	1.086	1.231	0.887	1.278	1.161	0.958	1.186
	More than 1 year	**0.466**	0.520	0.947	0.877	0.873	0.774	1.095	0.970	1.427	0.853
Frequency of antibiotic taking	Once a month	1	1	1	1	1	1	1	1	1	1
	Once in every 3 months	1.212	0.856	1.586	1.740	1.323	**2.047**	**2.684**	**2.901**	**2.479**	1.210
	Once in every 6 months	1.345	**2.573**	1.471	1.659	1.314	**1.897**	**2.504**	**3.379**	**2.089**	1.289
	Once a year	1.072	0.979	0.945	1.096	0.958	0.891	1.150	1.620	1.133	0.787
	More than a year	0.728	0.760	1.007	0.861	0.651	0.822	0.882	1.178	1.113	0.709
Have you self-medicated with antibiotics before?	Yes	1	1	1	1	1	1	1	1	1	1
	No	1.010	0.968	**0.323**	**0.601**	**0.632**	**0.379**	**0.339**	**0.355**	**0.144**	**0.575**
Have heard about antibiotic resistance?	Yes	1	1	1	1	1	1	1	1	1	1
	No	1.361	1.881	1.085	1.249	**1.824**	**1.375**	**2.601**	**1.315**	1.272	0.975

Bold values indicate significant correlations at the level of 0.05.

Among these inappropriate responses, 52.7% (n = 1386) of the respondents thought that viral infection can be cured by taking antibiotics, followed by 37.8% (n = 995) respondents thought that antibiotic can be stopped once symptoms of illness have improved. Moreover, 35.8% (n = 940) of the respondents agreed that taking low dose of antibiotics is better than not taking any dose.

Public practice in antibiotic use

The practice score ranged from 0 to 10 points, with a mean of 6.91 ± 2.07. Table 4 showed the percentages of inappropriate responses for 10 practice statements. The highest inappropriate response was respondents have high expectation on their doctor to prescribe antibiotics (1845, 70.1%), followed by taking antibiotics to prevent illness from getting worse (1737, 66.0%). Besides, almost half (1263, 48%) of the respondents admitted that they stop taking antibiotics once their illness or symptoms improved.

Pearson correlation coefficient demonstrated positive correlations between respondents' belief, knowledge and practice. The mean knowledge score was strongly correlated with mean practice score ($r = 0.553$, $p < 0.001$). Where else, mean belief was moderate correlated with mean score of practice ($r = 0.342$, $p < 0.001$) and the mean score of knowledge ($r = 0.342$, $p < 0.001$) respectively.

Positive correlations were found between a few knowledge statements and practice statements. Respondents who thought that antibiotics should be stopped when the symptoms of the illness improved were practicing it ($p < 0.001$). In addition, positive correlation was noted between respondents who

Table 6. Factors associated with inappropriate response for each belief statement.

Characteristics		**1**	**2**	**3**	**4**	**5**	**6**
Gender	Male	1	1	1	1	1	1
	Female	0.985	0.905	1.138	1.002	**0.775**	**0.824**
Age	> 60	1	1	1	1	1	1
	46 - 60	0.802	0.851	0.836	1.055	**1.372**	0.961
	31 - 45	0.892	1.077	0.869	0.960	1.254	0.985
	18 - 30	1.116	**1.470**	0.946	0.867	**1.670**	**1.590**
Race	Malay	1	1	1	1	1	1
	Chinese	1.135	1.176	0.873	**0.691**	0.802	0.869
	Indian	0.883	0.987	**0.579**	1.012	0.810	0.866
	Others	**2.415**	1.806	1.169	1.273	1.828	**2.476**
Highest academic level	College / University	1	1	1	1	1	1
	Higher secondary school	1.167	**1.279**	0.964	0.886	**1.516**	1.050
	Lower secondary school	**1.419**	**1.682**	0.845	0.856	**1.665**	**1.430**
	Primary school	1.334	**1.770**	1.113	0.865	**1.593**	**1.944**
	None						
Is your or your family's occupation related to health care?	Yes	1	1	1	1	1	1
	No	1.121	1.171	**1.279**	1.098	**1.704**	**1.296**
Recent antibiotic use	Within 1 month	1	1	1	1	1	1
	Within 6 months	1.081	1.066	1.054	1.017	0.959	1.089
	Within 1year	0.845	0.957	0.869	1.125	0.959	1.035
	More than 1 year	1.226	1.062	0.559	**0.577**	0.880	0.979
Frequency of antibiotic use	Once in a month	1	1	1	1	1	1
	Once in every 3 months	1.238	1.454	0.967	0.927	1.015	**2.084**
	Once in every 6 months	**2.146**	1.670	1.264	0.751	1.632	**1.915**
	Once in a year	1.372	1.236	1.019	0.828	0.882	1.336
	More than a year	1.426	1.238	0.681	**0.542**	0.704	1.173
Have you self-medicated with antibiotics before?	Yes	1	1	1	1	1	1
	No	0.917	0.987	1.007	0.762	**0.648**	**0.663**
Have you heard about antibiotic resistance?	Yes	1	1	1	1	1	1
	No	**1.515**	**1.395**	**1.675**	**1.270**	**1.995**	**1.594**

Bold values indicate significant correlations at the level of 0.05.

thought sharing antibiotic was harmless and those who practiced antibiotics sharing with their family members when they had similar symptoms or illness ($p < 0.001$). In addition, respondents who thought antibiotics can be obtained without a doctor's prescription, agreed that they would purchase antibiotics at private clinic or retail pharmacy without a doctor's consultation ($p < 0.001$).

Stepwise multiple logistic regression analysis was performed and adjusted odds ratios for belief, knowledge and practice statements were shown in Table 5, 6 and 7 respectively, along with demographic

Table 7. Factors associated with inappropriate response for each knowledge statement.

Characteristics		Number of questions											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Gender	Male	1	1	1	1	1	1	1	1	1	1	1	1
	Female	0.791	1.047	**0.753**	1.006	**0.668**	1.085	1.062	0.967	0.827	**0.806**	**0.770**	1.047
Age	> 60	1	1	1	1	1	1	1	1	1	1	1	1
	46 - 60	0.738	0.998	1.156	1.138	**1.366**	1.418	0.868	0.807	0.908	1.087	1.229	0.954
	31 - 45	0.732	0.972	1.226	1.292	**1.385**	1.184	0.934	1.074	0.865	1.035	0.915	0.879
	18 - 30	**0.606**	0.845	**1.870**	1.315	**1.812**	0.862	1.113	**1.673**	**2.052**	**1.467**	**2.178**	1.467
Race	Malay	1	1	1	1	1	1	1	1	1	1	1	1
	Chinese	**1.449**	**0.663**	1.237	**0.560**	**0.685**	**0.530**	**1.357**	1.022	0.765	**0.716**	0.926	1.139
	Indian	1.138	**0.735**	0.827	**0.714**	**0.738**	0.753	**1.355**	1.048	0.885	**0.764**	0.962	0.828
	Others	0.931	0.850	1.046	0.911	1.505	1.028	0.739	1.065	1.509	1.171	1.093	0.946
Highest academic level	College / University	1	1	1	1	1	1	1	1	1	1	1	1
	Higher secondary school	1.029	1.516	1.030	1.181	**1.720**	1.338	1.212	**1.255**	**1.327**	**1.436**	**1.360**	0.880
	Lower secondary school	0.965	1.389	0.846	0.795	**2.093**	0.871	1.211	**1.909**	1.349	**1.711**	1.117	1.272
	Primary school	0.874	1.410	**1.723**	1.198	**1.695**	0.974	**2.055**	**2.346**	1.408	1.254	1.257	1.611
Is your or your family's occupation related to health care?	Yes	1	1	1	1	1	1	1	1	1	1	1	1
	No	1.102	1.607	1.187	**1.236**	**1.537**	**1.371**	1.072	1.115	**1.472**	**1.431**	**1.399**	1.228
Recent antibiotic use	Within 1 month	1	1	1	1	1	1	1	1	1	1	1	1
	Within 6 months	0.846	1.002	1.124	1.076	0.986	1.100	1.035	1.010	1.066	1.053	0.932	1.000
	Within 1year	1.280	1.000	1.032	1.005	0.992	1.035	0.906	**1.430**	1.102	1.108	1.016	0.816
	More than 1 year	1.021	0.859	0.891	0.822	0.998	0.796	1.078	1.186	0.920	1.097	0.915	0.541
Frequency of antibiotic use	Once in a month	1	1	1	1	1	1	1	1	1	1	1	1
	Once in every 3 months	**1.884**	0.844	1.308	0.988	1.211	**0.381**	1.227	1.498	0.937	1.382	1.451	1.519
	Once in every 6 months	0.982	1.099	1.161	1.024	1.525	0.753	0.895	1.459	1.710	1.451	**1.732**	1.139
	Once in a year	0.858	0.896	0.951	0.791	0.954	0.834	1.033	1.230	0.842	0.963	0.999	0.760
	More than a year	0.930	0.856	0.773	0.655	0.762	0.613	1.042	1.007	0.757	0.792	0.816	0.571
Have you self-medicated with antibiotics before?	Yes	1	1	1	1	1	1	1	1	1	1	1	1
	No	0.937	1.280	**0.541**	0.932	**0.681**	1.229	1.104	0.781	**0.657**	0.793	**0.639**	**0.334**
Have you heard about antibiotic resistance?	Yes	1	1	1	1	1	1	1	1	1	1	1	1
	No	**1.570**	**2.922**	**1.412**	**1.928**	**2.015**	**3.043**	**3.010**	**2.431**	**1.303**	**2.016**	**1.459**	**1.362**

Bold values indicate significant correlations at the level of 0.05.

characteristics. Male respondents, aged younger than 60 years old, with non-tertiary level education, and have not heard of antibiotic resistance were found to have higher odds in using leftover antibiotics and not completing whole course of antibiotics. (Table 5).

In the belief domain, respondents who were not aware of the term 'antibiotic resistance' were found to have significantly higher odds of inappropriate responses in all the statements. Males and respondents aged 18-30 years were found to have higher odds to falsely believe that antibiotics should be stopped when symptoms improved and that their health in future will depend on antibiotics (Table 6).

In the knowledge domain, all respondents who had not heard about antibiotics resistance had significantly higher odds of inappropriate knowledge. Males and respondents age between 18-30 years were found to have higher odds of inappropriate knowledge on adhering complete course of antibiotics regime and also taking leftover antibiotics (Table 7).

Discussion

The current study found that 10% of the respondents self-medicated with antibiotics and this finding was consistent with the previous study [11]. The main sources of antibiotic supply without prescriptions were community pharmacies and purchasing from private clinics without consulting the doctor. The same sources of antibiotics were previously described, where most of the community members in Putrajaya and Penang preferred to obtain their antibiotics from retail pharmacy or private clinics if they chose to self-medicate [8,12]. This shows that antibiotics are still easily accessible without prescription which in turn implies that the health care system especially community pharmacies and private clinics are still struggling to cope with their task in enhancing rational antibiotic use [13].

Majority of the respondents (n = 2026, 77%) mistakenly thought that symptoms caused by virus infection can be treated with antibiotic, notably fever, sore throats, colds and flu. Similar misunderstandings were reported in previous studies whereby more than 80% of the respondents thought that antibiotics can be used to treat viral infections [8,10,12]. This shows that the respondents were unaware or confused about the actual role of antibiotics and might have mistaken antibiotics as equivalent to antipyretics and analgesics.

In addition, most of the respondents had inappropriate belief on antibiotic use. Most of them believed that they can recover faster from the symptoms and prevent worsening of symptoms by taking antibiotics [8,12]. These responses were mainly found in respondents with lower secondary school education, whose occupations were not related to healthcare and had no knowledge on antibiotic resistance. There is a need to develop effective educational programme for those community members from the lower social classes with lower educational background, in order to impart essential information on appropriate use of antibiotics among this group of people.

This study found that inappropriate knowledge about antibiotic use was common, which may further lead to inappropriate use of antibiotics and increased risk of antibiotic resistance emergence. The most common misconceptions were about the role of antibiotics, with more than 70% of the respondents answered that antibiotics can be used to treat viral infection and 36% answered that taking low dose of antibiotic is better than not taking at all. These figures are comparable to the previous study [8]. Future public educational programmes might need to focus on these areas of inappropriate knowledge among the public.

A WHO report showed that developing countries have a higher rate of inappropriate responses, whereby more than half of the respondents in Sudan (62%), Egypt (55%) and China (53%) agreed that they should stop taking antibiotics when they feel better [10]. However, this study found that only 37.8% of the respondents stopped taking antibiotics once symptoms improved, which was slightly lower compared to the previous studies [8,10,12]. A minority of respondents reported self-medication using antibiotics without consulting a doctor (10.0%, n = 264), using leftover antibiotics (2.8%, n = 75), and sharing of antibiotics for similar symptoms (20.4%, n = 537). This might be due to the results of various campaigns organised by the Ministry of Health Malaysia, including Quality Use of Medicine Campaign, Know Your Medicine Campaign and World Antibiotic Day Campaign which had improved the public knowledge pertaining to completion of antibiotics course. However, further studies are needed to evaluate the actual impact of these campaigns towards the knowledge of public.

More than half (66.5%) of the respondents in this study had no knowledge about antibiotic resistance, which was consistent with one study conducted in India [14], but unlike the previous survey done by WHO [10], whereby only 30% of the respondents from all countries surveyed stated that they have not heard of the term. This implies that more targeted awareness campaign might be needed to increase awareness of antibiotic resistance among the general public. It is beneficial for future studies to explore the level of awareness of urban

and rural population, in order to develop targeted strategies in future antibiotic awareness campaign.

This study found that most of the respondents had poor practice in which 66% of them admitted taking antibiotics at the early stage of the illness to prevent it from worsening and expected the doctors to prescribe antibiotic when they experienced some illnesses. This was consistent with the previous study findings [8,11]. These responses were mainly found in respondents of the age group less than 60 years old with the educational background of higher secondary school and below, as well as those with no family members with occupations related to health care. On the other hand, more than 80% of the respondents did not keep extra antibiotics for emergency use nor purchase antibiotic without prescription.

On an encouraging note, a few knowledge aspects have been improved to a notable extent compared to previous studies [8,12]. A large proportion of the respondents were able to correctly identify the use of antibiotics for treating bacterial infection. Although slightly more than half of the respondents still thought that viral infection could be cured by taking antibiotics, the percentage of inappropriate responses had been reduced by more than 30% compared to previous studies [8,12]. Future educational materials should be developed to remedy the identified knowledge gaps among the public by including relevant information to correct popular misconceptions regarding antibiotics [15].

There were several limitations in our study. Firstly, recall bias might occur because all the responses were dependent on the honesty and reading comprehension of the respondents. Secondly, these findings might not be generalizable to the whole country because it was conducted in the state of Perak. Next, the extent of exploring the level of understanding and intent of the respondents was limited because this study used closed-ended survey questions. Thus, future study is needed to further explore the reasons of inappropriate antibiotic use through qualitative approach such as in-depth interviews.

The study findings exhibited the need for more targeted educational intervention. Certain aspects of knowledge aspects had been improved compared to previous studies [8,12]. Awareness and targeted education campaigns should be conducted to educate the public on antibiotic usage as well as the danger of antibiotic resistance [15]. For example, age-appropriate educational material regarding medicine and antibiotic use can be introduced in schools. Besides, healthcare professionals should play their role in providing proper counselling to the patients in term of antibiotics use [15]. Private clinics and community pharmacies being the main source of antibiotic supply should also practise rational antibiotic prescribing and dispensing [13].

Conclusion

Majority of the respondents expect doctors to prescribe antibiotics for their illness, and most believed that antibiotics can speed up recovery of illness. Lack of awareness on antibiotic resistance was found to be a significant factor associated with inappropriate antibiotic use. Future education campaigns should focus on the indication of antibiotic use and increasing awareness towards antibiotic resistance.

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Corresponding author
Associate Prof. Dr. Asrul Akmal Shafie, PhD
School Of Pharmaceutical Sciences,
Universiti Sains Malaysia
Minden Pulau Pinang,
11800 Pulau Pinang, Malaysia
Tel: 604-6533888
Fax:604-6532211
Email: aakmal@usm.my

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