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Health literacy, knowledge, household disposal, and misuse practices of antibiotics among UAE residents: a nationwide cross-sectional study

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ABSTRACT

Background: The study aimed to evaluate health literacy, knowledge, household disposal, and misuse practices of antibiotics among the United Arab Emirates (UAE) residents.

Research design and methods: An observational cross-sectional study was conducted between May 1st and August 31st, 2022. The study encompassed a sample of 1074 participants.

Results: Participants involved in a medical field (OR: 1.98, 95% CI: 1.45–2.69, $p < 0.001$) were more likely to have adequate health literacy. Most participants rarely ($n = 315$; 29.33%) or sometimes ($n = 292$; 27.19%) sought help from a doctor or pharmacist with reading the instructions and leaflets of antibiotics. A bachelor`s degree was associated with a reduced odds ratio of self-medication with antibiotics (OR: 0.46, 95% CI: 0.29–0.75, $p = 0.002$). Only 10.61% of unneeded antibiotics were returned to the pharmacy, 79.42% were disposed of at home and 10% were disposed of using other disposal practices.

Conclusions: Higher levels of adequate health literacy were observed in those involved in the medical field and those with higher educational levels. The prevalence of self-medication with antibiotics among the UAE population was low. These findings highlight the importance of improving health literacy, promoting responsible antibiotic use, and encouraging proper disposal practices among the population.

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Self-medication; antibacterial agents; antimicrobial resistance; literacy; health knowledge; practice; antibiotic misuse; antibiotic household disposal

1. Introduction

Antimicrobial Resistance (AMR) refers to the phenomenon wherein bacteria, viruses, parasites, and fungi change over time, rendering them less susceptible to the effects of medications [1]. AMR reduces the effectiveness of treatments, leading to challenges in managing infections, escalating the likelihood of disease transmission, and raising the severity of illnesses and mortality rates [1]. Bacterial AMR is a rapidly expanding global concern, resulting from bacterial changes that render medications used to treat illnesses less effective [2,3]. The World Health Organization (WHO) identified 12 families of bacteria that threatened human health due to their specific antibiotic resistance mechanisms [4,5].

The Sustainable Development Goals (SDGs), which are 17 distinct goals developed by the United Nations (UN) and encompassing various domains such as ecology, societal issues, climate change, education, economy, and healthcare, were designed to serve as a worldwide framework for fostering an improved, fairer, and more sustainable existence on our planet [6]. The SGDs considered AMR as a prevailing global concern that extends beyond public health to encompass broader societal implications [7]. Furthermore, the continued growth of AMR may restrict the achievement of numerous SDGs [7].

Public health organizations have underscored the need to act early to minimize the spread of multidrug-resistant bacteria [4,8]. Among the factors contributing to this problem, antibiotic abuse and misuse are prominent causes. Poor adherence to therapy and self-medication can result in antimicrobial drug misuse [9,10].

Self-medication is one of the most common forms of antibiotic misuse and is based on patients' self-evaluation instead of a professional medical diagnosis [11,12]. Such behavior can have adverse effects, including a higher risk of AMR, treatment failure, and increased mortality [13]. The widespread use of antibiotics without a prescription or medical guidance can lead to the emergence of multidrug-resistant pathogens, concealment of severe and potentially fatal diseases, inaccurate diagnoses, unsuitable dosages, drug interactions, side effects, and adverse drug reactions [13–15].

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As highlighted in a scoping review conducted by Aslam et al., the prevalence of self-medication with antibiotics varied across low to middle-income countries, with rates ranging from 7.3% in Indonesia to 81.23% in Pakistan [16]. Notably, among Middle Eastern countries, Saudi Arabia exhibited the highest prevalence of SMA at 80.6%, while Jordan demonstrated the lowest prevalence at 40.7% [16]. Moreover, countries with individuals with higher levels of education exhibit lower rates of self-medication with antibiotics, highlighting the potential of implementing educational policies to improve health literacy and substantially minimize self-medication with antibiotics [16].

The link and impact of health literacy on various infections and behaviors related to infection prevention are one of the paramount subjects of significance. Castro-Sanchez et al. conducted a review that revealed how limited or inadequate health literacy contributes to a reduced adoption of protective behaviors, such as immunization [17].

Improving the population's knowledge and health literacy can increase awareness of antibiotic resistance and positively impact behavior, such as self-medication and illogical drug dispensing [18–20]. The WHO defines health literacy as the ability to make decisions that enhance one's health [21]. Previous studies have identified a link between health literacy and knowledge of antibiotic resistance. In an Egyptian cross-sectional study, 40% of individuals had used antibiotics without a prescription the previous month, and 92% were unaware of antibiotic resistance [22].

Although research in the literature has identified various causes of antibiotic misuse, our study's novelty lies in the fact that previous research on self-medication in the UAE needed to be updated or not representative of the entire community. Furthermore, this study is the first to examine the relationship between self-medication and health literacy in UAE society and to address antibiotic household disposal practices. The primary objective of this study was to assess the levels of health literacy regarding antibiotics and self-medication with antibiotics and to evaluate the predictors of adequate health literacy. The secondary objectives of the study were to comprehensively assess the population of the UAE in terms of their knowledge of the use and disposal of antibiotics, patterns of antibiotic misuse, and self-medication practices related to antibiotics.

2. Methods

2.1. Study design and sampling technique

This study adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting observational cross-sectional studies. Participants were from the general public in Abu Dhabi, Dubai, Sharjah, Ajman, and other UAE cities. The data collection period spanned four months, from May 1st to the end of August 2022. Convenience sampling was employed to select participants from a recommended sample size of 384 individuals calculated using the RaoSoft calculator (RaoSoft, Inc 2004, www.raosoft.com/samplesize.html). The sample size was determined based on an assumed population of 9.9 million UAE locals and expats [23]. The Raosoft sample size calculator was employed considering a confidence limit of 5%, a response distribution of 50%, and a 95% confidence interval estimate for the proportion [24]. A minimum sample size of 384 was needed. The study included both locals (Emiratis) and expats (residents). We recruited a larger sample size ($n = 1074$) to interpret significant results and allow a more precise estimate of the study questions as it is easier to assess the sample's representativeness and to generalize the result. [anonymized] Research Ethics Committee (REC) approved the study and granted the necessary ethical permissions (REC_B3_ 05/22).

2.2. Study objectives

The primary objective of this study was to assess the levels of health literacy regarding antibiotics and self-medication with antibiotics and to evaluate the predictors of adequate health literacy. The secondary objectives of the study were to comprehensively assess the population of the UAE in terms of their knowledge of the use and disposal of antibiotics, patterns of antibiotic misuse, and self-medication practices related to antibiotics.

2.3. Study tool

The questionnaire used in this study was based on the WHO survey on antibiotic resistance and on a previously validated instrument, which had been employed in similar studies conducted in Jordan [21,25,26]. However, some questions were modified to be more suitable for the population of the UAE and to better align with the aims of this study. The questionnaire comprised closed-ended questions that were organized into three distinct sections. Section 1 gathered demographic data from the participants, including age, gender, city of residence, and education level. Section 2 focused on antibiotic resistance, while Section 3 addressed questions related to self-medication. The Single Item Literacy Screener (SILS) developed by Morris et al. (2006) was adapted to serve as a predictor of the participants' overall health literacy [27]. The participants were asked, 'How often do you ask someone for help reading instructions and leaflets from a doctor or pharmacy' The replies to the preceding question were scored using a 5-point Likert scale (5 = never, 4 = rarely, 3 = sometimes, 2 = often, 1 = always). The SILS scale has been employed in numerous published articles to assess participants' health literacy [18,28–30]. In the present study, a health literacy score of 4 or 5 indicated sufficient health literacy, while a score of 3 or below was categorized as inadequate. To evaluate antibiotic knowledge, the validated Antibiotic Resistance: Multi-country Public Awareness Survey developed by the WHO was used [31]. While the survey is originally available in English, a previously translated version used in a comparable setting was employed for this study [25].

2.4. Validation and reliability testing of the study questionnaire

The validation and reliability of the study questionnaire were assessed through a process involving a panel of

experts and a pilot test. The principal investigator invited four experts in clinical pharmacy, who were professors in clinical pharmacy and pharmacy practice from Sharjah University, Ajman University, and [anonymized] in the UAE, and two experts in the fields of antimicrobial stewardship, to attend a virtual meeting to evaluate the content of the questionnaire. The experts were requested to rate each item in the questionnaire based on its clarity, relevance, appropriateness, length, and time required to fill it using a scale of 1–10. The overall mean scores for clarity, relevance, appropriateness, question length, and time to fill the questionnaire were 8.24 (SD = 1.67), 9.48 (SD = 2.07), 8.30 (SD = 1.41), 9.41 (SD = 1.67), and 9.13 (SD = 2.67), respectively. The panel members' recommendations for any necessary modifications and amendments were considered. The research team then conducted a pilot test with 50 participants, using the validated questionnaire to assess the questionnaire's reliability and comprehensibility. Participants were asked to provide feedback on any questions or words that hindered their understanding of the questionnaire. The responses were entered into SPSS version 26 (IBM Corp, Armonk, NY), and the internal consistency of the questionnaire items was calculated. The overall Cronbach's alpha was 0.67 for self-medication and 0.61 for the use and disposal of antibiotics.

2.5. Inclusion and exclusion criteria

The present study employed specific inclusion and exclusion criteria. To enroll qualified participants for this study, we utilized instructions within the survey's advertisements to discourage those who do not fulfill the requirements from taking the survey. Participants were chosen based on their proficiency in understanding and speaking Arabic, being 18 years of age or older, residents of the UAE, and expressing voluntary willingness to participate. Conversely, exclusion criteria were limited to participants residing outside the UAE, those who do not speak or understand Arabic, those younger than 18 years old, or those who declined to participate in the study.

2.6. Data collection

The data collection process involved distributing surveys through various online platforms, such as Facebook, Twitter, and others. Eligible participants were first provided with an overview of the study's objectives and subsequently given the option to consent to participate. Following their consent, participants were provided with the study questionnaire, which included an explanation of the study's aims. Participants were informed about the confidentiality and anonymity policies in place to protect their privacy. In addition, participants were provided with a participants information sheet which gives potential participants the necessary understanding of the motivation and procedures of the study and sources of information to answer any further questions allowing them to give informed consent. This included definitions and general information about antibiotics.

2.7. Statistical analysis

Descriptive statistics were used to describe patient sociodemographic characteristics, knowledge, and practice concerning the use and disposal of antibiotics, symptoms and diseases that are thought to be treated with antibiotics, the practice and perception of self-medication with antibiotics, and participants' practice of antibiotics misuse. Multivariable logistic regression models were conducted to assess predictors of participants' adequate health literacy regarding antibiotics and predictors of self-medication among participants. All data were coded and entered into the Statistical Package for Social Sciences (SPSS Inc., Chicago, IL) version 23. Statistical significance was set at a 2-sided $P < 0.05$.

3. Results

3.1. Sociodemographic characteristics of the study population

A total of 1074 participants from the UAE consented and completed the survey. The population's sociodemographic characteristics are described in Table 1. The majority of our study population were females ($n = 809$; 75.33%). All were adults aged between 18–69-year-old with most aged between 18–29-year-old ($n = 469$; 43.67%). Most participants were involved in a non-medical field ($n = 824$; 76.72%), while a small proportion were involved in a medical field ($n = 250$; 23.28%). The most common city of residency of the study participants was Abu Dhabi ($n = 483$; 44.97%) followed by Sharjah ($n = 224$; 20.86%) and Dubai ($n = 167$; 15.55%). The majority of respondents were married ($n = 626$; 58.29%) or single ($n = 427$; 39.76%). Furthermore, a bachelor's degree ($n = 541$; 50.37%) was the participants' most recorded level of education. On the other hand, participants who did not complete schooling ($n = 14$; 1.3%) and participants with a doctorate ($n = 11$; 1.02%) were the least to be documented.

3.2. Levels and predictors of adequate health literacy regarding antibiotics

According to the SILS scale, when participants were asked 'How often do you ask someone for help reading instructions and leaflets from a doctor or pharmacy' their responses were the following: always ($n = 86$, 8.01%), often ($n = 116$, 10.8%), sometimes ($n = 292$, 27.19%), rarely ($n = 315$, 29.33%), and never ($n = 265$, 24.67%) (Figure 1a). Respondents with adequate health literacy regarding antibiotics were slightly higher than those with inadequate health literacy (Figure 1b).

A multivariable logistic regression analysis was conducted to evaluate predictors of adequate health literacy among study participants (Table 2). Participants in the medical field (OR: 1.98, 95% CI: 1.45–2.69, $p < 0.001$) were more likely to have adequate health literacy. Furthermore, adequate health literacy was higher in those with a Doctorate or Master's/Professional degree (OR: 1.86, 95% CI: 1.11–3.11, $p = 0.019$), those aged 30–39-year-old (OR: 1.44, 95% CI: 1.02–2.03, $p = 0.041$), and those aged 40–49-year-old (OR: 1.61, 95% CI: 1.07–2.41, $p = 0.021$).

Table 1. Sociodemographic characteristics of the study population ($n = 1074$).

Variable	Frequency (percentage)
Gender	
Female	809 (75.33%)
Male	265 (24.67%)
Age group	
18–29	469 (43.67%)
30–39	309 (28.77%)
40–49	207 (19.27%)
50–59	77 (7.17%)
60–69	12 (1.12%)
Work or study field	
Medical sector (health related job)	250 (23.28%)
Non-medical sector (non-health related job)	824 (76.72%)
City of residence	
Al Fujairah	19 (1.77%)
Abu Dhabi	483 (44.97%)
Ras Al Khaimah	37 (3.45%)
Um Quwain	14 (1.30%)
Sharjah	224 (20.86%)
Dubai	167 (15.55%)
Ajman	130 (12.10%)
Marital status	
Widowed	6 (0.56%)
Single	427 (39.76%)
Married	626 (58.29%)
Divorced	15 (1.40%)
Educational level	
No schooling completed	14 (1.30%)
12th grade or less, no diploma/qualifications	69 (6.42%)
Some college credit, no degree	134 (12.48%)
Technical/Vocational training or Associate degree	69 (6.42%)
High school graduate with diploma/qualifications	150 (13.97%)
Bachelor's degree	541 (50.37%)
Master's/Professional degree	86 (8.01%)
Doctorate degree	11 (1.02%)

Table 2. Predictors of participants' adequate health literacy regarding antibiotics.

	OR	P value*	95% CI
Involvement in the medical field	1.98	<001	1.45–2.69
Male gender	0.83	0.195	0.62–1.1
Marital status (Married vs single)	1.03	0.847	0.75–1.43
Education**			
1	0.84	0.370	0.57–1.23
2	1.32	0.092	0.95–1.84
3	1.86	0.019	1.11–3.11
Age (years)			
30.39	1.44	0.041	1.02–2.03
40–49	1.61	0.021	1.07–2.41
50–69	1.55	0.096	0.93–2.59

OR: Odds Ratio and **CI**: Confidence interval.
*Adjusted analysis (Multivariable logistic regression).
**the scores for education are the following: 0: No schooling completed, some college credit, no degree, or 12th grade or less, no diploma/qualifications, 1: Technical/Vocational training or Associate degree, or High school graduate with diploma/qualifications, 2: Bachelor's degree, and 3: Doctorate degree, or Master's/Professional degree.
Number of observations = 1,074.

3.3. Knowledge and practice regarding the use and disposal of antibiotics

Table 3 presents an overview of the knowledge and practice of the study participants concerning the use and disposal of antibiotics. Most of the participants reported consuming antibiotics in the last 6 months ($n = 274$, 25.51%), in the last month ($n = 260$; 24.21%), and more than a year ago ($n = 2016$; 19.18%). Only a small proportion of respondents reported never having consumed antibiotics ($n = 28$; 2.61%). Furthermore, when asked whether they received advice from a physician or pharmacist on how to take antibiotics, most participants reported receiving advice from a physician ($n = 874$; 81.38%) or pharmacist ($n = 925$; 86.13%). In addition, the majority of respondents knew the type of infection they had used antibiotics for ($n = 770$; 71.69%), while some did not know ($n = 276$; 25.7%). Furthermore, the most common methods of antibiotic disposal reported by participants were disposing of them in the bin ($n = 800$; 74.49%), returning them to a pharmacy ($n = 114$; 10.61%), and disposing of them in the toilet ($n = 53$; 4.93%).

The present study found that the most symptoms and diseases that participants believed could be effectively treated with antibiotics were cold and flu/cough ($n = 731$; 68.06%), sore throat ($n = 595$; 55.4%), Bladder infection or urinary tract infection ($n = 503$; 46.83%), and runny nose/nasal congestion ($n = 437$; 40.69%) (Figure 2). Furthermore, over one-third of participants believed that fever ($n = 380$; 35.38%) could be treated with antibiotics. A significant proportion of participants correctly believed that bladder and urinary tract infections ($n = 503$; 46.83%) and skin and wound infections ($n = 370$; 34.45%) are effectively treated with antibiotics. Additionally, a considerable proportion of respondents ($n = 224$; 20.86%) believed that antibiotics could be used to treat COVID-19 infection.

3.4. Practice and perception of antibiotics self-medication

The present study investigated the practice and perception of self-medication with antibiotics among the participants, and the results are presented in Table 4. The majority of participants ($n = 945$; 87.99%) reported using a medical prescription to dispense antibiotics, while a small proportion ($n = 129$; 12%) reported not using a prescription. The most common reasons for self-medication with antibiotics were the following: successful resolution of a previous

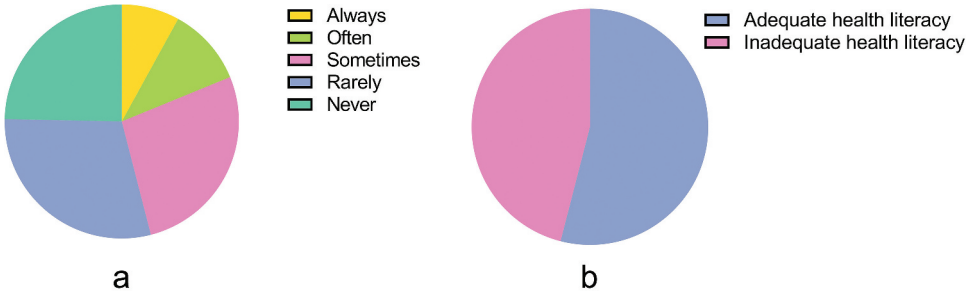

Figure 1. Responses to the Single Item literacy Screener (SILS) (a) and levels of health literacy among participants (b).

Table 3. Participants` knowledge and practice regarding the use and disposal of antibiotics ($n = 1074$).

Question	Frequency (percentage)
When did you last take antibiotics?	
Never	28 (2.61%)
In the last month	260 (24.21%)
In the last 6 months	274 (25.51%)
In the last year	143 (13.31%)
More than a year ago	206 (19.18%)
Can't remember	163 (15.18%)
On that occasion, did you get advice from a doctor on how to take them?	
I have never taken antibiotic	28 (2.61%)
Can't remember	172 (16.01%)
Yes, I received advice on how to take them (e.g. with food, for 7 days)	874 (81.38%)
On that occasion, did you get advice from a pharmacist on how to take them?	
I have never taken antibiotic	28 (2.61%)
Can't remember	121 (11.27%)
Yes, I received advice on how to take them (e.g. with food, for 7 days)	925 (86.13%)
On that occasion, do you know what type of infection your antibiotics were used for, (respiratory tract infection, urinary tract infection, skin infection or others)?	
I have never taken antibiotic	28 (2.61%)
No	276 (25.70%)
Yes	770 (71.69%)
How often do you ask someone for help reading instructions and leaflets from a doctor or pharmacy?	
Always	86 (8.01%)
Often	116 (10.80%)
Sometimes	292 (27.19%)
Rarely	315 (29.33%)
Never	265 (24.67%)
How do you dispose unused antibiotics?	
Dispose them in the toilet	53 (4.93%)
Dispose them in the bin	800 (74.49%)
Return them to Pharmacy	114 (10.61%)
Others	107 (9.96%)

Table 4. Participants' practice and perception of antibiotics self-medication ($n = 1074$).

Question	Frequency (percentage)
Was the dispensed antibiotic obtained using a medical prescription?	
Yes	945 (87.99%)
No	129 (12%)
Why did you choose self-medication with the above-mentioned medicine(s) instead of going to Doctor for your complaint(s)? (You may choose more than one option)	
Saves Time	273 (25.42%)
Saves money	208 (19.37%)
To avoid the hassle of going to the doctor	202 (18.81%)
The same medicine successfully resolved my complains previously	351 (32.68%)
The same medicine worked for my friends/family members with similar complaints	101 (9.40%)
Left over medicine was present at home	264 (24.58%)
Other (please specify)	71 (6.61%)
What do you think about self-medication with antibiotics for self-health care?	
Good practice	34 (3.17%)
Not acceptable practice	797 (74.21%)
Acceptable practice	243 (22.63%)
Did you ever change the dosage of antibiotics deliberately during the course of self-treatment?	
Never	846 (78.77%)
Yes, sometimes	199 (18.53%)
Yes, always	29 (2.7%)
Why did you change the dosage of antibiotics during the course of self-treatment? (check more than one if applicable)	
Improving conditions	129 (12.01%)
Worsening conditions	41 (3.82%)
To reduce adverse reactions	68 (6.33%)
Drug insufficient for complete treatment	21 (1.96%)
Others	6 (0.56%)
It's okay to buy the same antibiotics, or request these from a doctor, if you're sick and they helped you get better when you had the same symptoms before	
False	557 (51.86%)
True	325 (30.26%)
Don't know	192 (17.88%)
It's okay to use antibiotics that were given to a friend or family member, as long as they were used to treat the same illness	
False	767 (71.42%)
True	170 (15.83%)
Don't know	137 (12.76%)

complaint with the same medicine ($n = 351$; 32.68%), time-saving ($n = 273$; 25.42%), presence of leftover medicine at home ($n = 264$; 24.58%), saving money ($n = 208$; 19.37%), avoiding the hassle of going to a doctor ($n = 202$; 18.81%), and successful treatment of friends/family members with similar complaints ($n = 101$, 9.4%). Most of the respondents considered self-medication with antibiotics for self-care to be an unacceptable practice ($n = 797$; 74.21%), while a smaller proportion considered it acceptable ($n = 243$; 22.63%) or good practice ($n = 34$; 3.17%).

Regarding intentional dosage modification during self-treatment, most respondents reported never deliberately changing the dosage of antibiotics during self-treatment ($n = 846$; 78.77%), while some reported sometimes ($n = 199$; 18.53%) or always ($n = 29$; 2.7%) doing so. The reasons for intentional dosage modification were the following: improvement in the condition ($n = 129$; 12.01%), reduction of adverse reactions ($n = 68$; 6.33%), worsening of the condition ($n = 41$; 3.82%), and drug insufficiency to complete treatment ($n = 21$; 1.96%).

Furthermore, when asked whether it is acceptable to purchase or request the same antibiotics as previously used for a similar illness, the majority of participants responded false ($n = 557$; 51.86%), while 30.26% responded true, and 17.88% did not know. Additionally, when participants were asked whether it is acceptable to use antibiotics previously given to a friend or family member for the same illness, their responses were the following: false ($n = 767$; 71.42%), true ($n = 170$; 15.83%), and do not know ($n = 137$; 12.76%).

3.5. Antibiotic misuse

Table 5 presents information pertaining to the misuse of antibiotics among participants. The majority of respondents indicated that they withhold antibiotic treatment until the completion of the prescribed course ($n = 537$; 50%), or until symptoms disappear ($n = 245$; 22.81%), a few days after recovery ($n = 199$; 18.53%), or following consultation with a doctor or pharmacist ($n = 172$; 16.01%). Participants' responses to the query on reasons for keeping antibiotics at home revealed that saving

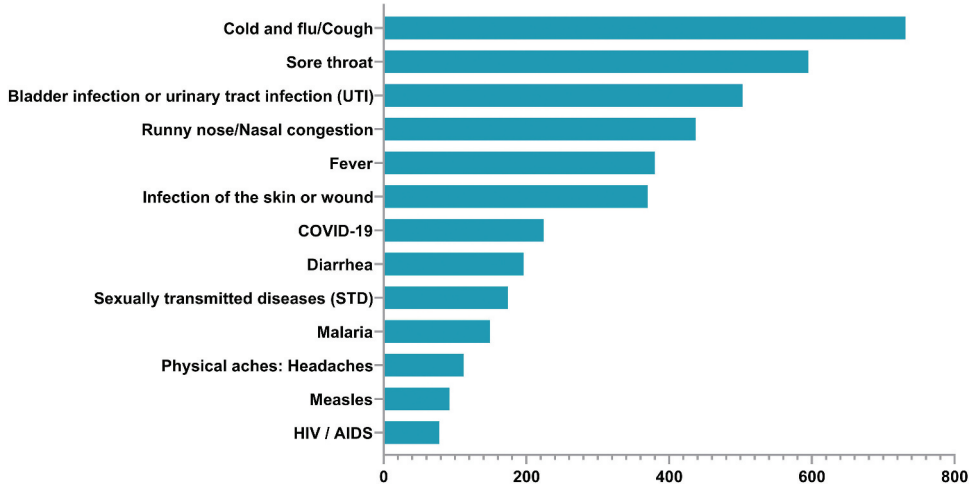

Figure 2. Number of participants with symptoms and diseases that are thought to be treated with antibiotics.

Table 5. Participants' practice of antibiotics misuse ($n = 1074$).

Question	Frequency (percentage)
When did you normally stop taking antibiotics? (Check more than one if applicable)	
After a few days regardless of the outcome	80 (7.45%)
After symptoms disappeared	245 (22.81%)
A few days after the recovery	199 (18.53%)
After antibiotics ran out	143 (13.31%)
At the completion of the course	537 (50%)
After consulting a doctor/pharmacist	172 (16.01%)
Others	23 (2.14%)
The option that best describes why antibiotics are kept at home	
I save them just in case my family and friends need them	355 (33.05%)
Save them for next time use	320 (29.80%)
I don't know what to do with them	193 (17.97%)
I don't know how to get rid of antibiotics	108 (10.06%)
Others	97 (9.03%)
What do you usually do with unused antibiotics?	
Get rid of it at home	407 (37.90%)
Take them back to the pharmacy	53 (4.93%)
Share them with friends/family	83 (7.73%)
Keep it at home	505 (47.02%)
Others	26 (2.42%)
When do you think, you should stop taking antibiotics when you have started one treatment?	
When all the antibiotics have been taken according to the instructions	759 (70.67%)
When you feel better	282 (26.26%)
Don't know	33 (3.07%)

antibiotics for potential future use by a family member or friend ($n = 355$; 33.05%) and keeping antibiotics for their subsequent use ($n = 320$; 29.8%), were the most prevalent. Other responses included not knowing what to do with antibiotics ($n = 193$; 17.97%), and not knowing how to dispose of them ($n = 108$; 10.06%).

When participants were asked about the fate of unused antibiotics, the majority stated that they store them at home ($n = 505$; 47.02%), while others stated that they dispose them at home ($n = 407$; 37.9%), share them with family members ($n = 83$; 7.73%), or return them to the pharmacy ($n = 53$; 4.93%). The majority of respondents believed that antibiotic treatment should be discontinued only after the entire prescribed course has been completed ($n = 759$; 70.67%), while some ceased treatment when they felt better ($n = 282$; 26.26%). A small proportion of respondents expressed uncertainty about when antibiotic treatment should be stopped ($n = 33$; 3.07%).

3.6. Predictors of self-medication with antibiotics

A multivariable logistic regression analysis was conducted to evaluate the predictors of self-medication among participants (Table 6). The only factor that decreased the rate of antibiotic self-medication was having a bachelor's degree (OR: 0.46, 95% CI: 0.29–0.75, $p = 0.002$). Adequate health literacy (OR: 0.85, 95% CI: 0.58–1.24, $p = 0.391$) was found to reduce the rate of antibiotics self-medication but without statistical significance.

4. Discussion

This is an observational cross-sectional study with the primary objective is to assess the levels of health literacy regarding antibiotics and self-medication with antibiotics and to evaluate the predictors of adequate health literacy. The study encompassed a comprehensive sample size of 1074 participants. According to the current study's findings, engaging in a healthcare profession and possessing an advanced degree such as a Doctorate or Master's/Professional degree emerged as significant predictors of possessing satisfactory and adequate health literacy. The findings of this study provide valuable insights into the knowledge, practices, and perceptions regarding antibiotic use and disposal. Slightly more than half of the participants exhibited adequate health literacy skills. Moreover, the participants reported various levels of antibiotic consumption in the past with only a small proportion (2.61%) reported never having consumed antibiotics. A notable proportion of respondents (20.86%) believed that antibiotics could treat COVID-19 infection. A noteworthy finding from the study is that 12% of participants acknowledged practicing self-medication, wherein antibiotics were used without obtaining a prescription. Moreover, a significant majority of the study population (70.67%) had good knowledge concerning the appropriate circumstances to withhold antibiotic treatment.

Table 6. Predictors of participants' self-medication with antibiotics.

	OR	P value*	95% CI
Adequate knowledge of antibiotic resistance	1.10	0.622	0.75–1.62
Involvement in the medical field	1.15	0.542	0.74–1.8
Male gender	1.42	0.094	0.94–2.14
Marital status	0.75	0.261	0.46–1.23
Education**			
1	0.89	0.675	0.53–1.5
2	0.46	0.002	0.29–0.75
3	0.82	0.579	0.40–1.66
Age			
30–39	1.00	0.994	0.59–1.69
40–49	0.63	0.188	0.31–1.26
50–69	0.92	0.848	0.41–2.1
Adequate health literacy	0.85	0.391	0.58–1.24

OR: Odds Ratio and **CI**: Confidence interval.
*Adjusted analysis (Multivariable logistic regression).
**the scores for education are the following: 0: No schooling completed, some college credit, no degree, or 12th grade or less, no diploma/qualifications, 1: Technical/Vocational training or Associate degree, or High school graduate with diploma/qualifications, 2: Bachelor's degree, and 3: Doctorate degree, or Master's/Professional degree.
Number of observations = 1,074.

4.1. Levels and predictors of health literacy

Health knowledge is a conceptual framework encompassing specific and comprehensive information concerning various aspects of health, including the causes, prevalence, risk factors, prevention strategies, transmission mechanisms, symptomatology, and treatment approaches for diseases [32]. Additionally, it encompasses knowledge about health services and patients' rights [32]. On the other hand, health literacy encompasses the capacity to locate, comprehend, and utilize information and services effectively, enabling individuals to make informed decisions and take appropriate actions regarding their health and others [33]. According to the World Health Organization (WHO), health literacy is the ability to make informed decisions about actions that improve individual health [21]. Health literacy and knowledge can significantly improve awareness of antibiotic resistance and positively influence behaviors such as self-medication and irrational drug dispensing [18,19]. This study aimed to investigate the levels of health literacy in the use of antibiotics and the predictors of adequate health literacy among participants in the UAE. The participants were asked about their frequency of seeking help in reading instructions and leaflets from a doctor or pharmacy. According to the SILS scale, when participants were asked 'How often do you ask someone for help reading instructions and leaflets from a doctor or pharmacy?' their responses were the following: always (8.01%), often (10.8%), sometimes (27.19%), rarely (29.33%), and never (24.67%). The results showed that 54% of the participants had adequate health literacy, while 46% had inadequate health literacy. The percentage of adequate health literacy was lower than the previously observed rate of 62.6% and 67.6% in Jordan [25,30].

The present study found that involvement in the medical field, either as a student or practitioner, was significantly associated with adequate health literacy regarding antibiotics. Additionally, higher educational levels, particularly Doctorate or Master's degree holders, were significantly associated with adequate health literacy. These findings are consistent with previous studies that highlight the positive impact of post-graduate education on health literacy [18,25,29].

4.2. Practice and knowledge regarding the use and disposal of antibiotics

This study aimed to assess the level of knowledge among participants regarding the usage of antibiotics. Results showed that most participants had taken antibiotics at some point in their lives, with only 2.61% reporting that they had never taken antibiotics and 15.18% indicating that they could not recall if they had taken antibiotics. Most participants sought advice on antibiotic usage from physicians (81.38%) or pharmacists (86.13%). Additionally, 71.69% of respondents reported some knowledge of the types of infections for which antibiotics are used.

In many underdeveloped countries, the practice of storing antimicrobials at home is frequent, leading to irrational antibiotic usage, the emergence of antibiotic resistance, and potential toxicities [34,35]. The escalating global health concern of AMR can be reduced by engaging in the practice of appropriately and responsibly disposal of unused or expired medications, including antimicrobial drugs and other medical products. In this study, only 10.61% of the population disposed of antibiotics by returning them to the pharmacy. Similar results were observed in Serbia, Nigeria, India, and other countries [36–38]. These findings suggest that a substantial number of households may retain unnecessary medicines, indicating the presence of unused drugs in considerable quantities. This study found that most respondents dispose of unused antibiotics by throwing them in the pin or toilet which may pose risks to the ecosystem as trace amounts of active drugs infiltrate the food chain, potentially exposing individuals and contributing to the development of drug resistance [39,40].

This study also found that more than half of the study population had the incorrect belief that antibiotics can be used to treat sore throats (55.4%), while approximately two-thirds of the respondent (68.06%) mistakenly assumed that antibiotics can be used to treat colds and flu/cough. Muflih et al. found that 83% and 43% of the participants believed antibiotics can effectively treat sore throat cold and flu, respectively [25]. Moreover, Mostafa et al found that more than half of the participant's wrongly believed antibiotics are helpful in the treatment of fever and diarrheal illnesses which is lower in our study (35.38% for fever and 18.25% for diarrhea) [22]. Interestingly, a significant proportion of participants correctly believed that bladder and urinary tract infections (46.83%) and skin and wound infections (34.45%) are effectively treated with antibiotics, as previously reported by the WHO [41].

These findings suggest that there is a lack of knowledge among the general public regarding the proper usage of antibiotics, which may contribute to the development of antibiotic resistance. Improving antimicrobial resistance education may help to address this knowledge gap and encourage individuals to seek more accurate medical information. This can aid in the fight against antibiotic resistance and improve overall health policy.

4.3. Practice and perception of antibiotics self-medication

Self-medication with antibiotics is a widespread phenomenon in both developed and developing countries, with reported rates ranging from 3% to 75% [42,43]. Previous research has

suggested that self-medication with antibiotics is more common among women, students, lonesome individuals, urban inhabitants, highly educated populations, and those in their middle years [44]. In this study, the majority of participants (87.99%) reported using antibiotics only with a medical prescription. Moreover, the prevalence of self-medication with antibiotics in this study (12%) is less than what was observed in most developing countries like Ghana (40%), Jordan (44%), and Pakistan (45%) [29,30,45,46]. However, it is higher than the rates observed in certain developed countries, such as the United Kingdom (5%) [47]. Studies have suggested that most non-prescription antibiotic purchases were made on the recommendation of a pharmacist [48,49]. Although the causes of pharmacists dispensing antibiotics without a prescription are not well known, some researchers have suggested that patient demand may be a contributing factor [50]. Studies conducted in low- and middle-income countries indicate that the public often self-medicates with antibiotics due to inadequate awareness regarding their inappropriate use [16,51]. Additionally, individuals may seek advice from unauthorized personnel and use antibiotics as over-the-counter medications, contributing to the accumulation of leftover antibiotics, unnecessary storage, and wastage [52,53].

The reasons individuals gave for self-medicating with antibiotics in a study by Radyowijati et al., were as the following: convenience (70%), previous experience (20%), and lack of access to physician care (10%) [54]. In this study, previous experience (personal or from family and friends) was the most common reason for self-medication with antibiotics (42.08%), followed by time-saving (25.42%), leftover medicine (24.58%), money-saving (19.37%), and avoiding the hassle of going to the doctor (18.81%).

While the majority of our study participants (74.21%) thought that self-medication with antibiotics is not an acceptable practice, some participants thought it was acceptable (22.63%) or even good (3.17%) practice. Moreover, Eltom et al found that 20.1% of participants thought that self-medication with antibiotics was a good practice and 41.6% thought it was an acceptable practice [55]. It is concerning that a significant portion (25.8%) of the individuals in our study population hold the belief that self-medicating with antibiotics is a good or acceptable practice. This perspective increases the likelihood of treatment ineffectiveness and adds to the emergence of antimicrobial resistance. Therefore, campaigns to raise awareness about the negative impacts of self-medication with antibiotics should be directed toward high-risk populations.

4.4. Antibiotic misuse

Self-medication with antibiotics is a prevalent phenomenon, which can lead to adverse pharmacological side effects, unsuccessful treatments, and increased antimicrobial resistance. In a study by Radyowijati et al., 70%, 20%, and 10% of individuals stopped self-medication with antibiotics after symptoms has disappeared, after a few days regardless of the outcomes, and a few days after the recovery, respectively [54]. Similarly, in our study, individuals stopped antibiotic treatment after completing the course (50%), after symptoms disappeared (22.81%), a few days after recovery (18.53%), and after consulting a doctor or pharmacist (16.01%).

The presence of antibiotics at home has been identified as a potential risk factor for irrational drug use and antimicrobial resistance [56–58]. In a study conducted in Northern Uganda, antibacterial drugs (40.1%) were the most common type of medicine kept at home, and the reasons for keeping antibiotics were current use of the antibiotics (18.6%), leftover antibiotics (14.9%), and anticipated future use (6.6%) [59]. Similarly, in our study, when participants were asked about the fate of their unused antibiotics, the majority of the responses were 'keeping them at home' (47.02%) or 'disposing of them at home' (37.9%). Insufficient public awareness regarding antibiotics may be the underlying factor contributing to the improper storage and wastage of medicines [30]. The persistence of improperly discarding antibiotics, such as the sink, toilet, or trash, may be attributed to the absence of a formal program to manage such waste [30]. Therefore, ensuring that healthcare personnel and patients are educated on the appropriate disposal methods holds significant importance. Further research is warranted to investigate procedures for disposing of leftover and expired antibiotics, to enhance public awareness regarding the rational utilization of antibiotics and to establish proper procedures for their return.

It is crucial to note that the majority of the population (70.67%) in our study had good knowledge regarding when to withhold antibiotic treatment. This rate is slightly higher than previously observed in a study investigating health literacy and knowledge regarding antibiotics (53.7%) [22]. However, 29.33% of our study respondents had poor knowledge regarding when to stop antibiotics. Thus, efforts should be directed toward improving public knowledge regarding the proper use and disposal of antibiotics to mitigate the potential risks associated with self-medication.

4.5. Predictors of self-medication with antibiotics

This study found that higher educational level is associated with a reduced ratio of self-medication with antibiotics. Furthermore, adequate levels of health literacy were also associated with a low rate of antibiotic self-medication. Despite that the previous findings were not statistically significant; it emphasizes how higher educational levels and adequate health literacy provide more exposure to information on antibiotic use and healthy behaviors. Several studies found that the absence of insurance coverage is a contributing factor in encouraging self-medication practices [30,60,61]. Furthermore, participants with limited knowledge were found to have a higher tendency to engage in self-medication with antibiotics, primarily due to a lack of comprehension regarding the appropriate indications for antibiotic use [25,30,62,63].

4.6. Strengths and weaknesses

The study's strength stems from its unique contribution as the first to evaluate health literacy, knowledge, and practices regarding antibiotics within the population of UAE. A notable strength of this study is the inclusion of a substantial number of participants, facilitating the evaluation of the associations between health literacy, and knowledge with various

sociodemographic factors. Considering the limited research conducted on this topic in UAE, the findings of this study hold significant value as they provide essential insights and bridge a gap in the existing literature by establishing a baseline understanding of emirates' health literacy, knowledge, and practice regarding antibiotics.

The findings of this study were subjected to several limitations. The absence of open-ended questions, which would have allowed respondents to explain their answers better, was a study limitation. In addition, although the research team tried to avoid the social desirability bias by several aspects including using a survey mode with respondent anonymity and analyzing the pertinence and coherence between the objectives and the methodological elements to be followed, this was another limitation of our study. Moreover, as our study applied a convenient sampling method to collect data from the participants that allowed for faster and easier data collection from the public in the UAE, it was not a representative sampling method though; this is another limitation of the study that needs to be carefully assessed in any future work. In this study, health literacy was defined as the capacity to locate, comprehend, and utilize health-related information effectively, enabling individuals to make informed decisions and take appropriate actions regarding their own health as well as that of others and it was assessed using the Single Item Literacy Screener (SILS) scale. However, it is important to note that the SILS scale may not identify individuals with limited reading abilities, potentially leading to false negative responses.

5. Conclusion

The primary objective of this study was to evaluate health literacy levels and elucidate the predictors of adequate health literacy. The study found that involvement in the medical field and higher educational levels were significant predictors of adequate health literacy. The prevalence of self-medication with antibiotics among the UAE population was low compared to other countries. However, a significant portion of the study population thought that self-medication with antibiotics was a good or acceptable practice which raises concerns regarding increased chances of treatment failure and the emergence of antimicrobial resistance. Among the study population, returning antibiotics to the pharmacy was identified as one of the least preferred methods for antibiotic disposal. Thus, efforts should be directed toward improving public knowledge regarding the proper use and disposal of antibiotics to mitigate the potential risks associated with self-medication.

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Declaration of interest

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Ethics statement

Al-Ain University Research Ethics Committee (REC) approved the study and granted the necessary ethical permissions (REC_B3_ 05/22).

Data availability statement

Data available on reasonable request and in line with permission approval processes from the Al-Ain University Research Ethics Committee.

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References

1. WHO. Antimicrobial resistance. [accessed 2023 Jun 11]. Available from: https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance.
2. Murray CJL, Ikuta KS, Sharara F, et al. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. Lancet. 2022;399(10325):629–655. doi: 10.1016/S0140-6736(21)02724-0
3. Ventola CL. The antibiotic resistance crisis: part 1: causes and threats. Pharm Ther. 2015;40:277–283.
4. WHO. Global priority list of antibiotic-resistant bacteria to guide research, discovery, and development of new antibiotics. [accessed 2023 Apr 7]. Available from: https://www.who.int/medicines/publications/global-priority-list-antibiotic-resistant-bacteria/en/.
5. Shrivastava S, Shrivastava P, Ramasamy J. World health organization releases global priority list of antibiotic-resistant bacteria to guide research, discovery, and development of new antibiotics. J Med Soc. 2018;32(1):76–77. doi: 10.4103/jms.jms_25_17
6. UN. Take action for the sustainable development goals. [accessed 2023 Jun 11]. Available from: https://www.un.org/sustainabledevelopment/sustainable-development-goals/.
7. Gajdács M, Urbán E, Stájer A, et al. Antimicrobial resistance in the context of the sustainable development goals: a brief review. Eur J Investig Health Psychol Educ. 2021;11(1):71–82. doi: 10.3390/ejihpe11010006
8. CDC. Antibiotic/Antimicrobial resistance (AR/AMR). [accessed 2023 Apr 7]. Available from: https://www.cdc.gov/drugresistance/about.html.
9. WHO. Global action plan on antimicrobial resistance. [accessed 2023 Apr 7]. Available fom: https://www.who.int/antimicrobial-resistance/global-action-plan/en/.
10. Kardas P, Devine S, Golembesky A, et al. A systematic review and meta-analysis of misuse of antibiotic therapies in the community. Int J Antimicrob Agents. 2005;26:106–113. doi: 10.1016/j.ijantimicag.2005.04.017
11. WHO. Antibiotic resistance. [accessed 2023 Apr 7]. Available online: https://www.who.int/news-room/fact-sheets/detail/antibiotic-resistance.
12. Alhomoud F, Aljamea Z, Basalelah L. "Antibiotics kill things very quickly" - consumers' perspectives on non-prescribed antibiotic use in Saudi Arabia. BMC Public Health. 2018;18:1177. doi: 10.1186/s12889-018-6088-z

13. Grigoryan L, Burgerhof JG, Degener JE, et al. Determinants of self-medication with antibiotics in Europe: the impact of beliefs, country wealth and the healthcare system. J Antimicrob Chemother. 2008;61:1172–1179. doi: 10.1093/jac/dkn054
14. Skliros E, Merkouris P, Papazafiropoulou A, et al. Self-medication with antibiotics in rural population in Greece: a cross-sectional multicenter study. BMC Fam Pract. 2010;11(1):58. doi: 10.1186/1471-2296-11-58
15. Shaghaghi A, Asadi M, Allahverdipour H. Predictors of self-medication behavior: a systematic review. Iran J Public Health. 2014;43(2):136–146.
16. Aslam A, Gajdács M, Zin CS, et al. Evidence of the practice of self-medication with antibiotics among the lay public in low- and middle-income countries: a scoping review. Antibiotics (Basel, Switzerland). 2020;9(9):597. doi: 10.3390/antibiotics9090597
17. Castro-Sánchez E, Chang PWS, Vila-Candel R, et al. Health literacy and infectious diseases: why does it matter? Int J Infect Dis. 2016;43:103–110. doi: 10.1016/j.ijid.2015.12.019
18. Anderson A, Angelillo IF. Online health information and public knowledge, attitudes, and behaviours regarding antibiotics in the UK: multiple regression analysis of wellcome monitor and eurobarometer data. PLoS One. 2018;13(10):e0204878. doi: 10.1371/journal.pone.0204878
19. Salm F, Ernsting C, Kuhlmey A, et al. Antibiotic use, knowledge and health literacy among the general population in Berlin, Germany and its surrounding rural areas. PLoS One. 2018;13(2):e0193336. doi: 10.1371/journal.pone.0193336
20. WHO. Worldwide country situation analysis: response to antimicrobial resistance. [accessed 2023 Apr 7]. Available from: https://www.who.int/drug.
21. Shah SJ, Ahmad H, Rehan RB, et al. Self-medication with antibiotics among non-medical university students of Karachi: a cross-sectional study. BMC Pharmacol Toxicol. 2014;15:74. doi: 10.1186/2050-6511-15-74
22. Mostafa A, Abdelzaher A, Rashed S, et al. Is health literacy associated with antibiotic use, knowledge and awareness of antimicrobial resistance among non-medical university students in Egypt? A cross-sectional study. BMJ Open. 2021;11:e046453. doi: 10.1136/bmjopen-2020-046453
23. GMI. UNITED ARAB EMIRATES POPULATION STATISTICS 2023. Available from: https://www.globalmediainsight.com/blog/uae-population-statistics/#:~:text=UAE%20Population%20in%202021%20is,to%20official%20Dubai%20Government%20website. (accessed on Apr 22, 2023).
24. Raosoft. Sample size calculator. [accessed 2021 Apr 22]. Available from: http://www.raosoft.com/samplesize.html.
25. Muflih SM, Al-Azzam S, Karasneh RA, et al. Public health literacy, knowledge, and awareness regarding antibiotic use and antimicrobial resistance during the COVID-19 pandemic: a cross-sectional study. Antibiotics. 2021;10(9):1107. doi: 10.3390/antibiotics10091107
26. Ateshim Y, Bereket B, Major F, et al. Prevalence of self-medication with antibiotics and associated factors in the community of Asmara, Eritrea: a descriptive cross sectional survey. BMC Public Health. 2019;19:726. doi: 10.1186/s12889-019-7020-x
27. Morris NS, MacLean CD, Chew LD, et al. The Single Item literacy Screener: evaluation of a brief instrument to identify limited reading ability. BMC Fam Pract. 2006;7(1):21. doi: 10.1186/1471-2296-7-21
28. Muflih SM, Al-Azzam S, Karasneh RA, et al. Public health literacy, knowledge, and awareness regarding antibiotic use and antimicrobial resistance during the COVID-19 pandemic: a cross-sectional study. Antibiotics. 2021;10(9):1107. doi: 10.3390/antibiotics10091107
29. Pereko DD, Lubbe MS, Essack SY. Public knowledge, attitudes and behaviour towards antibiotic usage in Windhoek, Namibia. S Afr J Infect Dis. 2015;30:134–137. doi: 10.1080/23120053.2015.1107290
30. Muflih SM, Al-Azzam S, Karasneh RA, et al. Public knowledge of antibiotics, self-medication, and household disposal practices in Jordan. Exp Rev Anti-Infective Ther. 2023;21:477–487. doi: 10.1080/14787210.2023.2182770
31. World Health Organization. 2015. Antibiotic resistance: multi-country public awareness survey. World Health Organization. [accessed 2022 Apr 10]. Available from: https://apps.who.int/iris/handle/10665/194460.
32. Trevethan R. Deconstructing and Assessing knowledge and awareness in public health research. *frontiers in public health*. 2017;5:194. doi: 10.3389/fpubh.2017.00194
33. NIH. Health literacy. [accessed 2023 Jun 11]. Available online: https://www.nih.gov/institutes-nih/nih-office-director/office-communications-public-liaison/clear-communication/health-literacy
34. Khan FU, Mallhi TH, Khan Q, et al. Assessment of antibiotic storage practices, knowledge, and awareness related to antibiotic uses and antibiotic resistance among household members in post-conflict areas of Pakistan: bi-central study. Front Med (Lausanne). 2022;9:962657. doi: 10.3389/fmed.2022.962657
35. Teni FS, Surur AS, Belay A, et al. A household survey of medicine storage practices in Gondar town, northwestern Ethiopia. BMC Public Health. 2017;17:238. doi: 10.1186/s12889-017-4152-8
36. Banwat S, Auta A, Dayom D, et al. Assessment of the storage and disposal of medicines in some homes in Jos north local government area of Plateau State, Nigeria. Trop J Pharm Res. 2016;15:989. doi: 10.4314/tjpr.v15i5.13
37. Magagula BK, Rampedi IT, Yessoufou K. Household pharmaceutical waste management practices in the Johannesburg area, South Africa. Int J Environ Res Public Health. 2022;19(12):7484. doi: 10.3390/ijerph19127484
38. Kumar YS, Raja SW, Sunitha J, et al. Household survey on rational use of medicines in India. Int J Pharm Ther. 2013;4:59–69.
39. Bronstein AC, Spyker DA, Cantilena LR Jr., et al. 2009 annual report of the American association of poison control centers' National Poison Data System (NPDS): 27th annual report. Clin Toxicol (Phila). 2010;48(10):979–1178. doi: 10.3109/15563650.2010.543906
40. Fernando DM, Tun HM, Poole J, et al. Detection of antibiotic resistance genes in source and drinking water samples from a first nations community in Canada. Appl environ microbiol. 2016;82(15):4767–4775. doi: 10.1128/aem.00798-16
41. WHO. Antibiotic resistance: multi-country public awareness survey. [accessed 2023 Apr 7]. Available from: https://apps.who.int/iris/handle/10665/194460.
42. Morgan DJ, Okeke IN, Laxminarayan R, et al. Non-prescription antimicrobial use worldwide: a systematic review. Lancet Infect Dis. 2011;11:692–701. doi: 10.1016/s1473-3099(11)70054-8
43. Ameko E, Achio S, Alhassan S. Effects of antibiotic self-medication on the effica cy of four antibiotics commonly used in Ghana on clinically isolated micro organisms. 2012. https://api.semanticscholar.org/CorpusID:13096380
44. Figueiras A, Caamaño F, Gestal-Otero JJ. Sociodemographic factors related to self-medication in Spain. Eur J Epidemiol. 2000;16:19–26. doi: 10.1023/a:1007608702063
45. Gillani AH, Ji W, Hussain W, et al. Antibiotic self-medication among non-medical University students in Punjab, Pakistan: a cross-sectional survey. Int J Environ Res Public Health. 2017;14(10):1152. doi: 10.3390/ijerph14101152
46. Ahiabu MA, Magnussen P, Bygbjerg IC, et al. Treatment practices of households and antibiotic dispensing in medicine outlets in developing countries: the case of Ghana. Res Social Adm Pharm. 2018;14:1180–1188. doi: 10.1016/j.sapharm.2018.01.013
47. McNulty CA, Boyle P, Nichols T, et al. Don't wear me out–the public's knowledge of and attitudes to antibiotic use. J Antimicrob Chemother. 2007;59(4):727–738. doi: 10.1093/jac/dkl558
48. Sabry NA, Farid SF, Dawoud DM. Antibiotic dispensing in Egyptian community pharmacies: an observational study. Res Social Adm Pharm. 2014;10:168–184. doi: 10.1016/j.sapharm.2013.03.004
49. Belkina T, Al Warafi A, Hussein Eltom E, et al. Antibiotic use and knowledge in the community of Yemen, Saudi Arabia, and Uzbekistan. J Infect Developing Countries. 2014;8:424–429. doi: 10.3855/jidc.3866
50. Radyowijati A, Haak H. Determinants of antimicrobial use in the developing world. Vol. 4. Baltimore MD (USA): Johns Hopkins University, Office of Design and Publications; 2002.

51. Makki M, Hassali MA, Awaisu A, et al. The prevalence of unused medications in homes. Pharmacy (Basel). 2019;7(2):61. doi: 10.3390/pharmacy7020061
52. Khan FU, Khan A, Shah S, et al. Exploring undergraduate pharmacy students perspectives towards antibiotics use, antibiotic resistance, and antibiotic stewardship programs along with the pharmacy teachers' perspectives: a mixed-methods study from Pakistan. Front Pharmacol. 2021;12:754000. doi: 10.3389/fphar.2021.754000
53. Wang X, Lin L, Xuan Z, et al. Keeping antibiotics at home promotes self-medication with antibiotics among Chinese University students. Int J Environ Res Public Health. 2018;15(4):687. doi: 10.3390/ijerph15040687
54. Rathish D, Wickramasinghe ND. Prevalence, associated factors and reasons for antibiotic self-medication among dwellers in Anuradhapura: a community-based study. Int J Clin Pharm. 2020;42(4):1139–1144. doi: 10.1007/s11096-020-01065-6
55. Eltom EH, Alanazi AL, Alenezi JF, et al. Self-medication with antibiotics and awareness of antibiotic resistance among population in Arar city, Saudi Arabia. J Infect Developing Countries. 2022;16:1762–1767. doi: 10.3855/jidc.16853
56. Sharif SI, Abduelkarem AR, Bustami HA, et al. Trends of home drug storage and use in different regions across the northern United Arab Emirates. Med Princ Pract. 2010;19(5):355–358. doi: 10.1159/000316372
57. Kheir N, Hajj ME, Wilbur K, et al. An exploratory study on medications in Qatar homes. Drug Healthc Patient Saf. 2011;3:99–106. doi: 10.2147/dhps.S25372
58. Yousif MA. In-home drug storage and utilization habits: a Sudanese study. Eastern Mediterranean Health Journal = La Revue de Sante de la Mediterranee Orientale = Al-Majallah Al-Sihhiyah Li-Sharq Al-Mutawassit. 2002;8(2–3):422–431. doi: 10.26719/2002.8.2-3.422
59. Ocan M, Bbosa GS, Waako P, et al. Factors predicting home storage of medicines in Northern Uganda. BMC Public Health. 2014;14:650. doi: 10.1186/1471-2458-14-650
60. Pagán JA, Ross S, Yau J, et al. Self-medication and health insurance coverage in Mexico. Health Policy. 2006;75:170–177. doi: 10.1016/j.healthpol.2005.03.007
61. Mainous AG 3rd, Cheng AY, Garr RC, et al. Nonprescribed antimicrobial drugs in latino community, South Carolina. Emerg Infect Dis. 2005;11(6):883–888. doi: 10.3201/eid1106.040960
62. Mboya EA, Davies ML, Horumpende PG, et al. Inadequate knowledge on appropriate antibiotics use among clients in the Moshi municipality Northern Tanzania. PLoS One. 2020;15(9):e0239388. doi: 10.1371/journal.pone.0239388
63. Adriaenssens N, Coenen S, Versporten A, et al. European Surveillance of antimicrobial Consumption (ESAC): outpatient antibiotic use in Europe (1997-2009). J Antimicrob Chemother. 2011;66 (Suppl 6):vi3–12. doi: 10.1093/jac/dkr190