OnLine Journal of Biological Sciences

Original Research Paper

Factors Associated with Irrational Use of Antibiotics. A Cross-Sectional Study in the City of Marrakech Morocco

[1]Naima Aoutil, [1]Mohamed Cherkaoui and [2]Mohamed Bouskraoui

[1]Department of Biology, Faculty of Science Semlalia, Pharmacology, Neurobiology, Anthropobiology, Environment and Behavior laboratory, Cadi Ayyad University, Marrakech, Morocco
[2]Faculty of Medicine and Pharmacy, Infectious Disease Research Laboratory, Cadi Ayyad University, Marrakech, Morocco

Article history
Received: 18-05-2024
Revised: 14-07-2024
Accepted: 15-07-2024

Corresponding Author
Naima Aoutil
Department of Biology, Faculty of Science Semlalia, Pharmacology, Neurobiology, Anthropobiology, and Environment and Behavior laboratory, Cadi Ayyad University, Marrakech, Morocco
Email: naima.aoutil@ced.uca.ma

Abstract: Overuse and inappropriate use of antibiotics leads to the emergence of antibiotic-resistant bacteria. This resistance leads to longer hospital stays, higher medical costs, and increased mortality. Therefore, its control must be a priority as it poses a threat to all nations, regardless of their territory and economic status. In Marrakech too, antibiotic resistance is a real public health problem, limiting treatment options. The population plays a crucial role in the irrational use of antibiotics. An appropriate analysis of the factors influencing correct use is of interest for any effective improvement intervention. Consequently, the aim of this cross-sectional study was to investigate the factors associated with the irrational use of antibiotics in the population of the city of Marrakech, with a view to proposing strategies for the proper use of these drugs adapted to the context of the study. The study population includes the general population of the city of Marrakech attending health centers and pharmacies. A total of 300 participants familiar with the term "antibiotic" were included in this study. They were selected using a stratified sampling method. The aim was to achieve a balanced distribution by gender, age, and place of residence. Regression analysis was performed to identify socio-demographic factors associated with knowledge, attitudes, and behaviors. Using Spearman's analysis, we examined the correlation between responses to questions on knowledge, attitudes, and behavior. A total of 269 questionnaires were analyzed. 69.9% of the participants had received antibiotics in the last year before the survey. Only 61.8% of the users were taking them on prescription. The reasons for taking antibiotics were mainly respiratory infections (50.8%). 56.3% of participants think antibiotics are effective against viruses, 35.1% think they should stop taking an antibiotic when they feel better and 57.9% have already stored antibiotics at home for future use. The use of a multiple logistic regression model showed that age between 30 and 49 years and family structure were associated with a good knowledge of antibiotics. Social security coverage and female gender were associated with good attitude. Nuclear family structure was associated with good behavior. Improving knowledge is a key factor in improving people's behavior towards the appropriate use of antibiotics. Our results show an irrational use of antibiotics. People aged between 14-29 years, over 50 years, and people living in extended family structures, as well as people without social security coverage, are the most predisposed to irrational use of antibiotics. What's more, the study showed a significant and positive relationship between knowledge, attitudes, and behavior. There is therefore an urgent need to organize awareness campaigns for the general public, particularly extended

families and the under-29 and over-50 age groups. It is also important to strengthen policies relating to the use of antibiotics and the prescription, distribution, and sale of medicines.

Keywords: Antibiotic Use, Attitudes, Behaviors, General Public, Knowledge

Introduction

Historically, infectious diseases have been the main cause of death. However, the advent of antibiotics has profoundly changed the medical field, leading to a considerable reduction in mortality caused by these infections (Piddock, 2012; Morens *et al*., 2004; Inoue and Minghui, 2017).

The irrational use of antibiotics has accelerated the development of resistant bacteria (Inoue and Minghui, 2017). This resistance is reflected in a 30-44% increase in mortality rates, prolonged hospital stays, and rising healthcare costs (College of Family Physicians of Canada, 2016; Dellit *et al*., 2007; Carlet, 2016; Keuleyan, 2017). It is one of the main causes of re-emerging infections. The most threatening to date are tuberculosis, S. Aureus infection, and recently multidrug-resistant *E. coli*. This problem is growing and has the potential to bring down all health systems in the world if not addressed collectively by both individuals and nations (Bégué, 2017; Desenclos and De Valk, 2005).

The determinants of antibiotic resistance are multiple. However, inappropriate and overuse of antibiotics are considered the major cause (College of Family Physicians of Canada, 2016; Sifri *et al*., 2019; Franco *et al*., 2009).

In Morocco, antibiotics are the most consumed drugs. Studies showed that the consumption of antibiotics increased by 25% over 9 years (Inouss *et al*., 2015). They rank third in self-medication treatments. They consume more than 25% of the total drug consumption in the hospital (Oirdi *et al*., 2015). This over-consumption of antibiotics is accompanied by growing resistance to these drugs. The city of Marrakech is also threatened by this problem, with one study showing antibiotic resistance in strains of uropathogenic *Escherichia coli*. Another study showed that 60% of *E. coli* strains were resistant to amoxicillin/clavulanic acid. This limits therapeutic options and represents a real public health problem. In addition, for the first time in the Marrakech region, an emergence of imipenem resistance has been identified.

This justifies urgent action with the public to reduce the use of these drugs, by identifying the factors at the root of antibiotic misuse (Dellit *et al*., 2007). These factors include the existence of an antibiotic treatment already prescribed (Alqarni and Abdulbari, 2019; Nepal and Bhatta, 2018), insufficient knowledge about antibiotics, (Dellit *et al*., 2007; Voidăzan *et al*., 2019), patient self-medication, non-compliance with recommended treatments, abrupt discontinuation of antibiotic treatment after symptoms have been resolved (Sifri *et al*., 2019; Nepal and Bhatta, 2018) and sharing of antibiotics between family members (Nepal and Bhatta, 2018). Other cultural, educational, demographic, and socio-economic factors have been described in the misuse and abuse of antibiotics (Harbarth and Samore, 2005; Touboul-Lundgren *et al*., 2015).

However, it is possible to improve the performance of existing antibiotics by ensuring optimal use of these drugs (World Health Organization, 2016). Excessive use of antimicrobials contributes to the emergence of resistance (Go *et al*., 1994; Madaras-Kelly *et al*., 2006). A reduction in their use reduces this phenomenon, as shown by a study on restricting the use of ciprofloxacin, which led to a reduction in *P. aeruginosa* resistance to group 2 carbapenems (Cook *et al*., 2011).

The aim of this study is therefore to analyze the factors associated with the irrational use of antibiotics, with a view to proposing strategies for the proper use of these drugs adapted to the context of the study.

Materials and Methods

Study Design

This cross-sectional study was carried out from September 2019 to January 2020. The aim of this cross-sectional study was to analyze the factors contributing to the irrational use of antibiotics in the general public of Marrakech who frequent health centers and pharmacies. Participants were selected to ensure adequate representation of the various demographic groups, such as gender, age, and place of residence. The conditions for inclusion were: (1) Residents of the city of Marrakech and (2) Familiar with the word ‘antibiotic’. The study did not include healthcare professionals.

Sampling Methods

We used a stratified sampling method. Ensure adequate coverage of the various demographic groups. The population was divided into homogeneous groups called strata. The strata selected were based on age, gender, and place of residence. We determined the number of people in each stratum using statistics from

the High Commission for Planning for the city of Marrakech. We then established quotas for each stratified group based on the city's demographic structure. We then proceeded to randomly select the health centers and pharmacies in each district, using a pre-established list of establishments in the city of Marrakech. Once the establishments had been selected participants were selected at random.

In each stratum of the independent samples, questionnaires were distributed to individuals who consented to participate in the study and met the inclusion criteria. The confidentiality of the data collected and the purpose of the survey were explained to the participants. Oral consent was requested from participants, while consent for children was obtained from their parents or guardians. The Marrakech University Hospital Research Ethics Committee has approved the study protocol (034/2020) and authorization for data collection has been granted by the Marrakech-Safi Regional Health Department.

We calculated the sample size using a Raosoft sample size calculator (Calculator.net, 2008). The estimated sample size was 271. In the calculation, we used parameters such as a margin of error of 5%, and a response distribution of 50%, as no similar study has been published in Morocco to assess response rates and a confidence interval of 90%, with a total population of 1330468 in the city of Marrakech. However, in order to take into account missing information or unsatisfactory responses, we extended the sample size to 300.

Data Collection

A self-administered questionnaire was used for the survey, with the exception of illiterate people and children, for whom interviews were conducted. The survey was designed on the basis of a literature review of comparative studies (Abu Taha *et al*., 2016), approved by a doctor, an epidemiologist, and a pharmacist, and then tested on a sample of 20 subjects drawn at random from the survey site, but not included in the study. These results were used to check the clarity and comprehensibility of the questions and to confirm their validity.

For each correct answer on knowledge, attitudes and behaviors, we awarded 1 and 0 points for each incorrect or uncertain answer. For each participant, we added up the points obtained for each question to obtain a total score for each domain (knowledge, attitudes and behaviors). The scores calculated were used to assess the level of knowledge about antibiotics as well as the level of attitudes and behavior of the population studied.

The overall median score for the participants' knowledges, attitudes and behavior was then calculated and a score equal to or below the median was interpreted as “Poor level”, while a score above the median was interpreted as “Good level”.

Data Analysis

SPSS software was used to capture, analyze and store data from the completed questionnaires. The socio-demographic characteristics of participants, antibiotic use, knowledge about antibiotics, attitudes and behaviors of study participants towards antibiotic use were described using descriptive statistics. We studied the interaction between the categorical variables using the chi-square test. In the multivariate logistic regression model, variables with a p-value of less than 0.2 were included (Vallin *et al*., 2016).

Results

A total of 300 questionnaires were filled out by the participants in the study frequenting health centers and pharmacies in the city of Marrakech. 269 (89%) of the questionnaires were considered complete and the others were excluded.

Participants’ Characteristics and Antibiotic Use

The population in the age group between 30 and 49 years represents the maximum distribution of participants, followed by the 14-29 age group. Women represent 52%. College/university graduates represent (69.9%) of the participants. 34.3% are single and 65.7% are married (Table 1).

Overall, 69.9% of participants have used an antibiotic in the year preceding the survey, 30.2% at least once 56.6% took antibiotics between 2-4 times, and more than 5 times (13.2%). Of those who had taken antibiotics (n: 188). 65.6% of participants completed their course of antibiotics as prescribed. Self-medication was observed in 38.2%. Respiratory infections were the main reason for the use of antibiotics (50.8%) (Table1).

Participants’ Knowledge of Antibiotic Use

In total, 31% of the participants had a good knowledge of antibiotics. 79.2% of participants gave a correct answer to the question about the effectiveness of antibiotics against bacteria. However, participants also think that "antibiotics are effective against viruses" (56.3%), all germs (42.5%), colds and coughs (61.3%), and fever and pain (62%). 59.5% know that antibiotics cause side effects. 72.5% of participants are aware that overuse of antibiotics renders them ineffective. 36% do not know that antibiotics cause side effects.

Table 1: Demographic and social characteristics of participants (n = 269)

Variable	Frequency (n)	Percentage (%)
Age		
14-29	102	37.9
30-49	120	44.6
>50 years	47	17.5
Gender		
Male	128	47.6
Female	141	52.4
Level of study		
Illiterate	23	8.5
Primary	58	21.6
College	117	43.5
University	71	26.4
Marital status		
Single	92	34.3
Married	177	65.7
Use of antibiotics		
Yes	188	69.9
No.	81	30.1
Compliance with treatment duration		
Yes	122	65.6
No.	64	34.4
Number of antibiotics taken		
<2 times	57	30.2
2-4 times	107	56.6
5 times	25	13.2
How antibiotics are used		
On medical prescriptions	115	61.8
Self-medication	71	38.2
Reasons for taking antibiotics		
Respiratory diseases	90	50.8
Pathologies of the Otorhinolaryngology	35	19.8
Urinary tract diseases	14	7.9
Other	38	21.5

Participants' Attitudes towards Antibiotic Use

More than half of participants (53.9) think it's normal to stop taking an antibiotic once symptoms have improved and around 35.8% of participants believe "that taking fewer antibiotics than prescribed is healthier than following the prescribed course". During cold spells, more than a third of participants (40.8%) believe that using antibiotics will help them recover more quickly. When they felt better, 35.1% of participants thought they should stop taking an antibiotic.

Participants' Behaviors about Antibiotics

Approximately 30.1% of participants have adopted good antibiotic use behaviors. A worrying finding was that more than half of the participants (57.9%) admitted to already having stored antibiotics at home for later use in an emergency. 26.4% of participants will use the remaining antibiotics to treat respiratory infections. Moreover, 45.1% shared their antibiotics with sick relatives. Fortunately, 75.9% of participants followed the instructions on the treatment label, before using antibiotics, 86.8% of participants check the expiry date (Table 2).

Table 2: Participants 'knowledge, attitudes and behaviors about antibiotics

Variable	Yes		No	
	n	(%)	n	(%)
Antibiotic knowledge				
Antibiotics are effective:				
Against Bacteria	213	79.2	56	20.8
Against viruses	151	56.3	117	43.6
Against all germs	114	42.5	154	57.8
In case of fever and pain	167	62.2	101	37.7
In case of colds and coughs	96	35.8	172	64.2
Antibiotics cause side effects	172	64	97	36
Overuse makes them ineffective	195	72.5	74	27.5
Participants ' attitudes about antibiotics				
Taking fewer antibiotics than prescribed is healthier than following the prescribed. course of treatment	101	37.5	168	62.5
When a family member is ill, I have to give them antibiotics	121	45.1	147	54.9
It's normal to stop taking an antibiotic when symptoms improve	152	53.9	127	45.1
Participant behavior				
Sharing antibiotics with others not prescribed to them	99	37.5	165	62.5
Use of an antibiotic originally prescribed for an infection that has income	117	44.5	146	55.5
Use of a TBA initially prescribed for another disease	85	32.3	179	67.7
Respecting the duration of treatment	122	65.6	64	34.4
I usually keep antibiotics at home for emergencies	156	58	113	42
I check the expiration date of antibiotics before taking them	232	86.9	35	13.1

Factors Associated with Knowledge, Attitude and Behavior

Multiple logistic regression analysis model shows that family structure (nuclear) and age groups 30-49 years (OR = 4.012; CI = 1.29-12.45) were significantly linked to knowledge. Nuclear structure (OR = 2.37; CI = 1.03-5.44) had better knowledge compared to the extended structure. The age groups of 30 to 49 years had better knowledge than the age groups of less than 29 years and more than 50 years. (Table 3). Origin, level of education, internet connection, social security coverage, antibiotic use, and marital status are not significantly associated with knowledge.

Social security coverage (OR = 3.202; CI = 1.75-5.84) and gender (OR = 0.47; CI = 0.27-0.82) were significantly associated with attitudes. People with social security coverage had better attitudes than those without social security coverage and women had more appropriate attitudes than men (Table 3).

Family structure (OR = 1.880; CI = 1.01-3.47) was found to be significantly associated with behaviors. The nuclear structure adopts correct behaviors compared to the extended structure (Table 3).

Table 3: Socio-demographic factors associated with knowledge, attitudes, and behaviors

					95% confidence interval	
Knowledge level score of participants		B	Sig.	Exp(B)	Lower terminal	Upper terminal
Good	Constant	-3.578	0			
	[The Origin = Urban]	-0.107	0.801	0.899	0.391	2.064
	[Marital status = Single]	0.425	0.311	1.529	0.673	3.475
	[Social Security Coverage = Yes1]	0.788	0.055	2.2	0.983	4.923
	[The level of education = primary 1.00]	-0.489	0.413	0.613	0.19	1.979
	[Education level = secondary 2.00]	0.825	0.059	2.282	0.968	5.378
	[The age range = under 30 years 1]	1.158	0.064	3.183	0.934	10.848
	[The age range = 30-49 years 2]	1.389	0.016	4.012	1.293	12.452
	[The family structure = nuclear 1.00]	0.864	0.042	2.372	1.033	5.447
	[The number of takes = less than 3 times 1]	0.618	0.108	1.855	0.874	3.94
Participants ' attitude level score [a]						
Good	Constant	-1.067	0.023			
	[study_level = Secondary 2.00]	0.389	0.28	1.476	0.729	2.987
	[Social security coverage=Yes]	1,164	,000	3,202	1.75	5.848
	[struct_familic = Nuclear 1.00]	0.325	0.297	1.384	0.752	2.548
	[sex = Male1]	-0.742	0.008	0.476	0.276	0.822
	[Connection_internt = Yes 1]	-0.032	0.921	0.968	0.511	1.835
Participant behavior level scores [a]						
Good	Constant	-1.684	0.005			
	[The level of study = university 3.00]	b				
	[The Family Structure = Nuclear 1.00]	0.631	0.045	1.88	1.015	3.479
	[gender = Male 1]	-0.427	0.128	0.652	0.377	1.13
	[Monthly family income = less than 2000 DH1]	-0.075	0.905	0.928	0.27	3.192

Table 4: Association between knowledge-attitudes, attitudes-behaviors and knowledge-behaviors

		Knowledge score	Behavior score	Attitude score
Knowledge level score	Correlation coefficient	1	,289**	,227**
	Sig.(bilateral)		0	0
	N	269	269	265
Behavior score	Correlation coefficient	,289**	1	,331**
	Sig.(bilateral)	0		0
	N	269	269	265
Attitude score	Correlation coefficient	,227**	,331**	1
	Sig.(bilateral)	0	0	
	N	265	265	265

******The correlation is significant at the 0.01 level (two-tailed)

The Association between Knowledge-Attitude, Attitude-Behavior, and Knowledge-Behavior

A significant and positive correlation was observed between each pair of knowledge, attitude, and behavior scores ($p =<0.01$) (Table 4).

Discussion

The misuse of antibiotics is considered to be one of the main factors in the development of antibiotic resistance. The concept of 'inappropriate use' refers to the excessive, often unnecessary, consumption of antibiotics and includes overuse, inappropriate prescribing, self-medication, incorrect dosage or incorrect duration of treatment (Rather *et al*., 2017; Haddadin *et al*., 2019).

The inappropriate and abusive use of antibiotics is largely influenced by public behavior, which encourages the development of antibiotic resistance. Over-consumption of antibiotics, self-medication, stopping treatment as soon as symptoms improve, sharing antibiotics and pressure on healthcare professionals to prescribe antibiotics are all examples of incorrect behavior.

The survey showed that 69% of respondents had used antibiotics in the year preceding the survey. This result is lower than in Ethiopia (79.2%) and higher than in Jordan (51.1%), Kosovo (58.7%), and Ireland (39%) (Jifar and Ayele, 2018; Abdel-Qader *et al*., 2020; Zajmi *et al*., 2017; Shebehe *et al*., 2021). The proliferation and spread of resistant bacterial strains are associated with the use of antibiotics (National Library of Medicine, 2013; Read and Woods, 2014). Taking antibiotics generates the appearance of resistance (zur Wiesch *et al*., 2011). One way of slowing down the evolution of antibiotic resistance consists of reducing the natural selection force of resistance genes (Barnett and Linder, 2014).

Several factors may explain this overuse of antibiotics, including their availability over the counter in pharmacies without prescription or diagnosis (Dellit *et al*., 2007), as well as inappropriate prescribing of these drugs (Giraldi *et al*., 2019).

According to this survey, 38.2% of the population self-medicate. This is a worrying finding, as it encourages the development of drug resistance (Richards and Linder, 2021; Lindberg *et al*., 2017; Kumar, 2003). Self-medication is widespread (Silverman *et al*., 2017) and is associated with

incorrect dosages and varying lengths of treatment (Zuckerman *et al*., 2007). Other studies show similar rates (Salihu Dadari, 2020; Yunita *et al*., 2022) and higher than those reported in other studies (Voidăzan *et al*., 2019; Napolitano *et al*., 2013).

Self-medication is mainly based on access to antibiotics without a prescription. In Morocco, this practice remains common, as the results of the study reveal: 80% of participants who had used antibiotics said they had obtained them from a pharmacy without a prescription. This finding is all the more alarming in that it far exceeds the data from a global meta-analysis, which indicates a rate of 62% without a patient request and 78% with a patient request (Auta *et al*., 2019).

Pharmacists point to complacency towards customers who are having difficulty seeing a doctor as the most important predictor of dispensing antibiotics without a prescription. Other important reasons cited by pharmacists include the customer's promise to bring a prescription at a later date, the customer's personal , the customer's unwillingness to see a doctor for a minor infection (Bianco *et al*., 2021) and the fear of losing a customer (Fahey *et al*., 1998; Servia-Dopazo and Figueiras, 2018; Gebretekle and Serbessa, 2016; Dekker *et al*., 2015).

In addition, the literature mentions other factors of interest, namely the expertise and knowledge of pharmacists, easy access to pharmacies, reduced profit margins (Servia-Dopazo and Figueiras, 2018) and the accumulation of drug stocks (Gebretekle and Serbessa, 2016), the weakness of the regulatory enforcement mechanism (Haddadin *et al*., 2019), , as well as public misconceptions regarding the use of antibiotics (Dekker *et al*., 2015).

Public awareness campaigns involving patient-pharmacist communication and pharmacist involvement have proved effective in several countries (Llor *et al*., 2010). It is important that policymakers give high priority to the creation and enforcement of laws prohibiting the sale of antibiotics without a prescription (Bianco *et al*., 2020). In this regard, one study demonstrated a significant decrease in the use of antibiotics without a prescription after the enforcement of a law requiring electronic prescriptions for the dispensing of antibiotics (Kopsidas *et al*., 2023). The effect of educational initiatives has also been demonstrated both on the quality of prescribing and dispensing of antibiotics by primary care professionals and on the responsible use of antibiotics (Rocha *et al*., 2022). Patients often use non-prescription antibiotics based on a previously prescribed course of antibiotics (Grigoryan *et al*., 2006). In our study, 44.3% of participants claimed to have used a previously prescribed antibiotic. A majority of participants (57.9%) admitted having already kept antibiotics at home for urgent needs, a higher rate than that reported in other studies (Rather *et al*., 2017). Nearly 37% of participants reported having already given someone else an antibiotic that had not been prescribed, which is similar to other studies (Haddadin *et al*., 2019). In addition, 45.1% of participants shared their antibiotics with their sick relatives.

These behaviors encourage the incorrect use of antibiotics, which accelerates the emergence of antibiotic resistance. Various actions can be taken to resolve the problem of unused antibiotics. It is essential to monitor and regulate doctors' prescribing methods in order to avoid over-prescribing. Reducing the duration of antibiotic prescriptions to three or five days also helps to reduce the use of remaining antibiotics (McNulty *et al*., 2007). Shorter courses of treatment have been approved in specific situations (Madaras-Kelly *et al*., 2006), the introduction of regulations concerning the use of leftover antibiotics, aimed at distributing precise doses rather than complete boxes and promoting take-back programs for unused medicines (Rogowska and Zimmermann, 2022).

Compliance with treatment is essential to prevent antibiotic resistance and ensure therapeutic efficacy (Bianco *et al*., 2020). In our study, 34.4% of participants stated that they had stopped using antibiotics before the end of treatment and more than a third of participants (37.4%) thought that once the symptoms had disappeared, they should stop the treatment. The same result was shown by a study carried out in Indonesia, and lower than that of a study conducted in Serbia (Yunita *et al*., 2022; Horvat *et al*., 2017). Another important factor in the development of antibiotic resistance is the premature cessation of medical treatment during illness. The explanation for this behavior may be that individuals tend to neglect to take their medication correctly when they start to feel better after their symptoms have disappeared (Voidăzan *et al*., 2019; Institute of Medicine, 2003).

Antibiotic resistance is largely influenced by the inappropriate use of antibiotics for self-limiting conditions such as colds, flu-like symptoms, and sore throats (Hicks *et al*., 2011). According to this study, many participants believe that antibiotics are effective medicines that can fight all types of germs, including viruses. Some 43.3% of them consider antibiotics to be powerful medicines.

These results are lower than those obtained in other research (Kim *et al*., 2011; Lim and Teh, 2012). On the other hand, more than 61% of those questioned thought that antibiotics were effective for colds and coughs, a higher rate than found in other studies carried out in various countries (Abu Taha *et al*., 2016; Pavydė *et al*., 2015).

The study also showed that the public was very enthusiastic about the use of antibiotics for certain illnesses, particularly respiratory diseases (50.8%) and

ear, nose and throat diseases (19.8%). This result is in line with other studies, which have also shown that respiratory symptoms are responsible for the majority of antibiotics prescribed (60%) (Gjelstad *et al*., 2009)

Although current guidelines advocate limited use of antibiotics for respiratory diseases, due to their limited therapeutic efficacy in most cases (Meropol *et al*., 2013), it is clear that they are widely prescribed (Linder, 2013; Gonzales *et al*., 2021) and are the most common reason for antibiotic prescribing in general practice (Haddadin *et al*., 2019; Jifar and Ayele, 2018; Abdel-Qader *et al*., 2020; Zajmi *et al*., 2017; Shebehe *et al*., 2021; National Library of Medicine, 2013; Read and Woods, 2014). In fact, 75% of all antibiotic prescriptions are made in primary care (Read and Woods, 2014).

Over-prescription of antibiotics can be attributed to a number of factors, including the limited length of consultations, which restricts in-depth discussion of treatment options and information on the limited efficacy of antibiotics (Richards and Linder, 2021; Kumar, 2003). Other influential factors include patient expectations (Richards and Linder, 2021; Kumar, 2003; Gulliford *et al*., 2014), doctors 'professional experience, guidelines, fear of not treating the disease correctly, availability of drugs, lack of time and patient complacency (McKay *et al*., 2016; Lee *et al*., 2017), diagnostic uncertainty (Richards and Linder, 2021; Kumar, 2003; McKay *et al*., 2016) and doctors' continuing education (Lee *et al*., 2017; Md Rezal *et al*., 2015; Teixeira Rodrigues *et al*., 2013). In addition, fear of litigation and concerns about the relationship with patients also influence decisions to prescribe antibiotics for respiratory infections (O'Connor *et al*., 2018; Gonzales *et al*., 2021; Avendaño Carvajal and Perret Pérez, 2020).

Pressure from patients requesting antibiotic treatment is the main factor determining the decision to prescribe antibiotics (Gulliford *et al*., 2014; Akkerman *et al*., 2005; Little *et al*., 2002). According to this study, 12.5% of participants will insist that the doctor agrees to prescribe antibiotics for their sick children. This pressure may stem from parental anxiety (Linder, 2013; Akkerman *et al*., 2005; Gonzales *et al*., 2021), the desire to get rid of the infection quickly to avoid any interruption of activities or fear of the unknown (Shapiro *et al*., 2014).

There is considerable evidence of the effectiveness of several strategies aimed at reducing the prescription of antibiotics for acute respiratory infections (Inoue and Minghui, 2017; College of Family Physicians of Canada, 2016; Dellit *et al*., 2007). Clinical trials show that delaying antibiotic prescribing can lead to a safe reduction in antibiotic use, with only 33-39% of patients receiving delayed antibiotic prescriptions actually ending up using them (Little *et al*., 2014; Spurling *et al*., 2017).

In addition, the use of the C-reactive protein test is encouraged in adults with cough (Andreeva and Melbye, 2014). According to the results of clinical trials, this test can also safely reduce the prescription of antibiotics in cases of acute cough (Little *et al*., 2013) and in cases of exacerbation of chronic obstructive pulmonary disease compared with usual care (Butler *et al*., 2019).

In children, strategies combining parent education and changes in clinicians' practices led to a reduction in antibiotic prescriptions of between 6 and 21% (Vodicka *et al*., 2013). Automated prescription reminders were also effective in increasing the appropriateness of prescriptions, whereas passive information such as educational material in the waiting room did not show significant benefits (Granger and Bosworth, 2011).

Prevention methods include raising health awareness and highlighting the problems caused by self-medication. These problems include using an old prescription for antibiotics to treat minor illnesses such as a sore throat and stopping antibiotics when symptoms disappear. A study has shown that media campaigns targeting people with less information are likely to change their consumption behavior (Sachdev *et al*., 2022). Patients need to be made aware of the importance of taking antibiotics as recommended, through effective health education programs. It is crucial to get the message across to educate people not to reuse antibiotics without a proper diagnosis and to understand the nature of their illness (Lee *et al*., 2015). It is also necessary to encourage patients to dispose of unused antibiotics appropriately (Dantuluri *et al*., 2023).

The results of this study showed that various factors have an impact on the knowledge, attitudes, and behaviors of the participants in the study. Knowledge was strongly related to age and family structure. Individuals aged 30-49 were better informed about antibiotics than other ages (14-29 and 50+). This is in line with research carried out in Sweden and Korea (Abdel-Qader *et al*., 2020; Rather *et al*., 2017). However, according to a study conducted in Malaysia, the younger participants were less aware than their elders. In addition, we found that participants living in nuclear family structures had better knowledge than those living in extended family structures. Family structure plays a crucial role in health behaviors and outcomes (McLanahan and Percheski, 2008). Nuclear families consist of either a couple and their unmarried children, a mother (or father) with her unmarried children, or a group of brothers and sisters who are all unmarried. A study of the Moroccan population revealed that nuclear families enjoy certain advantages over complex families, such as lower illiteracy rates and lower population density per room (Haut Commissariat au Plan, 2024). This enables parents to exert a more direct influence and to pass on their knowledge and behavior in a more controlled and consistent way, thus promoting better education on specific subjects such as the appropriate use of antibiotics.

Extended families, on the other hand, are made up of several family nuclei, possibly with isolated members, making them more complex and heterogeneous. They often retain traditional values such as honor, respect, mutual aid, and solidarity (Haut Commissariat au Plan, 2024) Members of these families tend to share antibiotics, either because of physical proximity or because of cultural beliefs about sharing healthcare resources. This practice of self-medication can lead to inappropriate use of antibiotics, which partly explains the prevalence of antibiotic sharing. Awareness campaigns on the dangers of self-medication and sharing antibiotics could be particularly effective in communities where extended families are predominant.

Social security coverage and gender also showed a significant association with attitudes. In our study, people with social security coverage showed good attitudes towards the use of antibiotics. In addition, women had more appropriate attitudes to antibiotic use than men. These results are consistent with those observed in Sweden (Abdel-Qader *et al*., 2020). Numerous studies show that men often feel the need to conform to an ideal of masculinity, which frequently leads them to delay taking charge of their health and opt for self-medication. For example, they may wait until they are physically unable to work, even in the case of serious illnesses such as tuberculosis (Daniels *et al*., 2021).

The study revealed a positive relationship between knowledge, attitudes, and behavior. Indeed, to influence behavior, it is essential to increase knowledge about antibiotics and reduce misconceptions about their use. This conclusion is supported by other research (Horvat *et al*., 2017; Karuniawati *et al*., 2021). This shows that increased knowledge leads to more appropriate use of antibiotics (Karuniawati *et al*., 2021; Nepal *et al*., 2019). These results underline the importance of health education and awareness campaigns targeting the general public, particularly the age group between 14-29 and 50+, the elongated structure, the male gender, and people without social security cover. Studies have shown that campaigns can reduce overall antibiotic consumption, but find it difficult to sustain these successes over time (Alqarni and Abdulbari, 2019; Nepal and Bhatta, 2018). Experience from other public health campaigns shows that repeated exposure of the target audience over long periods is often necessary to have a lasting effect (Voidăzan *et al*., 2019; Touboul-Lundgren *et al*., 2015). It is therefore essential to raise public awareness of the appropriate use of antibiotics and to implement communication strategies aimed at correcting false beliefs and unrealistic expectations.

Limitations

This study has several strong points. Firstly, the use of stratified sampling ensures a balanced representation of women and men and of all the target age groups, while guaranteeing diversity in terms of levels of education. This approach helps to ensure that the population studied is more representative. Moreover, the high response rate obtained in the study reduces the bias associated with non-response and means that the results can be generalized to the entire population studied.

Another important advantage of this study is the anonymous administration of the questionnaire. This helps to reduce the potential bias associated with participants' willingness to report socially desirable behaviors rather than their actual responses. It is also important to note that healthcare staff were excluded from the study. This exclusion is beneficial as it reduces the risk of overestimating positive results, given that healthcare professionals may have greater knowledge of or compliance with recommended health behaviors. In addition, the fact that the participants completed the questionnaire on-site also reduces the risk of overestimating the positive results.

However, this study also has a number of limitations that need to be taken into account. Firstly, it should be noted that the data set used was all cross-sectional in nature, which restricts the ability to establish causal links between responses and predictive factors. In addition, it is possible that the people who agreed to take part in this study on antibiotics were more interested or better informed on the subject than the general population. It is also important to emphasize that the data for this study were collected from questionnaires, which relied on self-reporting by the participants. Practices and knowledge were reported by the participants themselves, which may introduce memory or subjectivity bias. Another limitation of our study is the small sample size. Despite the precautions taken to ensure the representativeness of the sample using a stratified sampling method, the size of the sample could limit the scope of our conclusions. Future research with larger samples could provide a more robust validation of our results.

Conclusion

Promoting the appropriate use of antibiotics is key to improving public behavior. The results of this research would be useful in developing more effective public education and awareness initiatives, with the aim of improving knowledge, attitudes, and practices related to antibiotic use in the general population. Awareness programs should preferably target young people aged 29-30, people over 50, extended families, men, and people without medical insurance. These information and awareness campaigns should be included in public health programs.

To maximize the effectiveness of these awareness-raising campaigns, the initial and ongoing training of healthcare professionals must be stepped up so that they can better inform their patients about the use of antibiotics. In addition, professional and consumer organizations can

significantly influence awareness. What's more, a limited number of clear messages concerning the rational use of antibiotics should be selected.

It is also interesting to develop regional databases to collect information on antibiotic use, while setting up early warning systems to detect worrying trends in antibiotic use.

Acknowledgment

We would like to thank all the people who participated in this study for their time and all the nurses for their help. We also thank Mr. Ettifak Aziz and Mr. Amerzeg Mbarek for English editing.

Funding Information

This research received no external funding

Author's Contributions

Naima Aoutil1: Drafting the article, acquisition of data analysis, and interpretation of data.

Mohammed Cherkaoui: Analysis and interpretation of data, reviewing, and final approval.

Mohammed Bouskraoui: Conception and design, reviewing, final approval.

Ethics

Informed consent was obtained from all participants and their legal guardian(s).

The study protocol was approved by the institutional research ethics committee of the University Hospital of Marrakech (registration number: 034/2020), as well as the authorization of data collection from the Regional Directorate of Health of the Marrakech-Safi region.

All methods were carried out in accordance with current guidelines and regulations

Reference

Abdel-Qader, D. H., Albassam, A., Ismael, N. S., El-Shara', A. A., Shehri, A., Almutairi, F. S., Al-Harbi, D. M., Al Zahrani, M. M., Chen, L.-C., Al Mazrouei, N., & Mohamed Ibrahim, O. (2020). Awareness of Antibiotic Use and Resistance in Jordanian Community. *Journal of Primary Care & Community Health*, *11*, 2150132720961255. https://doi.org/10.1177/2150132720961255

Abu Taha, A., Abu-Zaydeh, A. H., Ardah, R. A., Al-Jabi, S. W., Sweileh, W. M., Awang, R., & Zyoud, S. H. (2016). Public Knowledge and Attitudes Regarding the Use of Antibiotics and Resistance: Findings from a Cross-Sectional Study among Palestinian Adults. *Zoonoses and Public Health*, *63*(6), 449–457. https://doi.org/10.1111/zph.12249

Akkerman, A. E., Kuyvenhoven, M. M., van der Wouden, J. C., & Verheij, T. J. M. (2005). Determinants of antibiotic overprescribing in respiratory tract infections in general practice. *Journal of Antimicrobial Chemotherapy*, *56*(5), 930–936. https://doi.org/10.1093/jac/dki283

Alqarni, S. A., & Abdulbari, M. (2019). Knowledge and attitude towards antibiotic use among consumers in Alkharj, Saudi Arabia. *Saudi Pharmaceutical Journal*, *27*(1), 106–111. https://doi.org/10.1016/j.jsps.2018.09.003

Andreeva, E., & Melbye, H. (2014). Usefulness of C-reactive protein testing in acute cough/respiratory tract infection: an open cluster-randomized clinical trial with C-reactive protein testing in the intervention group. *BMC Family Practice*, *15*(1), 80. https://doi.org/10.1186/1471-2296-15-80

Auta, A., Hadi, M. A., Oga, E., Adewuyi, E. O., Abdu-Aguye, S. N., Adeloye, D., Strickland-Hodge, B., & Morgan, D. J. (2019). Global access to antibiotics without prescription in community pharmacies: A systematic review and meta-analysis. In *Journal of Infection* (Vol. *78*, Issue 1, pp. 8–18). https://doi.org/10.1016/j.jinf.2018.07.001

Avendaño Carvajal, L., & Perret Pérez, C. (2020). Epidemiology of Respiratory Infections. *Pediatric Respiratory Diseases: A Comprehensive Textbook*, 263–272. https://doi.org/10.1007/978-3-030-26961-6_28

Barnett, M. L., & Linder, J. A. (2014). Antibiotic Prescribing for Adults with Acute Bronchitis in the United States, 1996-2010. *JAMA*, *311*(19), 2020. https://doi.org/10.1001/jama.2013.286141

Bégué, P. (2017). Séance commune de l'Académie nationale de médecine et de l'Académie d'Agriculture de France : « Émergence des maladies infectieuses : causes, détection, prévision ». *Bulletin de l'Académie Nationale de Médecine*, *201*(7–9), 1203–1207. https://doi.org/10.1016/s0001-4079(19)30414-5

Bianco, A., Licata, F., Trovato, A., Napolitano, F., & Pavia, M. (2021). Antibiotic-Dispensing Practice in Community Pharmacies: Results of a Cross-Sectional Study in Italy. In *Antimicrobial Agents and Chemotherapy* (Vol. 65, Issue 6). https://doi.org/10.1128/aac.02729-20

Bianco, A., Licata, F., Zucco, R., Papadopoli, R., & Pavia, M. (2020). Knowledge and practices regarding antibiotics use. *Evolution, Medicine and Public Health*, *2020*(1), 129–138. https://doi.org/10.1093/emph/eoaa028

Butler, C. C., Gillespie, D., White, P., Bates, J., Lowe, R., Thomas-Jones, E., Wootton, M., Hood, K., Phillips, R., Melbye, H., Llor, C., Cals, J. W. L., Naik, G., Kirby, N., Gal, M., Riga, E., & Francis, N. A. (2019). C - reactive protein testing to Guide Antibiotic Prescribing for COPD Exacerbations. *New England Journal of Medicine*, *381*(2), 111–120. https://doi.org/10.1056/nejmoa1803185

Calculator.Net. (2008). Sample Size Calculator. *Calculator.Net*. https://www.calculator.net/sample-size-calculator.html

Carlet, J. (2016). Réveillons-nous, la résistance aux antibiotiques devient un problème de santé publique dramatique! *Journal Des Anti-Infectieux*, *18*(2), 37–39. https://doi.org/10.1016/j.antinf.2016.01.005

College of Family Physicians of Canada and others. (2016). La résistance aux antimicrobiens : une menace à la santé mondiale. *Canadian Family Physician*, *62*(11), e659–e660.

Cook, P. P., Rizzo, S., Gooch, M., Jordan, M., Fang, X., & Hudson, S. (2011). Sustained reduction in antimicrobial use and decrease in methicillin-resistant Staphylococcus aureus and Clostridium difficile infections following implementation of an electronic medical record at a tertiary-care teaching hospital. *Journal of Antimicrobial Chemotherapy*, *66*(1), 205–209. https://doi.org/10.1093/jac/dkq404

Daniels, J., Medina-Marino, A., Glockner, K., Grew, E., Ngcelwane, N., & Kipp, A. (2021). Masculinity, resources and retention in care: South African men's behaviors and experiences while engaged in TB care and treatment. *Social Science & Medicine*, *270*, 113639. https://doi.org/10.1016/j.socscimed.2020.113639

Dantuluri, K. L., Bonnet, K. R., Schlundt, D. G., Schulte, R. J., Griffith, H. G., Luu, A., Charnogursky, C., Perkins, J. M., Whitmore, C. C., Banerjee, R., Howard, L. M., & Grijalva, C. G. (2023). Antibiotic perceptions, adherence and disposal practices among parents of pediatric patients. *PLOS ONE*, *18*(2), e0281660. https://doi.org/10.1371/journal.pone.0281660

Dekker, A. R. J., Verheij, T. J. M., & van der Velden, A. W. (2015). Inappropriate antibiotic prescription for respiratory tract indications: most prominent in adult patients. *Family Practice*, *34*(4), 401–407. https://doi.org/10.1093/fampra/cmv019

Desenclos, J.-C., & De Valk, H. (2005). Emergent infectious diseases: importance for public health, epidemiology, promoting factors and prevention. *Medecine et Maladies Infectieuses*, *35*(2), 49–61. https://doi.org/10.1016/j.medmal.2004.09.005

Dellit, T. H., Owens, R. C., McGowan, J. E., Gerding, D. N., Weinstein, R. A., Burke, J. P., Huskins, W. C., Paterson, D. L., Fishman, N. O., Carpenter, C. F., Brennan, P. J., Billeter, M., & Hooton, T. M. (2007). Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America Guidelines for Developing an Institutional Program to Enhance Antimicrobial Stewardship. *Clinical Infectious Diseases*, *44*(2), 159–177. https://doi.org/10.1086/510393

Fahey, T., Stocks, N., & Thomas, T. (1998). Systematic review of the treatment of upper respiratory tract infection. *Archives of Disease in Childhood*, *79*(3), 225–230. https://doi.org/10.1136/adc.79.3.225

Franco, B. E., Martínez, M. A., Rodríguez, M. A. S., & Wertheimer, A. I. (2009). The determinants of the antibiotic resistance process. *Infection and Drug Resistance*, *2*, 1–11. https://doi.org/10.2147/IDR.S4899

Gebretekle, G. B., & Serbessa, M. K. (2016). Exploration of over the counter sales of antibiotics in community pharmacies of Addis Ababa, Ethiopia: pharmacy professionals' perspective. *Antimicrobial Resistance & Infection Control*, *5*(1), 2. https://doi.org/10.1186/s13756-016-0101-z

Giraldi, G., Montesano, M., Napoli, C., Frati, P., La Russa, R., Santurro, A., Scopetti, M., & Orsi, G. B. (2019). Healthcare-Associated Infections Due to Multidrug-Resistant Organisms: a Surveillance Study on Extra Hospital Stay and Direct Costs. *Current Pharmaceutical Biotechnology*, *20*(8), 643–652. https://doi.org/10.2174/1389201020666190408095811

Gjelstad, S., Dalen, I., & Lindbæk, M. (2009). GPs' antibiotic prescription patterns for respiratory tract infections – still room for improvement. *Scandinavian Journal of Primary Health Care*, *27*(4), 208–215. https://doi.org/10.3109/02813430903438718

Go, E. S., Urban, C., Burns, J., Mariano, N., Mosinka-Snipas, K., Rahal, J. J., Kreiswirth, B., & Eisner, W. (1994). Clinical and molecular epidemiology of acinetobacter infections sensitive only to polymyxin B and sulbactam. *The Lancet*, *344*(8933), 1329–1332. https://doi.org/10.1016/s0140-6736(94)90694-7

Gonzales, R., Malone, D. C., Maselli, J. H., & Sande, M. A. (2001). Excessive Antibiotic Use for Acute Respiratory Infections in the United States. *Clinical Infectious Diseases*, *33*(6), 757–762. https://doi.org/10.1086/322627

Granger, B. B., & Bosworth, H. B. (2011). Medication adherence: emerging use of technology. *Current Opinion in Cardiology*, *26*(4), 279–287. https://doi.org/10.1097/hco.0b013e328347c150

Grigoryan, L., Haaijer-Ruskamp, F. M., Burgerhof, J. G. M., Mechtler, R., Deschepper, R., Tambic-Andrasevic, A. andrajati, R., Monnet, D. L., Cunney, R., Di Matteo, A., Edelstein, H., Valinteliene, R., Alkerwi, A., Scicluna, E. A., Grzesiowski, P., Bara, A.-C., Tesar, T., Cizman, M., Campos, J., … Birkin, J. (2006). Self-medication with Antimicrobial Drugs in Europe. *Emerging Infectious Diseases*, *12*(3), 452–459. https://doi.org/10.3201/eid1203.050992

Gulliford, M. C., Dregan, A., Moore, M. V., Ashworth, M., Staa, T. van, McCann, G., Charlton, J., Yardley, L., Little, P., & McDermott, L. (2014). Continued high rates of antibiotic prescribing to adults with respiratory tract infection: Survey of 568 UK general practices. *BMJ Open*, *4*(10), e006245. https://doi.org/10.1136/bmjopen-2014-006245

Haddadin, R. N., Alsous, M., Wazaify, M., & Tahaineh, L. (2019). Evaluation of antibiotic dispensing practice in community pharmacies in Jordan: A cross sectional study. *PLOS ONE*, *14*(4), e0216115. https://doi.org/10.1371/journal.pone.0216115

Haut Commissariat au Plan. (2024), Famille au Maroc: les réseaux de la solidarité familiale. Chapitre 1: Structures et caractéristiques des familles au Maroc. Disponible sur: https://www.hcp.ma/Famille-au-Maroc-les-reseaux-de-la-solidarite-familiale-Chapitre-1-Structures-et-caracteristiques-des-familles-au-Maroc_a3335.html

Harbarth, S., & Samore, M. H. (2005). Antimicrobial Resistance Determinants and Future Control. *Emerging Infectious Diseases*, *11*(6), 794–801. https://doi.org/10.3201/eid1106.050167

Hicks, L. A., Chien, Y.-W., Taylor, T. H., Haber, M., & Klugman, K. P. (2011). Outpatient Antibiotic Prescribing and Nonsusceptible Streptococcus pneumoniae in the United States, 1996-2003. *Clinical Infectious Diseases*, *53*(7), 631–639. https://doi.org/10.1093/cid/cir443

Horvat, O. J., Tomas, A. D., Paut Kusturica, M. M., Savkov, A. V., Bukumirić, D. U., Tomić, Z. S., & Sabo, A. J. (2017). Is the level of knowledge a predictor of rational antibiotic use in Serbia? *PLOS ONE*, *12*(7), e0180799. https://doi.org/10.1371/journal.pone.0180799

Hounet, Y. B., & Rupert, N. (2021). Chapter 2 – The application of family law in Morocco. *Centre Jacques-Berque*, 33–44. https://doi.org/10.4000/books.cjb.1772

Inoue, H., & Minghui, R. (2017). Antimicrobial resistance: translating political commitment into national action. *Bulletin of the World Health Organization*, *95*(4), 242–242. https://doi.org/10.2471/blt.17.191890

Inouss, H., Ahid, S., Belaiche, A., & Cherrah, Y. (2015). Évolution de la consommation des antibiotiques au Maroc (2003–2012). *Revue d'Épidémiologie et de Santé Publique*, *63*, S78. https://doi.org/10.1016/j.respe.2015.03.093

Institute of Medicine. (2003). *The Resistance Phenomenon in Microbes and Infectious Disease Vectors: Implications for Human Health and Strategies for Containment: Workshop Summary*. https://doi.org/10.17226/10651

Jifar, Al., & Ayele, Y. (2018). Assessment of Knowledge, Attitude and Practice toward Antibiotic Use among Harar City and Its Surrounding Community, Eastern Ethiopia. *Interdisciplinary Perspectives on Infectious Diseases*, *2018*, 1–6. https://doi.org/10.1155/2018/8492740

Karuniawati, H., Hassali, M. A. A., Suryawati, S., Ismail, W. I., Taufik, T., & Hossain, Md. S. (2021). Assessment of Knowledge, Attitude and Practice of Antibiotic Use among the Population of Boyolali, Indonesia: A Cross-Sectional Study. *International Journal of Environmental Research and Public Health*, *18*(16), 8258. https://doi.org/10.3390/ijerph18168258

Keuleyan, E. (2017). Antimicrobial Stewardship - A Strategic Task in Institutional and National Healthcare. *Journal of IMAB - Annual Proceeding (Scientific Papers)*, *23*(4), 1808–1812. https://doi.org/10.5272/jimab.2017234.1808

Kim, S. S., Moon, S., & Kim, E. J. (2011). Public Knowledge and Attitudes Regarding Antibiotic Use in South Korea. *Journal of Korean Academy of Nursing*, *41*(6), 742–749. https://doi.org/10.4040/jkan.2011.41.6.742

Kopsidas, I., Kokkinidou, L., Petsiou, D. P., Kourkouni, E., Triantafyllou, C., Tsopela, G.-C., & Zaoutis, T. (2023). Dispensing of antibiotics without prescription in the metropolitan area of Athens, Greece, in 2021—Can new legislation change old habits? *Antimicrobial Stewardship & Healthcare Epidemiology*, *3*(1), e40. https://doi.org/10.1017/ash.2022.357

Kumar, S. (2003). Why do general practitioners prescribe antibiotics for sore throat? Grounded theory interview study. In *BMJ* (Vol. 326, Issue 7381, pp. 138–138). https://doi.org/10.1136/bmj.326.7381.138

Lee, C.-R., Lee, J. H., Kang, L.-W., Jeong, B. C., & Lee, S. H. (2015). Educational Effectiveness, Target and Content for Prudent Antibiotic Use. *BioMed Research International*, *2015*, 1–13. https://doi.org/10.1155/2015/214021

Lee, T.-H., Wong, J. G., Lye, D. C., Chen, M. I., Loh, V. W., Leo, Y.-S., Lee, L. K., & Chow, A. L. (2017). Medical and psychosocial factors associated with antibiotic prescribing in primary care: survey questionnaire and factor analysis. *British Journal of General Practice*, *67*(656), e168–e177. https://doi.org/10.3399/bjgp17x688885

Lim, K. K., & Teh, C. C. (2012). A Cross Sectional Study of Public Knowledge and Attitude towards Antibiotics in Putrajaya, Malaysia. *South Med Rev*, *5*(2), 26–33.

Lindberg, B. H., Gjelstad, S., Foshaug, M., & Høye, S. (2017). Antibiotic prescribing for acute respiratory tract infections in Norwegian primary care out-of-hours service. In *Scandinavian Journal of Primary Health Care* (Vol. 35, Issue 2, pp. 178–185). https://doi.org/10.1080/02813432.2017.1333301

Linder, J. A. (2013). Antibiotic Prescribing for Acute Respiratory Infections—Success That's Way Off the Mark. *JAMA Internal Medicine*, *173*(4), 273–275. https://doi.org/10.1001/jamainternmed.2013.1984

Little, P., Moore, M., Kelly, J., Williamson, an, Leydon, G., McDermott, L., Mullee, M., & Stuart, B. (2014). Delayed antibiotic prescribing strategies for respiratory tract infections in primary care: pragmatic, factorial, randomised controlled trial. *BMJ*, *348*, g1606. https://doi.org/10.1136/bmj.g1606

Little, P., Stuart, B., Francis, N., Douglas, E., Tonkin-Crine, S., Anthierens, S., Cals, J. W., Melbye, H., Santer, M., Moore, M., Coenen, S., Butler, C., Hood, K., Kelly, M., Godycki-Cwirko, M., Mierzecki, A., Torres, A., Llor, C., Davies, M.,… Yardley, L. (2013). Effects of internet-based training on antibiotic prescribing rates for acute respiratory-tract infections: a multinational, cluster, randomised, factorial, controlled trial. *The Lancet*, *382*(9899), 1175–1182. https://doi.org/10.1016/s0140-6736(13)60994-0

Little, P., Watson, L., Morgan, S., & Williamson, I. (2002). Antibiotic prescribing and admissions with major suppurative complications of respiratory tract infections: a data linkage study. *British Journal of General Practice*, *52*(476), 187–193.

Llor, C., Monnet, D. L., & Cots, J. M. (2010). Small pharmacies are more likely to dispense antibiotics without a medical prescription than large pharmacies in Catalonia, Spain. *Eurosurveillance*, *15*(32), 19635. https://doi.org/10.2807/ese.15.32.19635-en

Madaras-Kelly, K. J., Remington, R. E., Lewis, P. G., & Stevens, D. L. (2006). Evaluation of an Intervention Designed to Decrease the Rate of Nosocomial Methicillin-Resistant*Staphylococcus aureus* Infection by Encouraging Decreased Fluoroquinolone Use. *Infection Control & Hospital Epidemiology*, *27*(2), 155–169. https://doi.org/10.1086/500060

McKay, R., Mah, A., Law, M. R., McGrail, K., & Patrick, D. M. (2016). Systematic Review of Factors Associated with Antibiotic Prescribing for Respiratory Tract Infections. *Antimicrobial Agents and Chemotherapy*, *60*(7), 4106–4118. https://doi.org/10.1128/aac.00209-16

McLanahan, S., & Percheski, C. (2008). Family Structure and the Reproduction of Inequalities. *Annual Review of Sociology*, *34*(1), 257–276. https://doi.org/10.1146/annurev.soc.34.040507.134549

McNulty, C. A. M., Boyle, P., Nichols, T., Clappison, P., & Davey, P. (2007). The public's attitudes to and compliance with antibiotics. *Journal of Antimicrobial Chemotherapy*, *60*(suppl_1), i63–i68. https://doi.org/10.1093/jac/dkm161

Md Rezal, R. S., Hassali, M. A., Alrasheedy, A. A., Saleem, F., Md Yusof, F. A., & Godman, B. (2015). Physicians' knowledge, perceptions and behaviour towards antibiotic prescribing: a systematic review of the literature. *Expert Review of Anti-Infective Therapy*, *13*(5), 665–680. https://doi.org/10.1586/14787210.2015.1025057

Meropol, S. B., Localio, A. R., & Metlay, J. P. (2013). Risks and Benefits Associated With Antibiotic Use for Acute Respiratory Infections: A Cohort Study. *The Annals of Family Medicine*, *11*(2), 165–172. https://doi.org/10.1370/afm.1449

Morens, D. M., Folkers, G. K., & Fauci, A. S. (2004). The challenge of emerging and re-emerging infectious diseases. *Nature*, *430*(6996), 242–249. https://doi.org/10.1038/nature02759

Napolitano, F., Izzo, M. T., Di Giuseppe, G., & Angelillo, I. F. (2013). Public Knowledge, Attitudes and Experience Regarding the Use of Antibiotics in Italy. In *PLoS ONE* (Vol. 8, Issue 12, p. e84177). https://doi.org/10.1371/journal.pone.0084177

National Library of Medicine. (2013). The antibiotic alarm. *Nature*, *495*(7440), 141. https://doi.org/10.1038/495141a

Nepal, A., Hendrie, D., Robinson, S., & Selvey, L. A. (2019). Knowledge, attitudes and practices relating to antibiotic use among community members of the Rupandehi District in Nepal. *BMC Public Health*, *19*(1), 1558. https://doi.org/10.1186/s12889-019-7924-5

Nepal, G., & Bhatta, S. (2018). Self-medication with Antibiotics in WHO Southeast Asian Region: A Systematic Review. *Cureus*, *10*(4), e2428. https://doi.org/10.7759/cureus.2428

O'Connor, R., O'Doherty, J., O'Regan, A., & Dunne, C. (2018). Antibiotic use for acute respiratory tract infections (ARTI) in primary care; what factors affect prescribing and why is it important? A narrative review. *Irish Journal of Medical Science (1971 -)*, *187*(4), 969–986. https://doi.org/10.1007/s11845-018-1774-5

Oirdi, M., Cherrah, Y., & Ahid, S. (2015). Profil de l'automédication chez des patients dans la région de Rabat-Salé-Zemmour-Zair, Maroc. *Revue d'Épidémiologie et de Santé Publique*, *63*, S78. https://doi.org/10.1016/j.respe.2015.03.092

Pavydė, E., Veikutis, V., Mačiulienė, A., Mačiulis, V., Petrikonis, K., & Stankevičius, E. (2015). Public Knowledge, Beliefs and Behavior on Antibiotic Use and Self-Medication in Lithuania. *International Journal of Environmental Research and Public Health*, *12*(6), 7002–7016. https://doi.org/10.3390/ijerph120607002

Piddock, L. J. (2012). The crisis of no new antibiotics—what is the way forward? *The Lancet Infectious Diseases*, *12*(3), 249–253. https://doi.org/10.1016/s1473-3099(11)70316-4

Rather, I. A., Kim, B.-C., Bajpai, V. K., & Park, Y.-H. (2017). Self-medication and antibiotic resistance: Crisis, current challenges and prevention. *Saudi Journal of Biological Sciences*, *24*(4), 808–812. https://doi.org/10.1016/j.sjbs.2017.01.004

Read, A. F., & Woods, R. J. (2014). Antibiotic resistance management. *Evolution, Medicine and Public Health*, *2014*(1), 147. https://doi.org/10.1093/emph/eou024

Richards, A. R., & Linder, J. A. (2021). Behavioral Economics and Ambulatory Antibiotic Stewardship: A Narrative Review. In *Clinical Therapeutics* (Vol. 43, Issue 10, pp. 1654–1667). https://doi.org/10.1016/j.clinthera.2021.08.004

Rocha, V., Estrela, M., Neto, V., Roque, F., Figueiras, A., & Herdeiro, M. T. (2022). Educational Interventions to Reduce Prescription and Dispensing of Antibiotics in Primary Care: A Systematic Review of Economic Impact. *Antibiotics*, *11*(9), 1186. https://doi.org/10.3390/antibiotics11091186

Rogowska, J., & Zimmermann, A. (2022). Household Pharmaceutical Waste Disposal as a Global Problem—A Review. *International Journal of Environmental Research and Public Health*, *19*(23), 15798. https://doi.org/10.3390/ijerph192315798

Sachdev, C., Anjankar, A., & Agrawal, J. (2022). Self-Medication with Antibiotics: An Element Increasing Resistance. *Cureus*, *14*(10), e30844. https://doi.org/10.7759/cureus.30844

Salihu Dadari, H. I. (2020). Antibiotics use, knowledge and practices on antibiotic resistance among breastfeeding mothers in Kaduna state (Nigeria). In *Journal of Infection and Public Health* (Vol. 13, Issue 12, pp. 2072–2079). https://doi.org/10.1016/j.jiph.2019.05.008

Servia-Dopazo, M., & Figueiras, A. (2018). Determinants of antibiotic dispensing without prescription: a systematic review. *Journal of Antimicrobial Chemotherapy*, *73*(12), 3244–3253. https://doi.org/10.1093/jac/dky319

Shapiro, D. J., Hicks, L. A., Pavia, A. T., & Hersh, A. L. (2014). Antibiotic prescribing for adults in ambulatory care in the USA, 2007–09. *Journal of Antimicrobial Chemotherapy*, *69*(1), 234–240. https://doi.org/10.1093/jac/dkt301

Shebehe, J., Ottertun, E., Carlén, K., & Gustafson, D. (2021). Knowledge about infections is associated with antibiotic use: cross-sectional evidence from the health survey Northern Ireland. *BMC Public Health*, *21*(1), 1041. https://doi.org/10.1186/s12889-021-11018-x

Sifri, Z., Chokshi, A., Cennimo, D., & Horng, H. (2019). Global contributors to antibiotic resistance. *Journal of Global Infectious Diseases*, *11*(1), 36–42. https://doi.org/10.4103/jgid.jgid_110_18

Silverman, M., Povitz, M., Sontrop, J. M., Li, L., Richard, L., Cejic, S., & Shariff, S. Z. (2017). Antibiotic Prescribing for Nonbacterial Acute Upper Respiratory Infections in Elderly Persons. In *Annals of Internal Medicine* (Vol. *166*, Issue 11, pp. 765–774). https://doi.org/10.7326/m16-1131

Spurling, G. K., Del Mar, C. B., Dooley, L., Clark, J., & Askew, D. A. (2017). Delayed antibiotic prescriptions for respiratory infections. *Cochrane Database of Systematic Reviews*, *9*. https://doi.org/10.1002/14651858.CD004417.pub5

Teixeira Rodrigues, A., Roque, F., Falcão, A., Figueiras, A., & Herdeiro, M. T. (2013). Understanding physician antibiotic prescribing behaviour: a systematic review of qualitative studies. *International Journal of Antimicrobial Agents*, *41*(3), 203–212. https://doi.org/10.1016/j.ijantimicag.2012.09.003

Touboul-Lundgren, P., Jensen, S., Drai, J., & Lindbæk, M. (2015). Identification of cultural determinants of antibiotic use cited in primary care in Europe: a mixed research synthesis study of integrated design "Culture is all around us." *BMC Public Health*, *15*(1), 908. https://doi.org/10.1186/s12889-015-2254-8

Vallin, M., Polyzoi, M., Marrone, G., Rosales-Klintz, S., Tegmark Wisell, K., & Stålsby Lundborg, C. (2016). Knowledge and Attitudes towards Antibiotic Use and Resistance - A Latent Class Analysis of a Swedish Population-Based Sample. *PLOS ONE*, *11*(4), e0152160. https://doi.org/10.1371/journal.pone.0152160

Vodicka, T. A., Thompson, M., Lucas, P., Heneghan, C., Blair, P. S., Buckley, D. I., Redmond, N., & Hay, A. D. (2013). Reducing antibiotic prescribing for children with respiratory tract infections in primary care: a systematic review. *British Journal of General Practice*, *63*(612), e445–e454. https://doi.org/10.3399/bjgp13x669167

Voidăzan, S., Moldovan, G., Voidăzan, L., Zazgyva, A., & Moldovan, H. (2019). Knowledge, Attitudes and Practices Regarding the Use of Antibiotics. Study on the General Population of Mureş County, Romania. *Infection and Drug Resistance*, *12*, 3385–3396. https://doi.org/10.2147/idr.s214574

World Health Organization. (2016). Plan d'action mondial pour combattre la résistance aux antimicrobiens. *Organisation Mondiale de La Santé*. https://www.who.int/fr/publications-detail/9789241509763

Yunita, S. L., Yang, H.-W., Chen, Y.-C., Kao, L.-T., Lu, Y.-Z., Wen, Y.-L., To, S.-Y., & Huang, Y.-L. (2022). Knowledge and practices related to antibiotic use among women in Malang, Indonesia. In *Frontiers in Pharmacology* (Vol. *13*, p. 1019303). https://doi.org/10.3389/fphar.2022.1019303

Zajmi, D., Berisha, M., Begolli, I., Hoxha, R., Mehmeti, R., Mulliqi-Osmani, G., Kurti, A., Loku, A., & Raka, L. (2017). Public knowledge, attitudes and practices regarding antibiotic use in Kosovo. *Pharmacy Practice*, *15*(1), 827–827. https://doi.org/10.18549/pharmpract.2017.01.827

Zuckerman, I. H., Perencevich, E. N., & Harris, A. D. (2007). Concurrent acute illness and comorbid conditions poorly predict antibiotic use in upper respiratory tract infections: a cross-sectional analysis. In *BMC Infectious Diseases* (Vol. *7*, Issue 1, p. 47). https://doi.org/10.1186/1471-2334-7-47

zur Wiesch, P. A., Kouyos, R., Engelstädter, J., Regoes, R. R., & Bonhoeffer, S. (2011). Population biological principles of drug-resistance evolution in infectious diseases. *The Lancet Infectious Diseases*, *11*(3), 236–247. https://doi.org/10.1016/s1473-3099(10)70264-4