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Association between bacteria resistance against antibiotics and people's behavior and general knowledge about in antibiotic consumption.

Abstract

Nowadays, antibiotics play a significant role in every healthcare system worldwide. One of the most important challenges with antibiotics is bacterial resistance against them which means the curing effects of antibiotics are being decreased by consuming antibiotics excessively or using them without a physician's order. This was a cross-sectional study based on a structured questionnaire. The population who participated in this study was 300 people, who were selected randomly from ordinary adults without considering any specifications. The analysis was performed in August 2022. The majority of the participants have reliable knowledge about antibiotic usage. Self-medication with antibiotics (SMA) is seen in 38.8% of the educated and 41.2% of the uneducated groups. 25.5% of those with a past medical history and 43.3% of people without a past medical history have experience taking medicine without a prescription. Amoxycillin is the 1st (28%), Cefixime is the 2nd (15%), and Azithromycin is the 3rd most without-prescription used antibiotic. The academic education and non-prescriptive usage of antibiotics in our statistical society are not related, and the p-value was more than 0.05%. The present study adds evidence to the debate on emerging antibiotic resistance. People have good knowledge about antibiotic consumption. Self-medication with antibiotics is considered the leading cause of growing bacterial resistance to antibiotics. There is a need to sensitize the public about bacterial resistance and its negative impact on treating diseases with potentially harmful pathogens.

Keywords: *Antibacterial; Self-treatment; Antibiotic; Prescription; Self-medication; Drug resistance*

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1. Introduction:

Nowadays, antibiotics play a significant role in every healthcare system worldwide. But like with other medicines, consuming antibiotics may face challenges too. One of the most critical challenges with antibiotics is bacterial resistance against them, which means the curing effects of antibiotics are being decreased by consuming antibiotics excessively or using them without physician order (1). This challenge could affect healthcare in all nations, specifically developing countries, and all people of different ages (2). Bacterial resistance to antibiotics will increase the healing period and cure costs in future generations, which is an alarm for patients (3). Without making changes in ordering antibiotics by physicians and consuming antibiotics by patients, even with the progress in new-generation antibiotic production, bacteria resistance against antibiotics may remain a severe threat (4). Knowledge and behavior in society play a significant role in controlling or decreasing this problem.

This study was performed to assess people's behavior and knowledge about consuming antibiotics, the abundance of consuming antibiotics without physician order among patients, and influential factors on these behaviors besides considering increasing general knowledge about antibiotics' role and its effects on bacteria resistance against antibiotics. Another aim of this study is to predict those antibiotics that may become useless in the future because of drug resistance.

2. Materials and Methods:

2.1. Study design, period, and setting:

A structured questionnaire was used in this cross-sectional study. The questionnaire was developed and formed by reviewing previous similar studies besides our researcher's debates, and it was printed and distributed among participants physically. A total of 300 participants in this study were randomly selected from ordinary adults without considering any specifications. The study was performed in August 2022.

2.2. Study questionnaire and data collection technique:

The questionnaire was developed to measure and assess the knowledge and behaviors in consuming antibiotics. Participants were given almost one to two days to complete the questionnaire, and this procedure took seven days until the last questionnaire was filled out. In this study, we randomly chose people of different ages, salaries, educations, and health situations. Before the main questions, we wrote a brief about our study aim and ensured participants that their data would be confidential and that ethics must be considered. Therefore, questions were divided into four distinct parts.

The first part of the questionnaire was dedicated to personal information, and we asked participants about their gender, age, education, salary amount, and past medical history (PMH). The second part was dedicated to the participants' behaviors in consuming antibiotics. In this part, we asked: 1. whether they consume antibiotics without a physician's prescription; 2. whether they keep antibiotics in their houses, 3. whether they consume the antibiotics continuously until the healing period that the physician ordered is finished, 4. whether they offer antibiotics to other people with similar symptoms to their past or present symptoms, 5. whether they stop consuming antibiotics because of common side effects like diarrhea, vomiting, etc., 6. whether they make changes in the ordered dosage of antibiotics by the physician. The third part of our questionnaire was dedicated to knowledge of our participants about antibiotics. We asked them: 1. If they know about the ineffectiveness of antibiotics for the common cold, 2. If they know about the possibility of bacterial resistance to antibiotics due to self-prescription, 3. If they know about the ineffectiveness of antibiotics for pain management, 4. If they know about the effect of antibiotics on normal flora. 5. If they know about the possibility of side effects occurring such as diarrhea and nausea, and a change in the color of the wound and feces. In the fourth part of our questionnaire, we aimed to measure the amount of each antibiotic consumed among our participants. Therefore, we had to choose 15 choices that consisted most famous antibiotics among the ordinary Iranian population. Participants in this part could choose one or more antibiotics that they: 1. Use without a physician's prescription, 2. Cut the consumption before the ordered healing time by the physician, and 3. They were used while infected with COVID-19. Thus, we had 300 filled-out questionnaires. Some questions were left unanswered in the questionnaire and were excluded from our study.

2.3. Statistical analysis:

The Pearson Chi-square test assessed all the correlations between different variables, and all p-values were included in the tables. Ultimately, we entered the data into IBM SPSS STATISTICS VERSION 26.

3. Results:

As in Table 1, 298 people participated in our study, 130 (43.6 %) men and 168 (56.4%) women. The observed age range includes 18 to 70, and 72.1% are under 35. 82.9% of our participants do not have any past medical history. 64.5 % of them have a university education.

Characteristics	**Frequency (percent)**	**Total (percent)**
Male **Gender** **Female**	130 (43.6) 168 (56.4)	298(100)
>35 **Age** **<35**	83 (27.9) 215 (72.1)	298(100)
Don't have a university education **Education.** **Have university education**	102 (35.5) 185 (64.5)	287(100)
Have **Past medical history** **Don't have**	51 (17.1) 247 (82.9)	298(100)
Salary 8< **8-10** **10>** **Dependent salary**	84 (28.2) 47 (15.8) 52 (17.4) 114 (38.3)	297(100)

Table1: Demographic details of study participant

For having a valid survey, in general, information evaluation of people, the answer 'I do not know' compiled with the false answer for each question which has been considered as a lack of knowledge of the meant person for each question.

Based on Table 2, 45.7% are aware of the ineffectiveness of antibiotics for the common cold, and 70.5% know about the resistance of bacteria against antibiotics. 42.3% of people know that antibiotics do not affect pain. Hence most of the participants have good knowledge about antibiotics consumption.

As shown in Table 4, 76.5% of academically educated people (who have a university education) know that antibiotics have no effect on viral diseases, and 69.6% of academically uneducated people are aware of the ineffectiveness of antibiotics on viral diseases. 68.9% of people with academic education know the ineffectiveness of antibiotics for the common cold. Although, 63.4% of uneducated people are aware of the ineffectiveness of the common cold. 74.3% of educated and 65.3% of uneducated people are informed of the possibility of bacteria resistance against antibiotics.

Key knowledge Question	**Correct answer**	**Answer**	**n**	**%**
Antibiotics are effective in treating the common cold	No	Yes	98	**32.9**
		No	135	**45.7**
		Not sure	62	**20.8**
	Yes	Yes	210	**70.5**

Self-prescription of antibiotics reduces its therapeutic effects and makes the treatment of the disease harder.		No	18	**6**
		Not sure	67	**22.5**
Taking antibiotics reduces pain.	No	Yes	91	**30.5**
		No	126	**42.3**
		Not sure	80	**26.8**
Antibiotics kill beneficial bacteria.	Yes	Yes	149	**50**
		No	48	**16.1**
		Not sure	101	**33.9**
Taking antibiotics can cause side effects such as diarrhea and nausea, and a change in the color of the wound and feces.	Yes	Yes	150	**50.3**
		No	16	**5.4**
		Not sure	132	**44.3**

Table 2: Actual knowledge of the respondents about antibiotic use and resistance

		Having university education **Number (%)**	**Not having university Education** **Number (%)**	**p-value**	**Having past medical history** **Number (%)**	**Not having a past medical history** **Number (%)**	**p-value**
Use without prescription	Use	71(38.8%)	42(41.2%)		13(25.5%)	106(43.3%)	
	Don't use	112(61.2%)	60(58.8%)		38(74.5%)	139(56.7%)	
	Total	183(100%)	102(100%)	0.227	51(100%)	245(100%)	0.019*
Restore antibiotics at home	restore	117(64.3%)	68(67.3%)		33(64.7%)	159(65.7%)	
	Don't restore	65(35.7%)	33(32.7%)		18(35.3%)	83(34.3%)	
	Total	182(100%)	101(100%0	0.710	51(100%)	242(100%)	0.892

Don’t complete the healing period	Don’t complete complete	67(36%) 117(64%)	36(36%) 65(64%)		12(23.5%) 39(76.5%)	97(39%) 148(61%)	
	Total	184(100%)	101(100%)	0.193	51(100%)	245(100%)	0.077
Offer antibiotics to other people	offer Don’t offer	55(29.9%) 129(70.1%)	24(23.5%) 78(76.5%)		18(35.3%) 33(64.7%)	65(26.4%) 181(73.6%)	
	Total	184(100%)	102(100%)	0.030*	51(100%)	246(100%)	0.199
Don’t complete the healing period because of side effects	Complete Don’t complete	102(55.4%) 82(44.6%)	60(58.8%) 42(41.2%)		24(47.1%) 27(52.9%)	143(58.1%) 103(41.9%)	
	Total	184(100%)	102(100%)	0.888	51(100%)	246(100%)	0.147

Change in dosage without consulting a doctor	change	25(13.5%)	20(19.8%)		6(11.8%)	41(16.7%)	
	Don’t change	160(86.5%)	81(80.2%)		45(88.2%)	205(83.3%)	
	Total	185(100%)	101(100%)	0.404	51(100%)	246(100%)	0.383

Table 3: Relation of university education and medical history with the usage of antibiotics

51.9% of educated people know enough about the possible side effects of consuming antibiotics, but 48% of uneducated people do not know about it. 53% of educated and 46.1% of uneducated people are informed of the antibiotic's effect on normal flora bacteria. 64% of those with past medical history know about the possibility of bacteria resistance against antibiotics, and 72.7% who don't have past medical history are aware of resistance in case of taking antibiotics without a prescription and in case of lack of need. 51% of this group of people with a past medical history and 50.2% without past medical history are informed of the possible side effects of antibiotics.

As in Table 3, self-medication with antibiotics (SMA) is seen in 38.8% of the educated and 41.2% of the uneducated groups. And also, 25.5% of those with a past medical history and 43.3% of people without a past medical history have the experience of taking medicine without a prescription. In this study, the antibiotic suggestion to others is seen in 35.3% of people with a past medical history and 26.4% of those without past medical history. Among participants who don't use antibiotics without a prescription, 76% are informed of bacteria resistance against antibiotics, and 24% of participants who don't use antibiotics without a prescription are not informed about the possibility of resistance. 65% of people that take antibiotics without a prescription have no information about the ineffectiveness of antibiotics regarding pain. 76% of those who take antibiotics without a prescription are informed of the ineffectiveness of antibiotics for the common cold, and 24% do not know about it. 60% of people who do not take antibiotics without a prescription, in case of some side effects, do not stop consuming till the healing period is completed. Also, 74% of people who do not take antibiotics without a prescription finish the treatment period and do not stop using antibiotics after feeling better themselves. 76% of those who suggest antibiotics to others keep antibiotics at home, and 24% of them do not keep antibiotics at home. 76% of people who do not keep antibiotics at home know about the ineffectiveness of antibiotics for the common cold

Based on Figure 1, among the most famous antibiotics people use without a prescription, Amoxycillin is the 1st (28%), Cefixime is the 2nd (15%), and Azithromycin is the 3rd most without-prescription used antibiotic. As mentioned in Figure 2, among antibiotics whose healing period was not completed, Amoxycillin is the first (25%), Azithromycin is 2nd (15%), and Cefixime is 3rd (12%) most healing period-uncompleted antibiotics. As mentioned in Figure 3, our participants have consumed Azithromycin, Amoxycillin, and Cefixime more than other antibiotics consumed by Covid-19 patients during the pandemic.

A(		Having academic Education Number (%)	Not having Academic Education Number (%)	p-value	Having medical history Number (%)	Not having medical History Number (%)	p-value
Aware of the ineffectiveness of antibiotics on the viral virus	Know Don't know.	140(76.5) 43(23.5)	71(69.6%) 31(30.4)		36(70.6%) 15(29.4%)	183(74.7%) 62(25.3%)	
	Total	183(100%)	102(100%)	0.139	51(100%)	245(100%)	0.512
Aware of the ineffectiveness 0f antibiotics on the common cold	Know Don't know	126(68.9%) 57(31.1%)	64(63.4) 37(36.6%)		32(64%) 18(36%)	165(67.3%) 80(32.7%)	
	Total	183(100%)	101(100%)	0.338	50(100%)	245(100%)	0.647

Knowledge of drug resistance	Know	136(74.3%)	66(65.3%)		32(64%)	178(72.7%)	
	Don't know	47(25.7%)	35(34.7%)		18(36%)	67(27.3%)	
	Total	183(100%)	101(100%)	0.003**	50(100%)	245(100%)	0.218
Knowledge of antibiotic side effect	Know	96(51.9%)	49(48%)		26(51%)	124(50.2%)	
	Don't know	89(48.1%)	53(52%)		25(49%)	123(49.8%)	
	Total	185(100%)	102(100%)	0.007**	51(100%)	247(100%)	0.919
Aware of the ineffectiveness of antibiotics on the pain	Know	90(48.9%)	29(28.4%)		24(47.1%)	102(41.5%)	
	Don't know	94(51.1%)	73(71.6%)		27(52.9%)	144(58.5%)	
	Total	184(100%)	102(100%)	0.004**	51(100%)	246(100%)	0.462
Aware of effectiveness of antibiotics on normal flora bacteria	Know	98(53%)	47(46.1%)		24(47.1%)	125(50.6%)	
	Don't know	87(47%)	55(53.9%)		27(52.9%)	122(49.4%)	

	Total	185(100%)	102(100%)	0.003**	51(100%)	247(100%)	0.644

Table 4: Relation of academic education and medical history with knowledge of antibiotics

Figure 1:Using without prescription

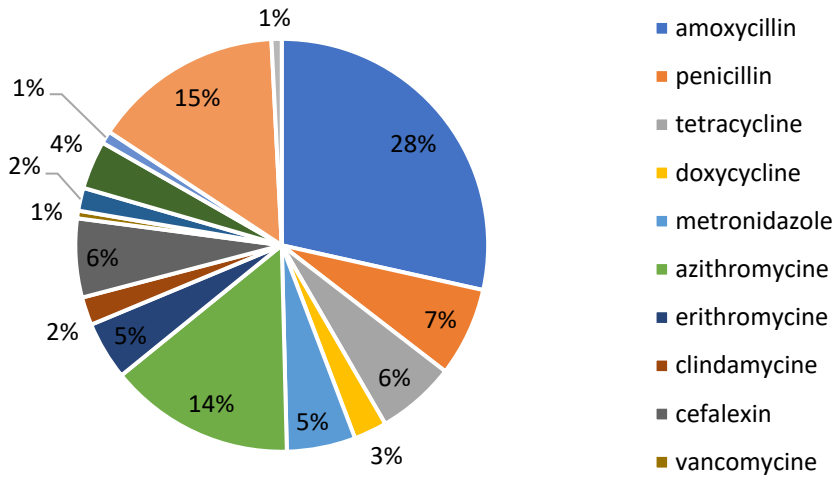


Figure 2: failure to complete the course of treatment

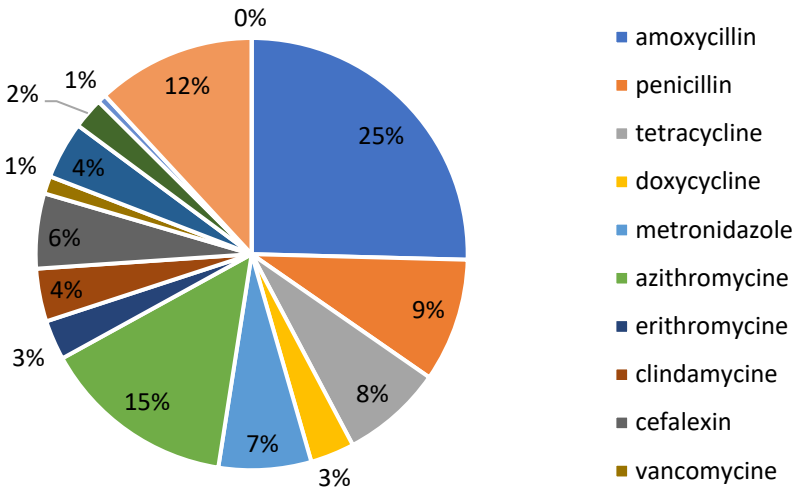
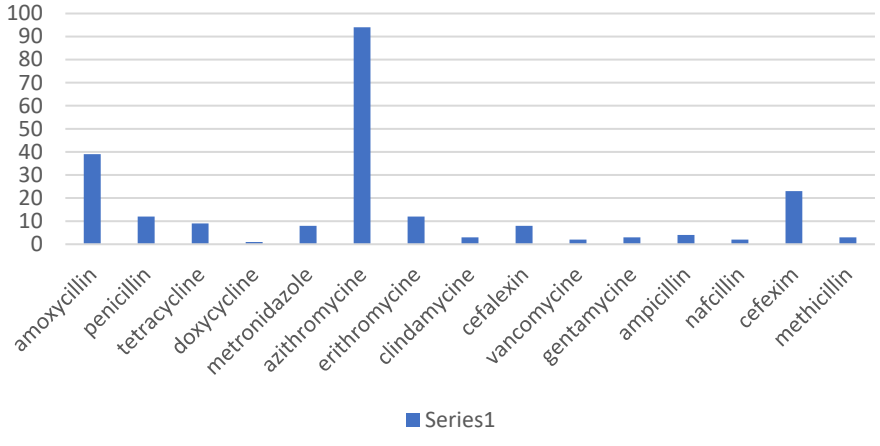


Figure 3: antibiotics that used in corona epidemy period



4. Discussion:

Antibiotics are common medicines worldwide; many people use them without a prescription. In the long term, this situation strengthens bacteria against common antibiotics and increases treatment costs. Mexico has less resistance to pathogens compared to other Latin countries because they have some principles for decreasing the arbitrarily using of antibiotics that are somehow helpful (5). Some of these principles are prohibiting selling antibiotics without prescription and reducing the dose of antibiotic usage. In research in Namibia, worrying issues were founded that are; selling antibiotics without a prescription, using antibiotics, especially for self-limited infections of the respiratory system, less knowledge, and non-optimal behavior of people with antibiotics and their usage of them (6).

Self-curing is common in developed and developing countries, with rates from 3% to 75%. And this issue is not only in Namibia but also in many other countries. Despite the rule of Namibia (number 13 in 2003) that classifies antibiotics as just prescription drugs, some drug stores sell them without a prescription (7). According to some research, this way of using drugs is because of pharmacists or pharmacy managers (8) (9), but some researchers deny this theory (10).

Some strict ways of repayment have to be used by the medical system to change people's decisions about using antibiotics without a prescription. Following the pharmacy rules more carefully and making pharmacists and the whole population aware of self-curing can decrease the usage of antibiotics without a prescription. According to research about the lack of effect of antibiotics on viruses instead of germs, 67% of participants in Panang (Malaysia) aren't aware because doctors and treatment cadre use the word microbe instead of bacteria or virus. And according to some other statistics in this research, insufficient control of the usage of antibiotics and being available everywhere can increase the wrong usage of antibiotics (11). In some countries, people can use them without a prescription, and they are even illegal (12) (13).

Self-treatment is a common and growing problem in many societies, which can have issues such as drug resistance. Using antibiotics kept at home, offering antibiotics to others, and selling antibiotics without a prescription ultimately lead to increased self-use, leading to side effects and bacterial resistance to common antibiotics (14). We can see the prevalence of SMA in the Middle Eastern part of the world (15).

In this study (Table 4), people's knowledge about the possibility of resistance against antibiotics and the effect of this knowledge on using antibiotics or offering them to other people are discussed. According to Table 4, people with an academic education know about drug resistance in more percentages than those who don't have an academic education so public awareness can increase the general knowledge of educated people. According to this result, we expect that knowledgeable people use antibiotics without prescription in less percentage than non-educated people because of their understanding of the possibility of resistance against drugs. Still, we observed in Table 3 that the academic education and non-prescriptive usage of antibiotics in our statistical society are not related, and the p-value was more than 0.05%. This result shows that people's general knowledge has increased by the notices on TV programs or related posts on social media, and this knowledge is not dependent on academic education.

In the past years, the consumption without prescription of drugs in the country was relatively high, which caused bacterial drug resistance to common antibiotics. It seems that if the general population consumes less medicine without a prescription, this can make treatments more effective in the long term, reduce the pace of bacterial resistance to common antibiotics, and reduce treatment costs.

According to the information obtained, more than half of the people who had consumed antibiotics without a prescription were not aware of the fact that antibiotics do not affect pain, probably these people use antibiotics to relieve pain such as headache, stomachache, etc., which is not only unnecessary to make the pain go away, but it can also create drug resistance in the bacteria or cause damage to the normal flora of the

intestine, so this important matter should be prevented by informing the public through the medical staff, social networks, and databases.

According to the obtained results, people who do not use drugs without a prescription have more commitment to their treatment process and do not stop taking antibiotics in case of side effects or recovery. According to Table 4, the ratio of the percentage of without prescription use of antibiotics in people with underlying diseases is lower than the percentage of those who do not have underlying conditions among the statistical population. From the statistical point of view, we also found that underlying diseases can be related to consumption without prescription. Probably people with an underlying condition due to a history of frequently visiting medical centers and having more trust in medical staff do not take antibiotics without a doctor's prescription and are more committed to the treatment process prescribed by the doctor.

According to Table 4, the awareness of people with a university education about the fact that antibiotics do not affect viral diseases or the common cold is higher than people without a university education. But the difference in the proportions in the conducted study is slight. Due to the p-value above 0.05, our data are not statistically related to each other, which shows that the general public's awareness of antibiotics has probably increased due to social networks and television, and the general public at any age and educational level has acquired basic knowledge about the use of antibiotics. By growing academic programs, it is possible to help elevate the general awareness of the community about the usage of drugs.

According to Table 4, even though the percentage of informed people in the community of people with the underlying disease about the development of drug resistance or the possibility of side effects is lower than the percentage of knowledgeable people in the neighborhood of people without underlying disease, but according to p-value and obtained statistical indexes, there is no statistically significant relationship between the underlying disease factor and awareness of the challenges, i.e., consumption without prescription of antibiotics.

The phenomenon of self-treatment is carried out by different antibiotics, among which amoxicillin is one of the most common antibiotics in the Middle East. Evidence shows that the consumption of penicillin in this region is very high, which can be due to its availability, low price, and fewer side effects than other antibiotics (14). People with colds or other upper respiratory infections have more self-inflicted use. At the same time, this is a viral disease; antibiotics do not affect it and can cause side effects (15).

According to Figures 1 and 2, the three antibiotics, Amoxicillin, Azithromycin, and Cefixime, had the highest consumption without prescription and the highest discontinuation percentage by our community so we may see resistance to these three common antibiotics in the future if not addressed. Pharmacies are expected not to sell these three antibiotics without a prescription, and doctors must oblige their patients to complete their treatment even if the symptoms disappear.

Amoxicillin is an antibiotic of the penicillin family and belongs to the beta-lactam class, and is one of the most widely used antibiotics in the world. This antibiotic is one of the main antimicrobial agents for the treatment of Helicobacter pylori. Still, with the increase in excessive and arbitrary use of this antibiotic, we are witnessing the resistance of Heliobacter pylori to this drug (16) (17). Helicobacter infection is associated with active chronic gastritis and optic ulcer disease and is one of the predisposing factors for adenoma carcinoma (18), So it can be expected that this bacterium will cause acute infections and disorders in the Middle East. To prevent this from happening, it is possible to ban the sale of amoxicillin in pharmacies without a prescription and inform most people about the side effects of this drug and the possibility of drug resistance.

Research in the eastern part of the Middle East considered the main reasons for random consumption at this time to be cost savings, fear of Covid-19, quarantine, and ease of access. During the Covid-19 pandemic, the arbitrary use of antibiotics has increased. In other words, during the quarantine, people avoided going to medical centers due to the fear of contracting the virus and resorted to self-treatment. By increasing counseling and virtual visits and informing people, the possibility of side effects and drug resistance to self-treatment can be reduced
(19).

According to Figure 3, during the COVID-19 pandemic, many people started using antibiotics due to the unknown nature of the virus and its treatment. Also, the pattern of antibiotic use has changed in this period, and certain antibiotic increased significantly in 2020 compared to 2019, especially Azithromycin, whose consumption has increased by 74% (14) (20). Among the antibiotics, the statistical community has used Azithromycin, Amoxicillin, and Cefixime the most, respectively. Azithromycin is a macrolide antibiotic mainly prescribed for treating skin, respiratory, and soft tissue

infections (21). There is evidence that this antibiotic can prevent the proliferation of viruses such as Human Influenza (H1N13) (22) and Zika virus (23). This drug has been recognized as the second most treatment for Covid-19 after hydroxychloroquine. Due to the increase in its use, it is essential to consider the safety of this antibiotic's side effects of this antibiotic.

It usually includes digestive problems such as diarrhea, vomiting, nausea, stomach discomfort, and unusually increased QT interval. Therefore, caution should be used if Azithromycin is prescribed to patients prone to increased QT interval or gastrointestinal diseases (21). Due to the increase in the use of Azithromycin in this era, we can expect to find problems in treating bacterial infections such as middle ear infections, strep throat, traveler's diarrhea, gastrointestinal inflammations, and other infections that were previously treated with this drug. Because the bacteria causing the infection, may be resistant to this antibiotic, it is necessary to look for alternative antibiotics with minimal side effects.

4.1. Limitations and Recommendations:

To the best of our knowledge, this is the first study in this region. It is an essential contribution to assessing the association between bacterial resistance against antibiotics and people's behavior regarding antibiotic consumption and general knowledge about antibiotics. Limitations include a modest sample size (n = 300) which cannot be generalized to Iranian cultural settings and backgrounds. To establish more accurate results, large-scale and varied samples are needed in future replications of the study. Moreover, this is a cross-sectional study as it determines etiology and outcome. Therefore, the results should be considered only exploratory in the absence of experimental work.

5. Conclusion:

The present study adds evidence to the debate on emerging antibiotic resistance. People have good knowledge about antibiotic consumption. But unfortunately, a handsome amount of the participants uses antibiotics without a prescription. Self-medication with antibiotics is considered the leading cause of growing bacterial resistance to antibiotics. There is a need to sensitize the public about bacterial resistance and its negative impact on treating diseases with potentially harmful pathogens.

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Ethical approval

Before each step of the investigation, for moral issues, the consent decree and complete informing subscriptions were obtained from everyone who had taken participant in the study.

Conflict of interest statement

All authors declared no conflict of interest.

Funding

No funding is required for the study.

Consent

The consent decree was obtained from everyone

Registration of research studies

1. Name of the registry: Not applicable
2. Unique Identifying number or registration ID: Not applicable
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): Not applicable

Provenance and peer review

Not commissioned, externally peer-reviewed.

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