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Medical Students' Understanding, Attitudes, and Awareness of Antibiotic Resistance

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ABSTRACT

Background: Antimicrobial agents are potent medication that can stop or significantly limit bacterial development. Misuse of antibiotics is one of the major problems worldwide. Antibiotic resistance has become a major worldwide health concern since it is linked and associated with an increased number of morbidity, mortality, cost of treatment and leads to increase hospital stay. Numerous studies on antibiotic awareness have demonstrated cultural, behavioral, educational, and healthcare system differences in students' perspectives on antibiotics. The purpose of this pilot study was to assess medical students' perspectives, familiarity, and understanding of antibiotics at two Saudi Arabian Universities.

Aim: Examine medical students' understanding and perspective on the proper use of antibiotics. The purpose of this survey is to assess the level of knowledge regarding antibiotic resistance among medical students and to provide suggestions for reducing this problem.

Methods: Comparison study between two Universities at Riyadh region (University A and University B) was surveyed using a pre-designed, self-administered questionnaire for this study. A panel of specialists in the field has reviewed the questionnaire. The study's success will depend on the opinions of three distinct cohorts of future doctors.

Results: The poll revealed a higher level of knowledge at University B (74.3%), but at University A (71.81%) it was lower. University B had a higher level of knowledge acquisition, according to the research. In addition, the study revealed that the level of awareness at University A was (86.35%), whereas the level of awareness at University B was (87.13%), and the level of attitude at University A was (86.23%). Moreover, we discovered that as students' progress in their education, so do their levels of knowledge, attitude, and awareness.

Conclusion: The foundation of a thriving society is the use of sound scientific methods. Effective education, from this vantage point, plays a crucial role in imparting knowledge, awareness, and attitude that leads to change in behavior and habits, and therefore in the level of outputs that feed the community with a comprehensive health strategy

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1. INTRODUCTION

Antimicrobial agents are medication and lifesaving used to prevent infection caused by bacteria while wrong use of antibiotics play a major role in developing drug-resistant microorganisms. Drug-resistant bacteria cause major health issues in underdeveloped nations [1, 2]. Antibiotic resistance can affect humans and animals of any age in any nation, making bacterial illnesses difficult to cure. WHO releases six-point antimicrobial resistance policy [2,3].WHO recommends education as integral part of stopping irrational use of antibiotics to decrease the resistant germs. There is misunderstanding that taking antibiotics can help faster to improve an illness and prevent infections [9]. Antibiotics are also misunderstood to treat viral infections [5,7,8]. Irrational use of antibiotics enhances to make the drugs ineffective very soon which is a serious healthcare problem in global societies [3, 7].

Inappropriate, Incomplete course, and illogical antibiotic treatment increases the risk of antibiotics resistance [1, 2, 3 4,5,7,8, 10, 11, 12]. In addition, noncompliance in the use of

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antibiotics promotes the emergence of resistant bacteria even during treatment course [4]. Irrational antibiotic use also produces resistant germs, which lead to increase hospital stays and treatment costs [5,6,1]. Unfortunately, antibiotic misuse and overuse accelerate antibiotic resistance. Around 50 % of antibiotics worldwide are obtained privately from pharmacies without prescription [1,3,10]. Many factors can increase antibiotic misuse [1, 2, 5]. Thus, many studies linked inappropriate antibiotic use to public, healthcare worker, and student awareness, attitude, practice, and knowledge [1, 2, 3, 5, 6, 7, 10]. Demographic factors such age, gender, race, education, residence, and family income affect knowledge [2,12]. Self-medication is another important component in antibiotic resistance [1,2,5,6]. Optimal use of antimicrobial agents leads to getting a high level of health for individual and communities [7].

History of antibiotics

In World War II, antibiotics were discovered to treat infectious diseases, a global event. Penicillin, developed by Sir Alexander Fleming in 1928, was the first antibiotic given for serious illnesses in the 1940s. WII soldiers treated bacterial illnesses using penicillin. By the 1950s, penicillin resistance threatened many of the previous decade's advances. New beta-lactam was found, developed, and trusted. In 1962, the UK reported the first MRSA case. Unfortunately, antibiotic resistance is widespread. MRSA in S.aureus and coagulase-negative staphylococci was controlled with vancomycin in 1972.However, vancomycin-resistant coagulase-negative staphylococci were reported in 1979 and 1983 [13].

Three generations of spectrum-active cephalosporins emerged in 1960. Journals published the first antimicrobial prescription in 1975- 1976 discovered β-lactamase inhibitors. Thienamycin became imipenem, which was useful in vitro and animals but short-lived in humans. Meropenem, approved in 1995, had fewer side effects [14].

Some antimicrobial drugs increased resistance bacterial infections.

When we look at the evolution in the manufacture and discovery of a new antibiotic and the ability of bacteria to resist, we find that several factors help overcome bacteria resistance and these factors can be deduced or highlighted as the central part, which is optimal antibiotic use.

Global Burden

Antibiotic resistance is a major public health problem. It can render antibiotic-resistant illnesses. Antimicrobial resistance (AMR) is anticipated to kill 10 million people per year by 2050, costing $100 trillion [15]. The World Health Assembly (WHA) agreed to address AMR in May 2015[16]. Understanding antibiotic use and AMR prevention is crucial to reducing AMR globally.

The main causes of antibiotic resistance are improper usage and misuse [17,18]. WHO recommend surveillance which plays a major tool to monitor the rising in AMR and to improve the usage of antibiotics through public and healthcare workers [19, 20].Furthermore, rational usage, policies and restrictions can reduce AMR [19]. Global studies showed the resistant bacteria are increasing and the urgent need to new antibiotics [21]. World governments have one strategy to prevent AMR and limit antibiotic use which is focus on the follow experimentation policy, activating stewardship program, restricting the use of last-resort antibiotic, and establish public awareness campaigns [22].

Antibiotics resistance

Mechanism of action of antibiotic resistance and definition

AMR occurs when microorganisms become immune to antimicrobials through intrinsic resistance, acquired resistance, or adaptive resistance [23]. It is essential point to understanding how the mechanism of action is work before knowing how the antibiotic acts with bacteria. Antimicrobial agents proceed selectively on vital microbial functions with the last effects or without affecting host functions. Different medicines act in different ways, and the understanding of these mechanisms as well as the chemical nature of antibiotics is critical point in the knowledge of the methods of how resistance against them has been developed. The device of action of antibiotics can be classified based on a function of bacteria or the structure that is affected by the agents, and these include the following:

Interfere with Cell Wall Synthesis

Bacterial ribosome's, cytoplasmic structure on which protein synthesis takes place, are targets for some antibiotic such as Chloramphenicol and Macrolide because bacterial ribosomes differ in size and structure from human (bacterial cell are prokaryotic and their ribosomes are 70S, whereas human cell are eukaryotic and their ribosomes are 80S).[S represent Svedberg units, a measurement of sedimentation rate].

Interfere with protein synthesis

Bacterial ribosomes, cytoplasmic structure on which protein synthesis takes place, are targets for some antibiotic such as Chloramphenicol and Macrolide because bacterial ribosomes differ in size and structure from human (bacterial cell are prokaryotic and their ribosomes are 70S, whereas human cell are eukaryotic and their ribosomes are 80S).

Interfere with Cell Membrane Function

Cell membranes are crucial gatekeepers. They regulate cell access. Antibiotics like polymyxin alter membrane function, causing membrane permeability and fast cell death.

Interfere with Nucleic Acid Synthesis

DNA expression involves DNA replication and RNA synthesis. Quinolone antibiotics inhibit DNA gyrase in gram-positive bacteria and topoisomerase IV in gram-negative bacteria.

Interfere with Metabolic Activity

Antimetabolites are medications that compete with metabolic enzymes and resemble natural substances. Sulfonamide work similarly. Bacteria generate folic acid for cell formation. Bacteria employ sulfa medicines to generate folic acid. Sulfa medicines can treat humans since mammalian cells don't synthesize folic acid [24].

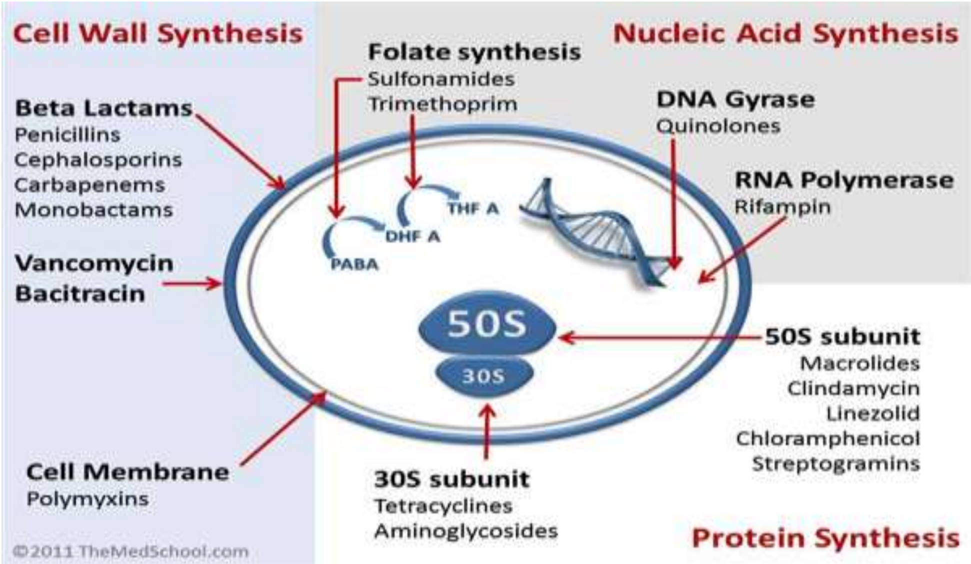

Figure (1): Mechanism of action of antibiotics [25].

Antibiotics failing to treat diseases due to multi-resistant bacteria have raised global concerns about this transition, which threatens the health of the environment. Thus, antibiotics' chemical structure and mechanism of action differ. Which mechanisms antibiotics inhibit determines resistance.

The two main mechanisms of antimicrobial resistance are intrinsic (passive) and acquired (active) resistance [26].

Germs become resistant as follow:

Infection happened and many of bacteria make you sick and some of these germs became resistant to antibiotics.

Antibiotics kill pathogens but not resistant bacteria. Antibiotics kill beneficial bacteria that prevent infection.

Antibiotic-resistant microorganisms have defenses. They multiply and sicken you.

Drug-resistant microorganisms can pass it on. Antimicrobials cannot treat your illness, and resistant organisms can spread [27].

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Epidemiology of AMR

Epidemiology of antibiotics resistance (Worldwide)

Antibiotics have greatly reduced death and morbidity. However, resistant bacteria have rapidly spread worldwide and locally, increasing mortality and morbidity. AMR causes 23,000 US and 25,000 EU deaths annually. In low- and middle-income areas, people use antibiotics unnecessarily, which increases the number of resistant bacteria. Other factors reinforce the frightening growth. Lack of infection control and over-the-counter medicine sales, poor surveillance, considered as main factors which driving the spread of antibiotics resistance [18–29]. European Centers for Disease Prevention and control (ECDC), European Food Safety Authority (EFSA), and European Medicine Agency (EMA) found a link between human and animal antibiotic use and AMR in 2015. They give several findings linking antibiotic use to resistance in people and animals. Antibiotic use in humans, animals, and hospitals has to be assessed. This threat requires a crucial strategy. Identifying AMR transmission channels and sources requires active surveillance [28].The new WHO Global Antimicrobial Surveillance System (GLASS) found antibiotic resistance in 500 000 probable bacterial illness patients in 22 countries. Escherichia coli, Klebsiella pneumonia, Staphylococcus aurous, and Streptococcus pneumonia were the most prevalent resistant bacteria, followed by Salmonella spp. Among patients with suspected bloodstream infection, the percentage that had bacteria resistant to at least one of the most commonly used antibiotics ranged wonderfully between different countries from zero to 82%. Countries reported penicillin resistance from 0 to 51%. 8% to 65% of urinary tract infection-associated E. coli were resistant to ciprofloxacin [30]. Saudi Arabia joined GLASS recently.

Antibiotic resistance kills 25,000 EU residents and adds 2.5 million hospital days. In India, resistant bacteria from mothers killed nearly 58,000 newborns in one year. Antibiotic resistance kills 38,000 Thais and costs 3.2m hospital days. Antibiotic resistance kills 23,000 Americans annually [31].

Epidemiology of antibiotics resistance (Local)

The Ministry of Health (MOTH) in the Kingdom of Saudi Arabia has begun to work hard to confront the danger of resistant germs to antibiotics, which has become a global health problem. Many epidemiological studies in KSA have shown an increase in bacterial resistance to different pathogens. From this perspective, the Ministry of Health organized a national committee comprising numerous national institutions to activate the WHO plan for antibiotic-resistant microorganisms. [32]. Epidemiological data and continual surveillance can help regulate and determine bacterial drug resistance [33,34,35].

Western KSA researchers found several drug-resistant microorganisms. This study reported 48.6% of E. coli resistant to SXT, 49.3% of Klebsiella isolated from respiratory secretions resistant to AMP, and 59.3% resistant to AMP and Piperacillin. 20.1% of 244 respiratory Acinetobacter baumannii were resistant to SXT, 56.3% E. coli and 31.1% Klebsiella were positive for Extended-Spectrum Beta-Lactamases (ESBLs), 50.3% S. aureus from miscellaneous cultures, and 35.9% were methicillin resistant [33].

Another study conducted in Saudi Arabia has shown the high level of antibiotics resistance for different pathogens. In that's study, they isolate gram-negative and gram-positive, and they found tin *E.coli* the resistance was 40% to ciprofloxacin, 30% to cefepime, 29% to ceftazidime, 8.5% to tazocin and amikacin, 40% to gentamicin and cefuroxime. In *K. pneumonia*, the resistance was 48%to ceftazidime, 49% to cefuroxime, 45.5% to cefepime, 38% to gentamicin, 30% to ciprofloxacin, 19% to istazocin, 7.5% to amikacin and 2.4% to imipenem /meropenem. In *A.bumannii*, 79% were resistant to ciprofloxacin, 68.5% to tazocin, 67% to cefepime, 66% to gentamicin and imipenem /meropenem, 65% to ceftazidime, 68% to amikacin and no resistance to colistin that reported. In *Pseudomonas aeruginosa*, almost 34% were resistant to ceftazidime, 31% to ciprofloxacin, 29% to cefepime, 26.5% to gentamicin, 19% to imipenem /meropenem, 17% to amikacin, and 15.5% were resistant to tazocin. In gram-positive isolates, *MRSA* counted only for 4.6%, and no *vancomycin-intermediate Staphylococcusaureus* was detected [36].

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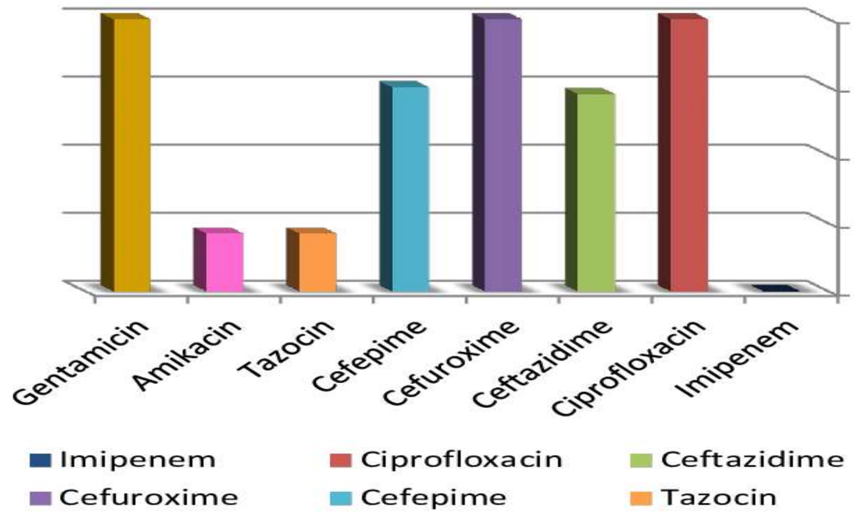

Figure (2) shown the overall resistance rate of E. coli isolates (N = 1703) to different used antibiotics [36].

Another KSA study on hospital-acquired infections by multi-drug-resistant organisms showed the significance of bacterial resistance and the importance of hospital surveillance to control MDR pathogens.

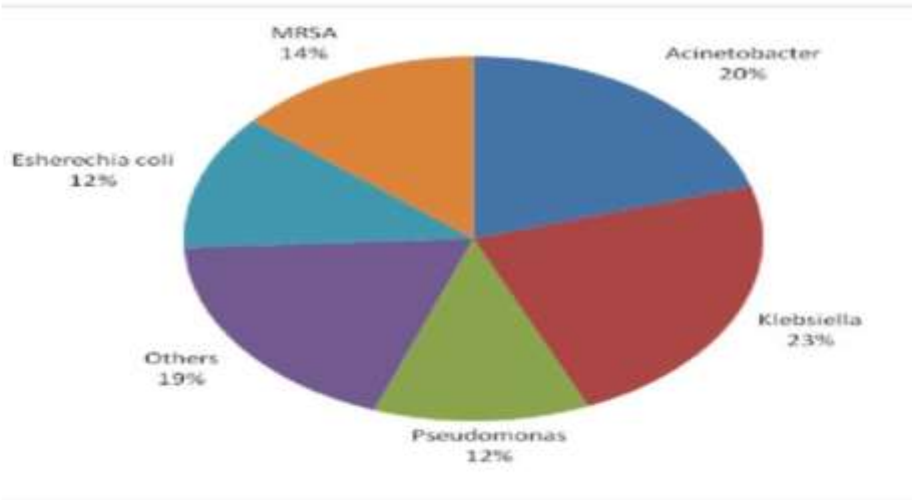

Figure (3) shown the most common hospital acquired MDROs (%) [37].

The WHO shows a severe problem toward the lack of new antibiotics and encourages creating a strong strategy for the regulation of the use of antibiotics. However, the rate of AMR is increasing globally. Therefore, the discovery of a new antibiotic is one of the priorities of the WHO and the desired goal through which experts from pharmacists or manufacturers work to achieve it. A critical solution of the emergence of antibiotics resistance is the development of new antimicrobial agents with high activity against multi-drug resistant bacteria which is a vital health need to cover the resistant bacteria that is a global health crisis now[40]. The expected rate of emergence and spread of antimicrobial resistance yearly will reach 10 million deaths by 2050 with an estimated cost of $100 trillion [41]. From this point of view, we can stress the urgent need of the health society to develop plans and strategies which may help to discover a

Due to lack of awareness and health culture, the KSA's resistant bacteria rate increased. The study found that private pharmacies are the main source of antibiotic abuse, especially among children. They need government regulation and a strategy to promote rational use. Riyadh pharmacy misused antibiotics 77%, Alkharj dental clinics 82%, Jeddah 97%, and Abha community hospital 72%. Many studies have shown that cultural factors, knowledge, behavioral traits, and education can influence antibiotic misuse [38].Research in multiple KSA regions found that 53% of individuals used antibiotics without a prescription and were unaware of antibiotic abuse. Thus, we need a medicine rationing program and an educational program to improve public and healthcare provider knowledge to reduce the antibiotics resistance [39].

Lack of new antibiotics

To prevent and control the spread of antibiotic resistance, individuals should [45]:

- Only use antibiotics when prescribed by a doctor.
- Never requesting antibiotics if the doctor doesn't prescribed.
- Don't use leftover.
- Follow the healthcare worker advice toward antibiotics.
- Hand hygiene and avoiding contact with sick people.
- Prepare food hygienically and choose foods that have produced without the use of antibiotics for growth promotion or disease prevention in healthy animals [46].

Doctors

Healthcare providers should prescribe antibiotics only for infections they believe caused by bacteria. Food and Drug Administration (FDA) has issued drug labeling regulations, emphasizing the judicious use of antimicrobial drugs. The rules support healthcare professionals to prescribe antibiotics only when clinically needed and to counsel patients about the correct use of drugs with the importance of taking them as directed. The primary challenge which facing healthcare professionals are to fight and reduce antibiotics resistance, so based on global studies the most effective strategy for reduction of antibiotics resistance is to activating stewardship program [47].

Policymakers

Antibiotic resistance needs to be addressing through national policies. An effective system is required to improve acting with antibiotics. Development countries started with a severe strategy based on evidence that reflects importance needs of new system or policy to rationing the use of antibiotics. A global burden toward challenges of increasing resistance bacteria to promotes standards to facing the most factors which accelerate the spread of AMR. Many factors are rapidly driving antibiotics resistance such as poor hygiene, misuse or abuse of drugs, malnutrition, crowded places, contaminated food, and contaminated water. Understanding the importance of international and national policy will help to reduce the antibiotics resistance. Effective efforts with strict strategies will help to optimize drugs as well as WHO recommendations. Effective efforts with strict strategies will help to optimize drugs as well as WHO recommendations [48]. Controlling the spread of infections is one of the critical pillars of healthcare facilities. In this regard, there is an urgent need for education and complying with national guidelines to control and minimize the overuse of antibiotics even this policy not exited it should be creating and ongoing updating [49].The importance of policy at healthcare setting for many reasons such as eliminate the use of unnecessary antibiotics and restrict the use of unnecessary powerful ones, regulate and support the optimal use of drugs, improve patient care by promoting a high level of practice, make the information available at a healthcare setting, and creation a national action plan to prevent the spread of antibiotic resistance is in place.

new antibiotic because of the spread of infectious diseases and at the same time to regulate the irrational use of antibiotics strictly.

New Strategies for Antibiotics Agents Discovery

New antibacterial drug discovery methods include: [42]

- Antibacterial drugs have unique physicochemical properties which are dependent on their spectrum of activity.
- Natural products are recommended to be an appropriate antibacterial drug screening library on the work of researchers.
- Identifying workable drug targets given the vast microbial genomics information by comparing several pathogen genomes and mechanism and absence of human homolog and low probability of resistance development is a failed strategy.
- Work on the improving the quality of libraries.
- Passive immunization which activates the host immune response that's leading to pathogen clearance by attacking the organism directly.
- Improving formulations of alternative drug delivery.
- Host factors enzymes that play a major role in host innate immunity could be designed for stability and used for antimicrobial therapy.
- Impact of infection control on minimize the spread of AMR

Individual

Personal habits and cultural behavior regarding the rational use of antibiotics is an essential part of the completion of the therapeutic phase and prevention of diseases that may result from non-compliance in the course of treatment. In this regard, many studies have shown that personal use by taking antibiotics without consulting a physician or not completing the course of treatment may lead to the unwelcome events. Self-medication may one of the significant causes of contribution the AMR worldwide [18]. Self-medication defined as the use of drugs without consultation or a device of a physician. Due to the lack of healthcare centers many individuals decide to take medications without prescription especially in the case of low- and middle-income countries where antimicrobial stewardship is almost poor, this program become more important to control and reduce AMR by right selection, right dose, and right duration. Also, according to international and national studies approved the main sources for inappropriate use among individuals are pharmacies and leftover medications from previous prescriptions [43]. So, there is urgent need to implement of WHO Global Strategy which aimed to reduce abuse and to do campaigns displayed in public areas such as malls and government departments.[17,44] Public education is one of the most important factors in reducing the burden of AMR at community[16].

related to resistant bacteria, enhancing surveillance on proper use of antibiotics and antibiotics resistance, and informing providers and the general public about antibiotic resistance and optimal use of antibiotics [55].

2. OBJECTIVES

Study goals were to assess the knowledge, attitude towards optimal use of antibiotics, and awareness regarding the resistant bacteria among medical students at two universities, University A University B, and to determine if gender, age, education, and nationality affect antibiotic use and resistance knowledge, attitude, and awareness and to statistically compare University A and University B medical students' antibiotic use and resistance knowledge, attitude, and awareness.

3. MATERIALS AND METHODS

Cross sectional survey by using structured self-administrative questionnaire. The questionnaire was adapted from the previous study to meet current goals [12]. The previous study's author granted permission if the source article and author are credited. The prior study validates and reliability. Experts examined a questionnaire. Three medical student groups: The first year: medical knowledge is still raw. Third year: Students begin undergraduate clinical rotations and learn basic medical knowledge. The fifth-year: students should have the most antibiotic knowledge in their last year of undergraduate clinical rotation.

This distribution will show student knowledge levels. This poll excludes the second and fourth years since their basic and clinical knowledge may be incomplete. The questionnaire has four sections. Demographics begin. The second section will test participants. The third portion will examine antibiotics attitudes. Finally, the fourth portion will determine antibiotic resistance awareness.

Questionnaire

Experts reviewed the questionnaire. The prior study validates and reliability. Hardcopy questionnaire distribution. See appendix for full questionnaire.

Site: University A and University B**.**

Data collection: From the period May 2018 to January 2019.

Study approval: The study was approved by IRB at University A and faculty of medicine at University B.

Sample size: University A has 307 first-year medical students, 208 third-year students, and 88 fifth-year students (total 603), while University B has 65 first-year students, 75 third-year students, and 58 fifth-year students (total 198).

University A sample size: 159 students. Three-group comparison.53 students per group assuming 0.5 effect size, $\alpha = 0.05$, $\beta = 0.2$.

University B sample size: 111 students. Three-group comparison.37 students per group assuming 0.5 effect size, $\alpha = 0.05$, $\beta = 0.2$.

Respond rate: 294 (73.5%) of 400 University A students completed a paper questionnaire.

Agriculture aspect

The resistant bacteria in agriculture sector being one of the global public health problems. Uses of antimicrobial agents without consultation will contribute and spread of antimicrobial populations with consequences for animal and public health. Antibiotics used in animal production and human medicine are very similar [50]. The overuse of antimicrobial agents in food-producing animals has been accelerating of AMR in bacterial populations [18,51]. The emergence of resistant bacteria organisms in animal populations can affect animal’s health and their productivity. It is essential that’s rational antibiotics practice dependable in veterinary as well as in human medicine to minimize the selection pressures with the aim of minimizing the emergence of resistant bacteria [51]. AMR may be spreading to the environment through farm waste which can reach human as a result of direct contact with animals, the consumption of contaminated foods of animal origin, water, and vegetables [50]. A close relationship between resistant bacteria in human and antibiotics uses in agriculture sector which we need to understand how antimicrobial prescribing sits amongst other factors that might drive antimicrobial use in both human and agriculture aspect. Strong responsibility that’s including pressure from clients and lack of roles and strategies such as management in the facility all may lead to irrational prescribing in some context. Interventions to improve or decrease antimicrobial use on farms will need to control and prevent the spread of this phenomenon at the human and agriculture sector [51]. Moreover, better awareness of the consequences of AMR in disease control and farm productivity would be helpful to preclude the overuse or abuse of antibiotics in animal production [50]. A recent WHO report emphasizes the importance of undergraduate training courses in prudent using of antibiotics [52].

Education programs play an essential role in teaching and changing the behavior among students and healthcare workers, where physicians are well-informed and share suggestions. Many studies have shown that guidelines and education intervention programs in hospitals reduce antimicrobial consumption costs and minimize the emergence of resistant germs. A strategy that can be used to promote the rational use of antibiotics and decrease the resistant germs through ongoing education programs, ongoing drug-auditing practices, work on formulations restriction, pharmacy justification, surveillance, and work by multidisciplinary team [53]. Moreover, Antibiotic stewardship programs (ASPs) should address not only for doctors in practice but also students in medical school. Work on the program from the academic levels will give a positive impact reflected on awareness in the optimal use and dangerousness of resistant organisms [54]. With this funding, CDC is fighting the antibiotic resistance by accelerating outbreak detection and prevention in every healthcare facility, supporting innovative research to address gaps in knowledge

Statistical Methods:

Numerical averages, standard deviations, frequencies, and percentages have been used. Also, the chi-square test, independent samples T-test, the ANOVA test and the LSD test, and simple linear regression have been used. For statistical analysis: we used a statistical package for social science software (SPSS).

123 of 150 University B students completed a paper questionnaire.

Research variables

- **Dependent variables**
  - Knowledge, attitude, and awareness of antibiotics use and resistance among medical students.
- **Independent variables**
  - Gender, year of birth, year of undergraduate study, place of birth (country), and at least one member of your family works in a health-related field

4. RESULTS

University A

Description of the sample according to the demographic variables.

Table (1): Distribution of the members for at University A.

Demographic		Frequency	Percent
Gender	Male	144	49.0
	Female	150	51.0
Year of birth	18-21	169	57.5
	22-25	120	40.8
	Over	2	0.7
Place of birth (country)	Saudi Arabia	137	47.2
	Non-Saudi	153	52.8
Year of study	First year	104	35.4
	Third year	107	36.4
	Fifth year	83	28.2
At least one member of your family works in a health related field	Yes	188	64.4
	No	104	35.6

From the table (1) the number of males at university A and their percentage (144, 49%), while the number of females and their percentage (150, 51.1%). The age group (18-21) was the biggest number (169, 57.5%), while the percentage of the group aged between (22 -25) was (120, 40.8%), and the lowest percentage for group age more than 25 (2, 0.7%). The number and percentage of Saudis (137, 47.2%), while the number and percentage of non-Saudis (153, 52.8%). The number and percentage of students in the first year (104, 35.2%) and the number and percentage of students in the third year (107, 36.4%), while the number and percentage of students in the fifth year (83, 28.2%). The number and percentage of students with a family member working in the health sector were (188, 64.4%) and the percentage of students who do not have relatives working in the health sector (104, 35.6%).

The level of knowledge toward antibiotics among medical students at University A

Table (2): Statistical averages, mean, and standard deviations of the antibiotic's knowledge.

Question	True		FALSE		Mean	SD	Chi-square	P-Value	Level
	N	%	N	%					
1	260	88.4	34	11.6	0.88	0.320	173.728[a]	0	High
2	246	83.7	48	163	0.84	0.370	133.347[a]	0	High
3	286	97.3	8	2.7	0.97	0.163	262.871[a]	0	High

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4	220	74.8	74	25.2	0.75	0.435	72.503[a]	0	High
5	194	66	100	34	0.65	0.475	30.054[a]	0	Medium
6	178	60.5	116	39.5	0.61	0.490	13.075[a]	0	Medium
7	246	81.6	54	18.4	0.82	0.388	117.673[a]	0	High
8	61	20.7	231	78.6	0.22	0.432	288.510[b]	0	Low
	Knowledge				0.7181	0.20884			High

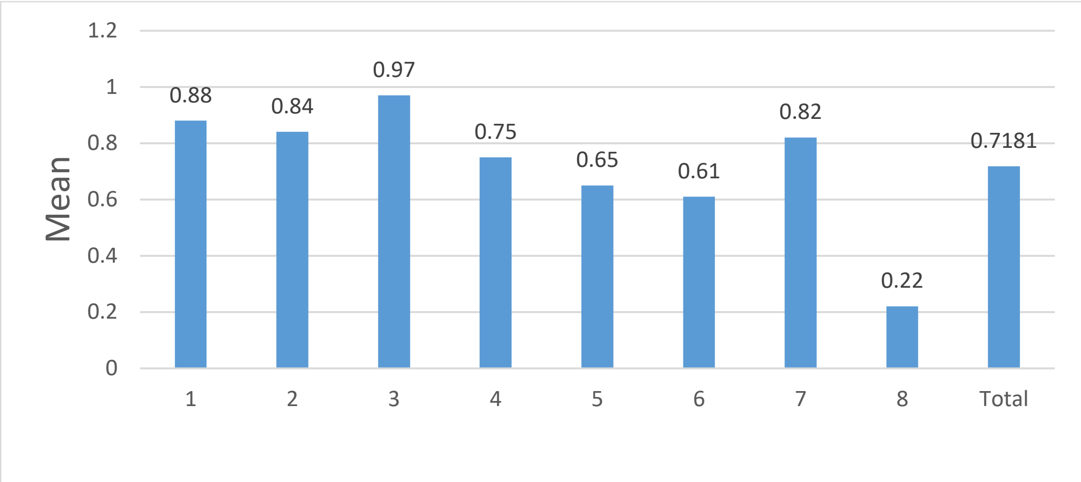

Figure (4): Statistical averages and standard deviations of knowledge toward antibiotics at University A.

- **Knowledge: To classify the level of knowledge the low (0-0.33), Medium (0.334-0.666), and high (0.667-1).**

Table (2) and figure (4) show antibiotic knowledge is high. Mean (0.7181), standard deviation (0.2088), and knowledge rate (71.81%). Table (2) and figure (4) indicate a spectrum of expertise. The mean in all paragraphs ranged from (0.22 to 0.97), with the highest level of knowledge in question 3 (Antibiotics are used to treat bacterial infections) with a mean of 0.97, a standard deviation of 0.136, and a knowledge ratio of 97%, and the lowest in question 8 (New antibodies are usually better than old ones) with 0.432 and 22%. Chi-square tests demonstrated statistical significance. Except for question 8, the wrong answer was more than the correct answer and statistically significant.

The level of awareness toward antibiotics among medical students at University A

Table (3): Statistical averages, mean, and standard deviations of the awareness toward antibiotics.

Question	True		FALSE		Mean	SD	Chi-square	P-Value	Level
	N	%	N	%					
1	260	11.6	34	88.4	1.88	0.320	173.73	0	High
2	222	75.5	72	24.5	1.76	0.431	76.53	0	High
3	247	84	47	16	1.84	0.367	136.05	0	High
4	242	82.3	52	17.7	1.82	0.394	122.79	0	High
5	244	83	50	17	1.83	0.388	128.01	0	High
6	103	35	191	65	1.32	0.507	26.34	0	Low
	Awareness				1.7432	0.24767			High

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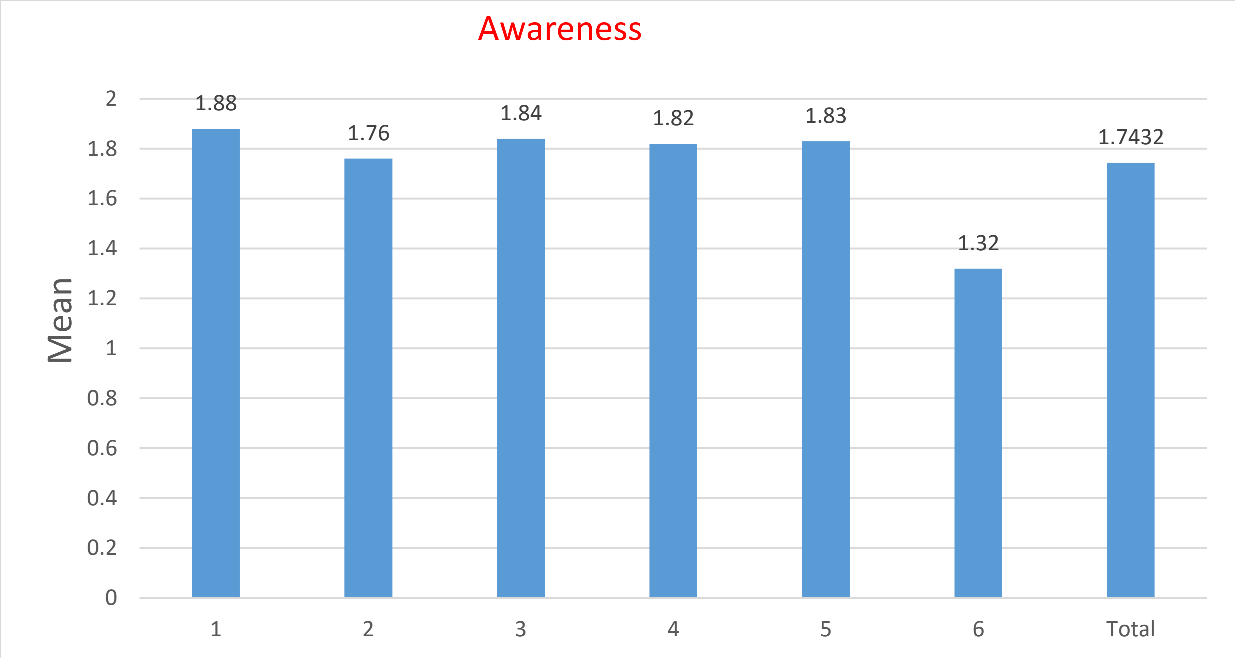

Figure (5): Statistical averages, mean, and standard deviations of awareness toward antibiotics at University A.

- **Awareness: To classify the level of awareness from low (1-1.333), medium (1.334-1.666), and high (1.667-2).**

Antibiotic awareness is high, as shown in table (3) and figure (5). The level of awareness toward antibiotics, in general, is high. The level of the mean is (1.7432), with a standard deviation (0.24767). The table and figure illustrate low and high awareness. The mean average in all paragraphs ranged from (1.32 - 1.88), with the highest level of awareness in question 1 (Have you ever heard about antibiotic resistance?), where the mean is (1.88) standard deviation (0.320), rate of awareness is (94%), and the lowest level in question 6 (Antibiotics used in animals can lead to antibiotic resistance), where the mean was (1.32), standard deviation (0.507), and awareness rate of (66%). Chi-square tests demonstrated statistical significance. There is a difference between those who answered a correct answer and those who responded incorrect answer and for those who answered correctly in all statements and statistical terms.

The level of attitude toward antibiotics among medical students at University A

Table (4): Statistical averages and standard deviations of attitude toward antibiotics at University A.

Question	True		False		Mean	SD	chi square	P-Value	Level
	N	%	N	%					
1	231	78.36	63	21.4	1.79	0.411	96	0	High
2	228	77.6	66	22.4	1.77	0.428	89.26	0	High
3	212	72.1	82	27.9	1.71	0.467	231.51	0	High
4	203	69	91	31	1.69	0.463	42.67	0	High
5	208	70.7	86	29.3	1.70	0.465	50.63	0	High
6	191	65	103	35	1.65	0.486	26.34	0	Medium
7	160	54.4	133	45.2	1.55	0.499	2.49	0.115	Medium
8	274	93.2	20	6.8	1.93	0.271	219.44	0	High

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	Attitudes	**1.7270**	**0.26168**			**High**

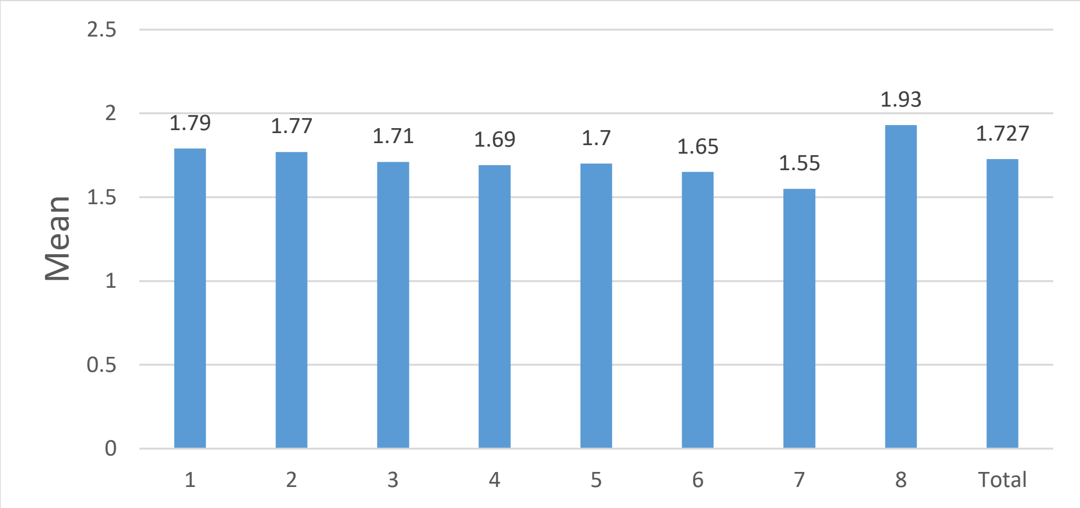

Figure (6): Statistical averages and standard deviations of attitude toward antibiotics at University A.

- **Attitude: To classify the level of attitude from low(1-1.333), medium(1.334-1.666), and high(1.667-2).**

The level of attitudes is high, according to the table (4) and figure (6). The mean (1.7270), standard deviation (0.26168), and attitude ratio (86.35%) are positive. As indicated in the table and figure, positive attitudes regarding antibiotics ranged from medium to high, and the mean in all paragraphs was (1.55–1.93). Question 8 (do you think hand hygiene will prevent infection transmission) had the highest level of attitude with a mean (1.93), standard deviation (0.271), and estimated (96.5%). Question 7 (Have you ever started an antibiotic therapy after a simple doctor call, without a proper medical examination) had the lowest mean (1.55), standard deviation (0.499), and estimated positive attitude (77.5%). Chi-square tests demonstrated statistical significance. All statements except the seventh had a difference between those who answered correctly and those who answered incorrectly.

University B

Description of the sample according to the demographic variables.

Table (5): Distribution of the members of the sample at University B.

Demographic		**Frequency**	**Percent**
Gender	**Male**	**78**	**63.4**
	Female	**45**	**36.6**
Year of birth	**18-21**	**51**	**41.5**
	22-25	**63**	**51.2**
	Over	**9**	**7.3**
Place of birth (country)	**Saudi Arabia**	**81**	**93.1**
	Non-Saudi	**6**	**6.9**
Year of study	**First year**	**44**	**35.8**
	Third year	**45**	**36.6**
	Fifth year	**34**	**27.6**
Atleast one member of your family works in a healthrelated field	**Yes**	**61**	**53.5**
	No	**53**	**46.5**

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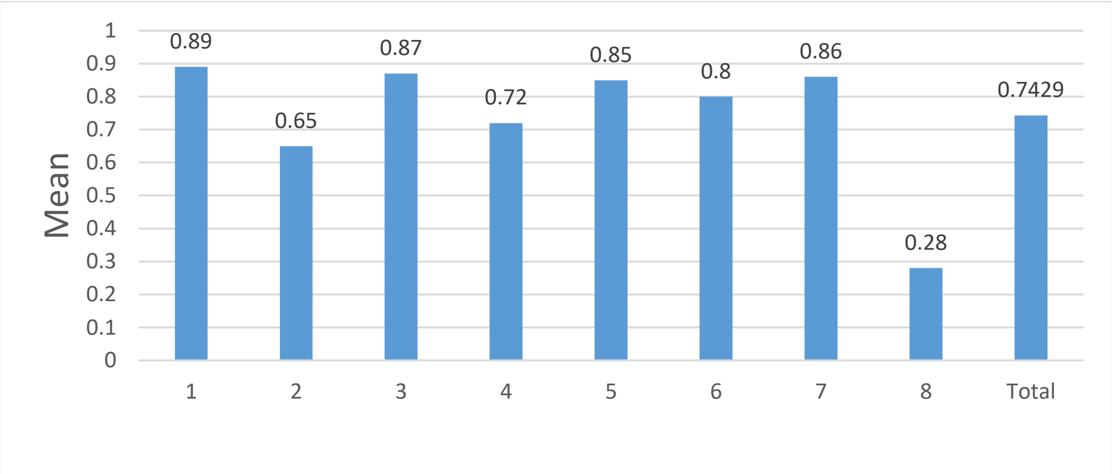
Demographic variables of University B as shown in table (5): Males were 78 (63.4%) and females 45 (36.6%). The highest age group was (22-25) (63, 51.2%), followed by (18-21) (41.5%) and over 25 (9.3%). Saudis 981, 93.1%), non-Saudis (6, 6.9%). The first year had 44 students (35.8%), the third year 45 (36.6%), and the fifth year 34 (27.6%). 61 students (53.5%) have family members in the health industry, whereas 53 students (46.5%) did not.

The level of knowledge toward antibiotics among medical students at University B.

Table (6): Statistical averages and standard deviations of knowledge toward antibiotics at University B.

Question	True		FALSE		Mean	SD	Chi-square	P-Value	Level
	N	%	N	%					
1	13	10.6	110	89.4	0.89	0.309	76.496[a]	0	High
2	82	66.7	41	33.3	0.65	0.473	13.667[a]	0	Medium
3	107	87	16	13	0.87	0.338	67.325[a]	0	High
4	89	72.4	34	27.6	0.72	0.449	24.593[a]	0	High
5	105	85.4	18	14.6	0.85	0.355	61.537[a]	0	High
6	98	79.7	25	20.3	0.80	0.404	43.325[a]	0	High
7	106	86.2	17	13.8	0.86	0.347	64.398[a]	0	High
8	34	27.6	89	72.4	0.28	0.449	24.593[a]	0	Low
	knowledge				0.7429	0.211			High



Figure(7): Statistical averages and standard deviations of knowledge toward antibiotics at University B.

- **Knowledge: To classify the level of knowledge from low (0-0.33), Medium (0.334-0.666), and high(0.667-1).**

From the table (6) and figure (7) shown the level of knowledge about antibiotics among medical students at University B, in general, is high. The level of the mean is (0.7429) with a standard deviation of (0.211) and an estimated rate of (74.3%). As shown in the table (6) and figure (7) the level of knowledge ranged from low to high. The arithmetic mean in all the paragraphs ranged between (0.28 and 0.89). The highest level of knowledge was in the question 1 (Penicillin or Amoxicillin are antibiotics) where the mean is (0.89) with a standard deviation (0.309) and an estimated knowledge rate (89%), while the lowest level of the knowledge of medical students found in question (8) (New antibiotics are usually better than old ones) where the mean is (0.28), standard deviation (0.499), and an estimated knowledge rate (28%). The results of the chi-square test are statistically significant, and there is a difference between those who responded correctly and those who answered the wrong answers in all of the statements except the question (8) where those who answered the wrong answer were more than the correct answer and statistical significance.

The level of awareness toward antibiotics among medical students at University B

Table (7): Statistical averages and standard deviations of awareness toward antibiotics at University B.

Question	True		FALSE		Mean	SD	Chi-square	P-Value	Level
	N	%	N	%					
1	110	89.4	13	10.6	1.89	0.309	76.496a	0	High
2	111	90.2	12	9.8	1.90	0.298	79.683a	0	High
3	103	83.7	20	16.3	1.84	0.371	56.008a	0	High
4	101	82.1	22	17.9	1.82	0.385	50.740a	0	High
5	91	74	32	26	1.74	0.441	28.301a	0	High
6	34	27.6	89	72.4	1.28	0.449	24.593a	0	Low
	Awareness				1.7425	0.21366			High

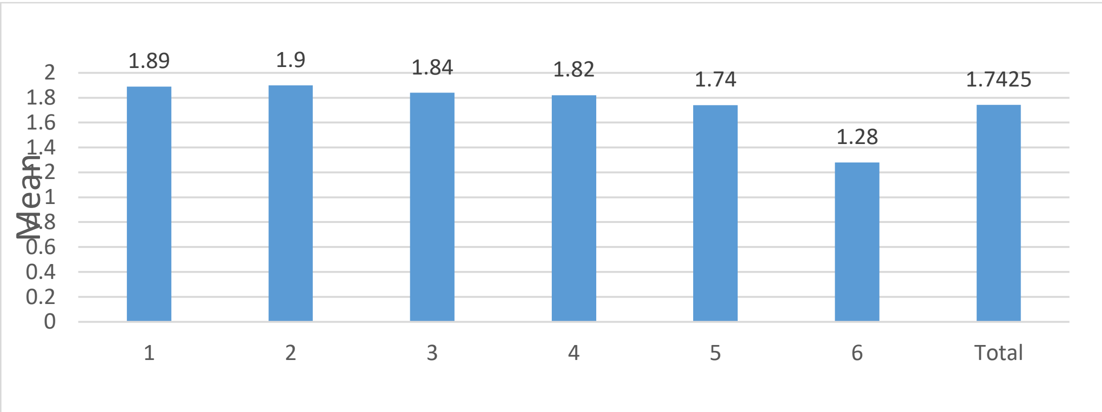


Figure (8): Statistical averages and standard deviations of awareness about antibiotics at University B.

- **Awareness: To classify the level of awareness from low(1-1.333), medium(1.334-1.666), and high(1.667-2).**

According to the table (7) and figure (8) shown the level of awareness toward antibiotics among the medical students at University B is high with a mean (1.7425), a standard deviation (0.21366), and an awareness rate of (87.13%). As shown by the table(7)and figure(8) the level of awareness was low and high, the mean average in all the paragraphs ranged from (1.28 to 1.90), where the highest level of awareness found in question (2) (In particular, have you discussed the problem of antibiotic resistance during study courses), the mean was (1.90), with a standard deviation (0.298), and an awareness rate of (95%) , while the lowest expression measures the level of awareness (6) (Antibiotics used in animals can lead to antibiotic resistance) the mean was (1.28), standard deviation (0.449), and an awareness rate of (64%). The results of the chi-square test are statistically significant, there is a difference between those who answered correctly and those who answered incorrect answers and for those who answered correctly in all the statements except the question (6) where those who responded the wrong answer were more than the correct answer which means statistically significant.

The level of attitude toward antibiotics among medical students at University B

Table (8): Statistical averages and standard deviations of attitude toward antibiotics at University B.

Question	True	FALSE	True	FALSE	Mean	SD	chi square	P-Value	Level
	N	%	N	%					
1	96	78	27	22	1.78	0.416	38.707a	0	High
2	97	79.5	25	20.5	1.80	0.405	42.492b	0	High
3	80	65	43	35	1.65	0.479	11.130a	0.001	Medium
4	95	77.2	28	22.8	1.77	0.421	36.496a	0	High
5	89	72.4	34	27.6	1.72	0.449	24.593a	0	High
6	83	67.5	40	32.5	1.67	0.470	15.033a	0	High
7	90	73.2	33	26.8	1.73	0.445	26.415a	0	High
8	109	88.6	14	11.4	1.89	0.319	73.374a	0	High
	Attitude				1.7449	0.258			High

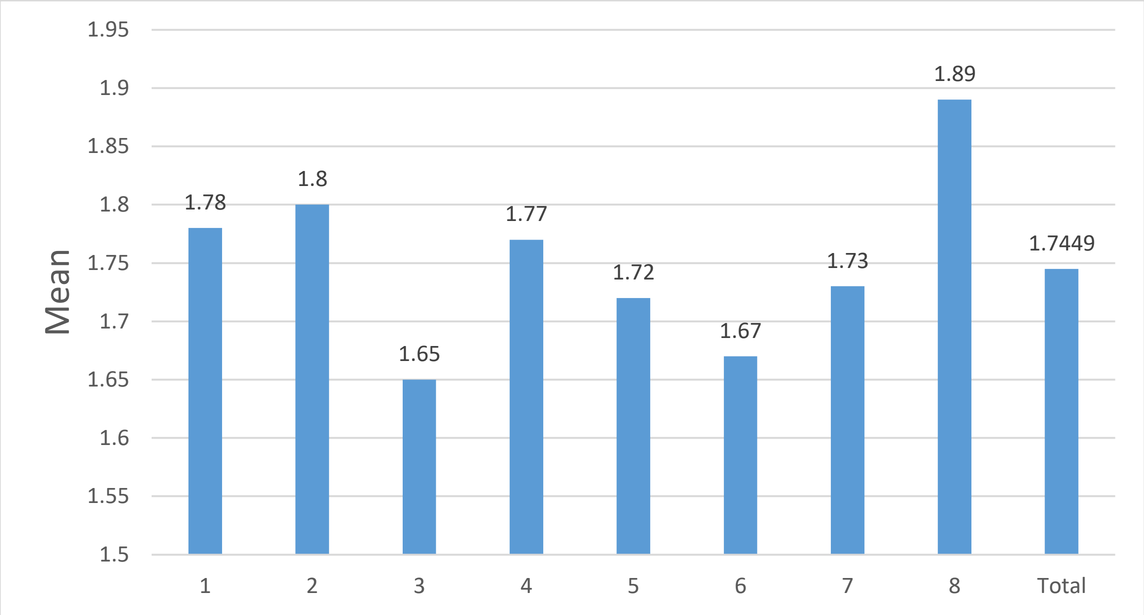


Figure (9): Statistical averages and standard deviations of attitude toward antibiotics at University B.

- **Attitude: To classify the level of attitude from low(1-1.333), medium(1.334-1.666), and high(1.667-2).**

According to table (8) and figure (9), University B students generally have a positive view of antibiotics. Mean (1.7449), standard deviation (0.258), and favorable attitude rate (86.23%). As demonstrated in table (8) and figure (9), antibiotic positivity ranged from mild to high. All paragraphs averaged (1.65–1.89). Question 8 (Do you think hand hygiene will reduce the chance of infection transmission) had the greatest antibiotic attitude, with a mean of (1.89), a standard deviation of (0.319), and a positive attitude of (94.5%). The lowest level of attitude was question (3) (Do you stop taking antibiotics when you start feeling better), with a mean (1.65), standard deviation (0.479), and estimated positive attitude (82.5%). The chi-square test shows a difference between those who replied properly, those who answered incorrectly, and those who answered right in all statements.

Statistical significant and correlation between different independent variables related to:

A. Knowledge

The difference in the average knowledge of antibiotics in the study sample by the gender differences at the level of statistical significance 0.05.

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Table (9): The difference in the average knowledge toward antibiotics by the gender variables.

Gender		N	Mean	Std. Deviation
knowledge	Male	223	0.7029	0.22265
	Female	196	0.7526	0.19071

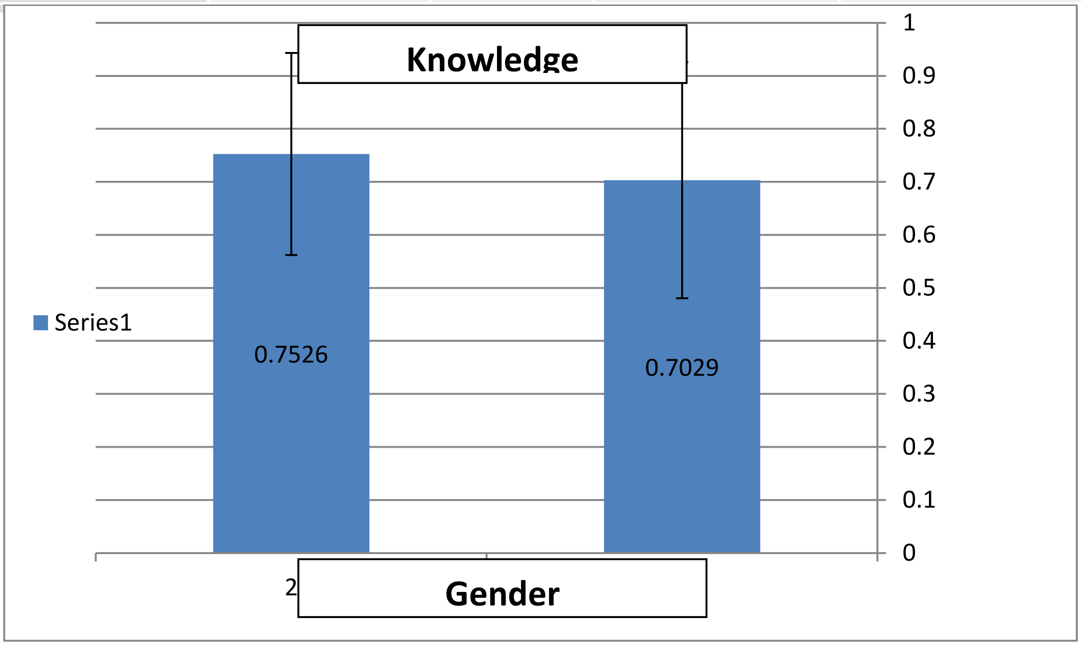

Figure (10) of the average of knowledge toward antibiotics by the gender variables.

According to the table (9) and figure (10), differences are found in the mean of knowledge toward antibiotics in the sample of the study based on the gender variable and for females. To determine the statistical significance of these differences, we used the Independent Samples T-test.

Table (10): Independent Samples T-test, the statistical differences of knowledge based on gender variable.

T-test for Equality of Means			
t	df	P-value	Mean Difference
-2.458	416.732	0.014	-0.04964

According to the table (10), the Independent samples T-test shown that the value of T = -2.458 is a statistically significant value of (P_ VALUE) <0.05 so, the decision will be the acceptance of research hypothesis, the average knowledge of the sample of the study population varies by gender at the statistical significance level (0.05) for females in mathematical terms. So, the level of knowledge regarding antibiotics is higher among females (0.75) than males (0.70). **The difference in the average knowledge of antibiotics in the study sample according to year of birth at the level of statistical significance 0.05.**

Table (11): Statistical average knowledge toward antibiotics in the study sample according to year of birth variables.

	Year of birth	N	Mean	Std. Deviation

Knowledge	18-21	220	0.6852	0.22106
	22-25	196	0.7723	0.18707

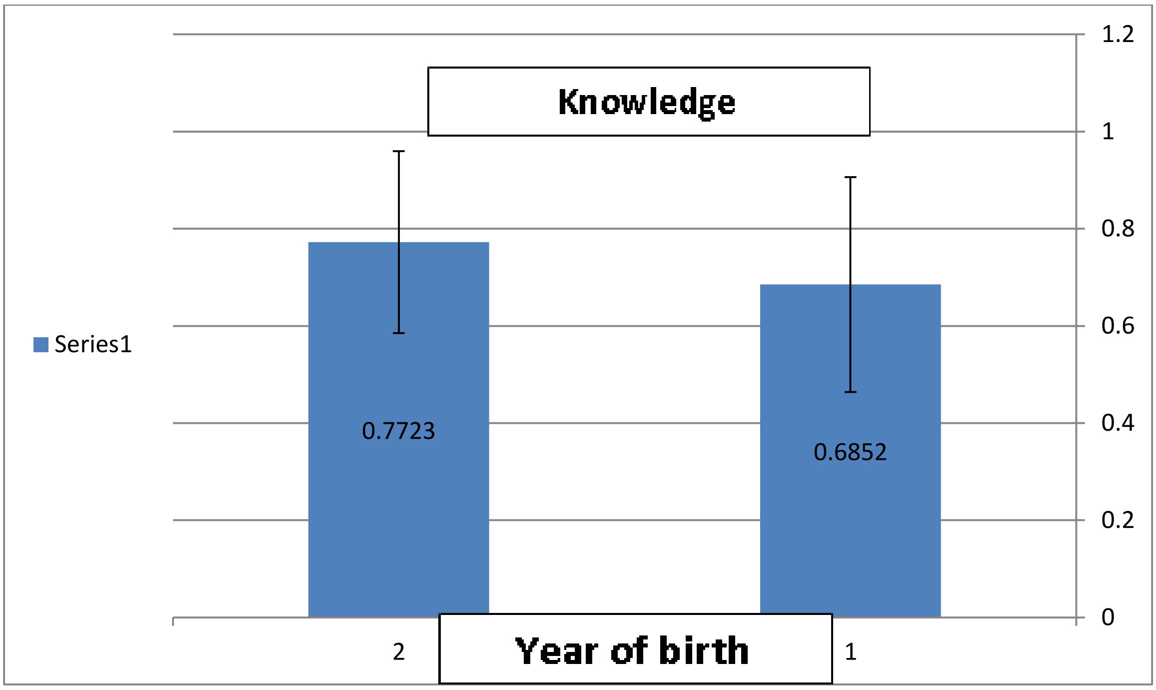

Figure (11): Average knowledge toward antibiotics in the study sample according to the year of birth variable.

According to the table (11) and figure (11) there are differences in the mean of knowledge toward antibiotics in the study sample which is related to the year of birth variable (22-25). To determine the statistical significance of these differences, we used the Independent samples T-test.

Table (12): Independent samples T-test, the statistical differences of knowledge based on year of birth variable.

T-test for Equality of Means			
t	**df**	**P-value**	**Mean Difference**
4.351	**412.932**	**0.000**	**0.08709**

From the table (12), the Independent samples T-test shown that the value of T = 4.351 is statistically significant (P-value <0.05) so, the decision will be the acceptance of research hypothesis, the average of the knowledge in the study sample varies according to the year of birth at the statistical significance level (0.05) age group (22-25), mathematical terms. In this regard, the level of knowledge regarding antibiotics is higher among the age group (22-25) (0.77) than other age group.

The difference in the average knowledge of antibiotics in the study sample according to year of study at the level of statistical significance 0.05.

Table (13): Statistical averages and deviations of the level of knowledge toward antibiotics according to year of study variable.

Year of study	N	Mean	Std. Deviation
First year	**148**	**0.6115**	**0.21780**

Third year	154	0.7638	0.19204
Fifth year	117	0.8216	0.14709
Total	419	0.7261	0.20955

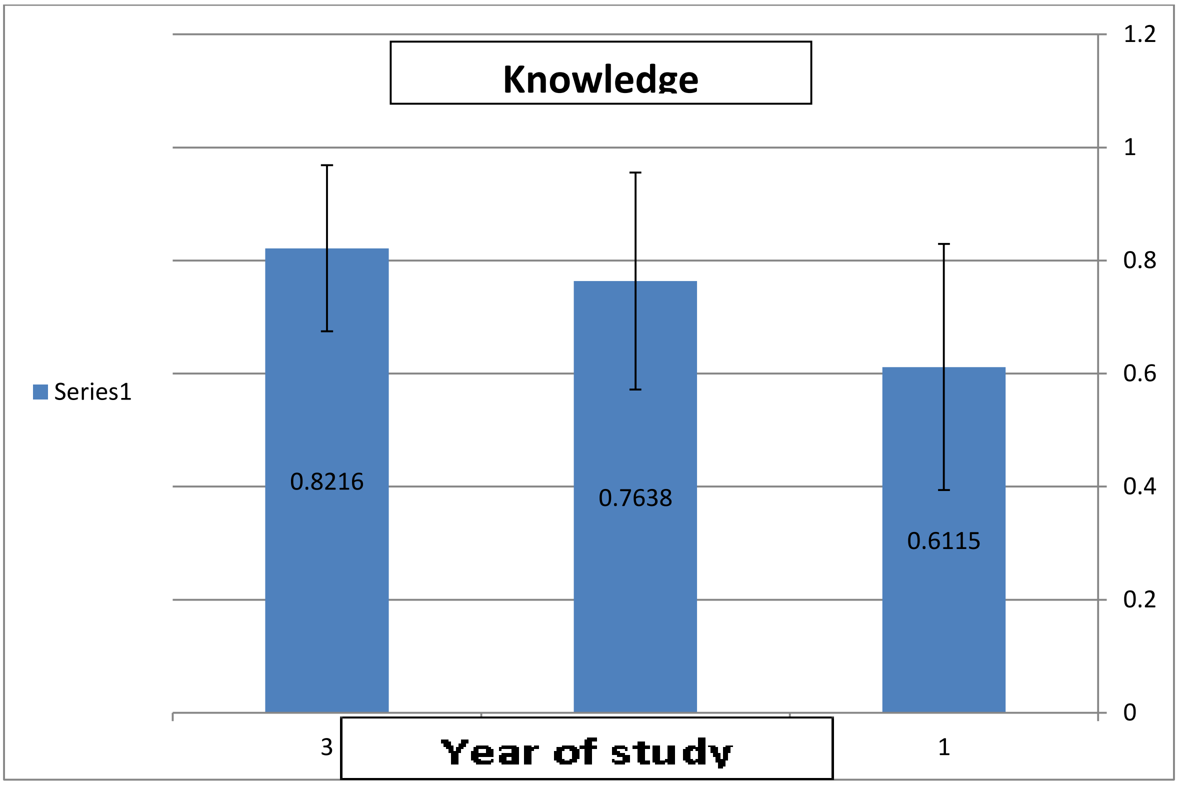

Figure (12): The average of knowledge toward antibiotics according to the year of study variable.

According to the table (13) and figure (12), there are differences in the average knowledge of medical students toward antibiotics in the sample of the study attributed to the year of study. To determine the statistical significance of these differences, we used the ANOVA Test.

Table (14): ANOVA test, the statistical differences of knowledge based on the year of study variable.

Source	Sum of Squares	df	Mean Square	F	P-value
Between Groups	3.230	2	1.615	44.414	0.000
Within Groups	15.125	416	0.036		
Total	18.355	418			

By used the ANOVA Test, we found the value of F = 44.414 test is statistically significant (P-VALUE <0.05) and the this mean the acceptance of research hypothesis, the average of knowledge in the sample of the study differs according to the year of study at the statistical significance level of (0.05). To know which antibiotic knowledge averages have statistically significant differences depending on the year of study variable, we did the LSD test.

Table (15): Multiple comparisons using the LSD test, statistical differences of knowledge based on year of study variable.

Year of study		Mean Difference (I-J)	P-value
First year	Third year	-0.15231*	0.000
	Fifth year	-0.21009*	0.000
	Fifth year	-0.05778*	0.014

Third year			
Fifth year	First year	0.21009*	0.000
	Third year	0.05778*	0.014

From the LSD test, we found a statistical difference in the average knowledge regarding antibiotics between first-year students and third-year students and the positivity for third-year students, also a statistically significant difference in the average knowledge toward antibiotics between first and fifth-year students and the benefit for fifth-year students, and a statistically significant difference in the average knowledge of antibiotics between third and fifth-year students and the positivity for fifth year students.

B. Awareness

The difference in the average awareness of antibiotics in the study sample according to the year of birth at the level of statistical significance 0.05.

Table (16): Statistical averages and deviations of the level of awareness of antibiotics according to year of birth variable

	Year of birth	N	Mean	Std. Deviation
Awareness	18-21	220	1.6924	0.26859
	22-25	196	1.7985	0.18274

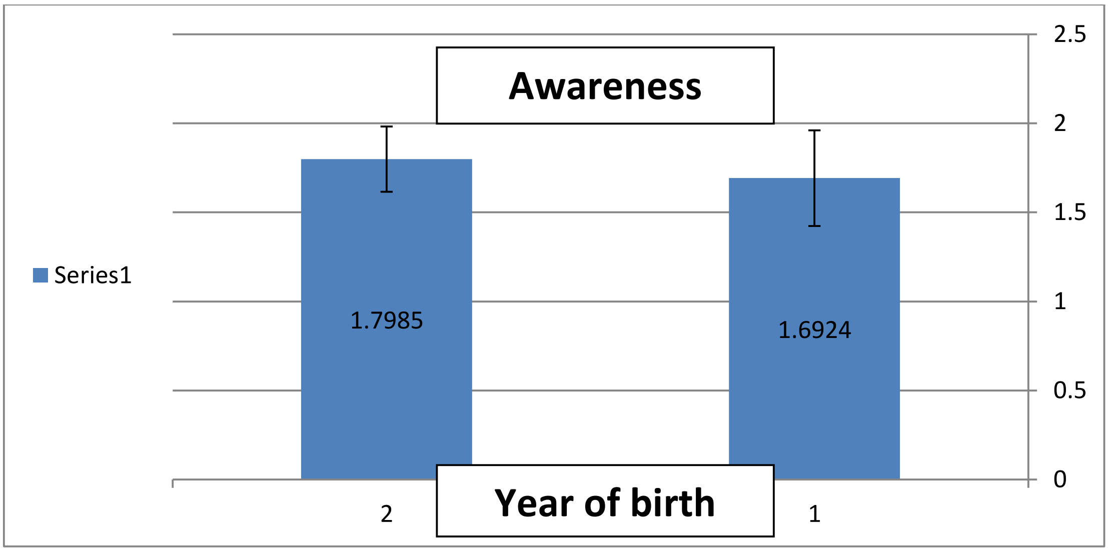

Figure (13): The average awareness toward antibiotics according to the year of birth variable.

According to table (16) and figure (13), there are differences in the mean of awareness about antibiotics among the study sample which based on the year of birth, and we found these differences appear on age (22-25). To determine the statistical significance of these differences, we used the Independent samples T-test.

Table (17) Independent Samples T-test, the statistical differences of awareness toward antibiotics according to year of birth variable

T-test for Equality of Means			
t	df	P-value	Mean Difference
-4.751	388.048	0.000	-0.10605

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Through the Independent Samples T-test, we found that the value of T = -4.751 is statistically significant (P-value <0.05) and this acceptance of research hypothesis, the average awareness of the study sample varies according to the year of birth at the statistical significance level (0.05), and the level of awareness toward antibiotics is higher among the age group (22-25) (0.77) compared to the age group (18-21) (0.70).

The difference in the average awareness of antibiotics in the study sample according to the year of study at the level of statistical significance 0.05.

Table (18): Statistical averages and deviations of the level of awareness toward antibiotics according to year of study variable.

Year of study	N	Mean	Std. Deviation
First year	148	1.6239	0.28314
Third year	154	1.7857	0.19123
Fifth year	117	1.8390	0.15308
Total	419	1.7434	0.23740

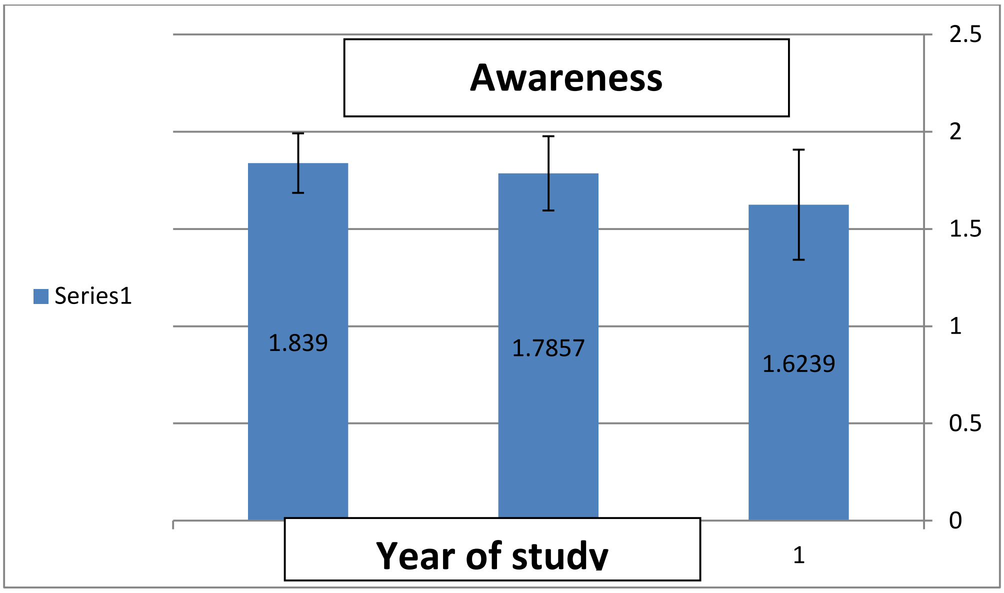

Figure (14): The average awareness towards antibiotics according to the year of study variable.

According to the table (18) and figure (14), we found the differences in the mean of awareness regarding antibiotics among the study sample were attributed to the year of study variable. In order to determine the statistical significance of these differences, we used the ANOVA Test.

. Table (19): ANOVA test, the statistical differences of awareness according to year of study variable.

Source	Sum of Squares	df	Mean Square	F	P-value
Between Groups	3.460	2	1.730	35.810	0.000
Within Groups	20.098	416	0.048		
Total	23.558	418			

The study hypothesis will be accepted because the F = 35.810 test is statistically significant (P-VALUE <0.05) in the ANOVA test table. We will use the LSD test to compare years of study statistically.

Table (20): LSD test, statistical differences of awareness toward antibiotics based on year of study variable.

Year of study		Mean Difference (I-J)	P-value
First year	Third year	-0.16184*	0.000
	Fifth year	-0.21516*	0.000
Third year	Fifth year	-0.05332*	0.049

From the LSD test, we found a statistical difference in the average awareness about antibiotics among first and third-year students and the positivity for third-year students, a statistical difference in the average awareness of antibiotics among first and fifth-year students and the positivityfor fifth-year students, and a statistical difference in the average awareness towards antibiotics among third and fifth-year students and the positivity for fifth-year students.

C. Attitude

The difference in the average attitude of antibiotics in the study sample according to the gender variable at the level of statistical significance 0.05

Table (21): Statistical averages and deviations of the level of attitude toward antibiotics according to the gender variable.

	Gender	N	Mean	Std. Deviation
Attitude	Male	223	1.7040	0.26634
	Female	196	1.7684	0.25040

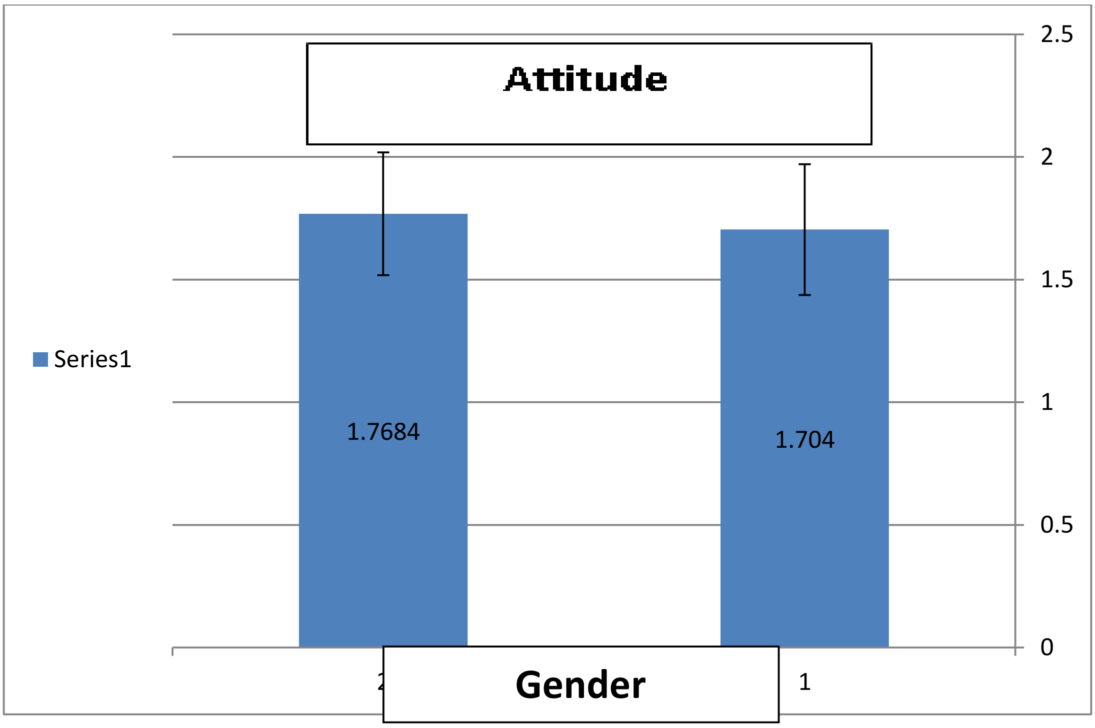

Figure (15): The average of attitude toward antibiotics according to the gender variable.

According to the table (21) and figure (15), we found virtual differences in the average attitude regarding antibiotics in the sample of the study to be attributed to the gender variable and these virtual differences appeared for females. To determine the statistical significance of these differences, we used the Independent samples T-test.

Table (22): Independent Samples T-test, the statistical differences of attitude toward antibiotics according to gender variable.

T-test for Equality of Means			
t	**df**	**P-value**	**Mean Difference**
-2.538	**417**	**0.012**	**-0.06437**

From the Independent samples T-test we found, that the T = -2.538 test value is statistically significant (P-VALUE <0.05) so, the decision will be to accept research hypothesis, the average of the attitude toward antibiotics in the sample of the study varies by gender at the statistical significance level (0.05). So, the level of attitude toward antibiotics varies according to the gender of the student and the positivity appeared for the females.

The difference in the average attitude of antibiotics in the study sample according to the year of birth at the level of statistical significance (0.05).

Table (23): Statistical averages and deviations of the level of attitude toward antibiotics according to year of birth variable

	Year of birth	N	Mean	Std. Deviation
Attitude	**18-21**	**220**	**1.6999**	**0.27140**
	22-25	**196**	**1.7698**	**0.24418**

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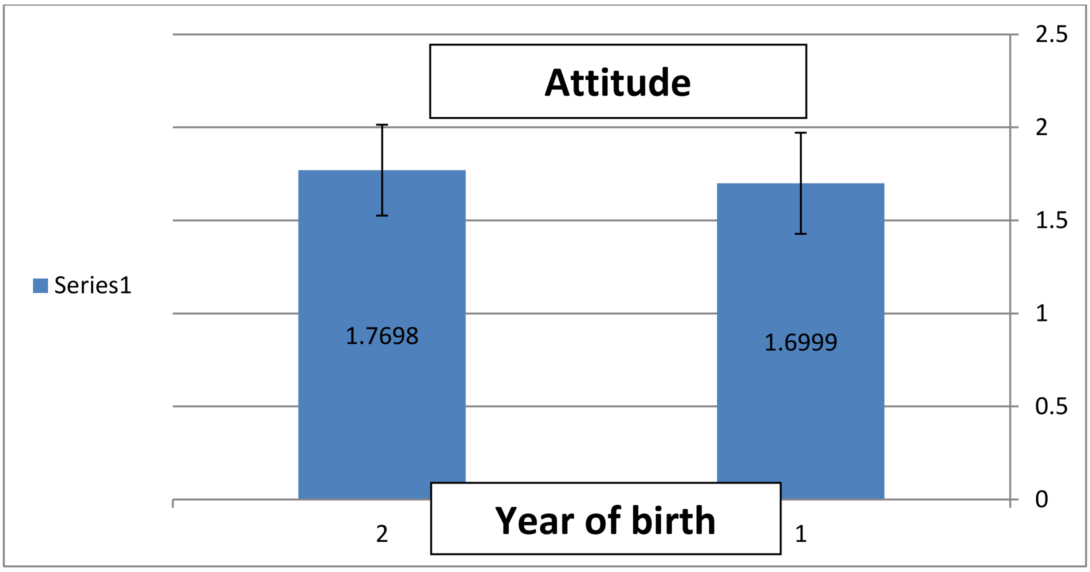


Figure (16): The average of attitude toward antibiotics according to the year of birth variable.

According to the table (23) and figure (16), there are simple differences in the mean of attitude regarding antibiotics in the study sample and it's attributed to the year of birth variable and for the age group (22-25). To determine the statistical significance of these differences, we used the Independent samples T-test.

Table (24): Independent Samples T-test, the statistical differences of attitude toward antibiotics according to the year of birth.

T-test for Equality of Means			
t	**df**	**P-value**	**Mean Difference**
-2.746	**414**	**0.006**	**-0.06985**

From the Independent samples T-test table, we found that the value of the T = -2.746 test is statistically significant (P-VALUE <0.05) and this indicate the acceptance of the research hypothesis, the mean of attitude toward antibiotics in the study sample varies according to year of birth at the statistical significance level (0.05). The difference was in favor of the age group (22-25) in mathematical terms, which mean the attitude of antibiotics in the age group (22-25) is greater than group age (18-21).

The difference in the average attitude of antibiotics in the study sample according to the year of study at the level of statistical significance (0.05).

Table (25): Statistical averages and deviations of the level of attitude toward antibiotics according to the year of study variable.

Year of study	N	Mean	Std. Deviation
First year	148	1.6637	0.27955
Third year	154	1.7792	0.22451
Fifth year	117	1.7639	0.26352
Total	419	1.7341	0.26069

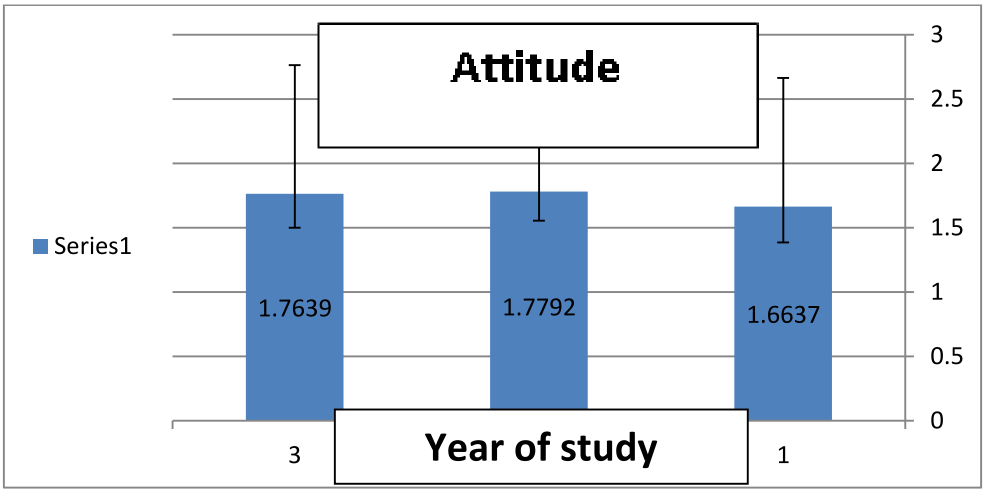


Figure (17): The average of attitude toward antibiotics according to the year of study variable.

According to table (25) and figure (17), the sample's average attitude toward antibiotics differs by the year. We used the ANOVA Test, to determine the statistical significance of these differences.

Table (26): ANOVA test, the statistical differences according to the year of study.

Source	Sum of Squares	df	Mean Square	F	P-value
Between Groups	1.150	2	0.575	8.778	0.000
Within Groups	27.256	416	0.066		
Total	28.406	418			

From the ANOVA Test table, we found that the value of the F = 8.778 and it's a statistically significant where (P-VALUE <0.05) in this regard, the decision to accept the research hypothesis and there are statistically significant differences according to the year of study variable. For a comparison the years of study we used the LSD test

Table (27): Multiple comparisons using the LSD test, the statistical differences according to the year of study.

Year of study		Mean Difference (I-J)	P-value
First year	Third year	-0.11549*	0.000
	Fifth year	-0.10016*	0.002
Third year	Fifth year	0.01533	0.626

According to the LSD test results we found a statistical difference in the average attitude toward antibiotics between first-year students and third-year students and the positivity for third-year students, a statistically significant difference in the average attitude regarding antibiotics between first and fifth-year students and this significance for the fifth-year students, and no statistical significance difference in the average attitude of antibiotics between third and fifth-year students.

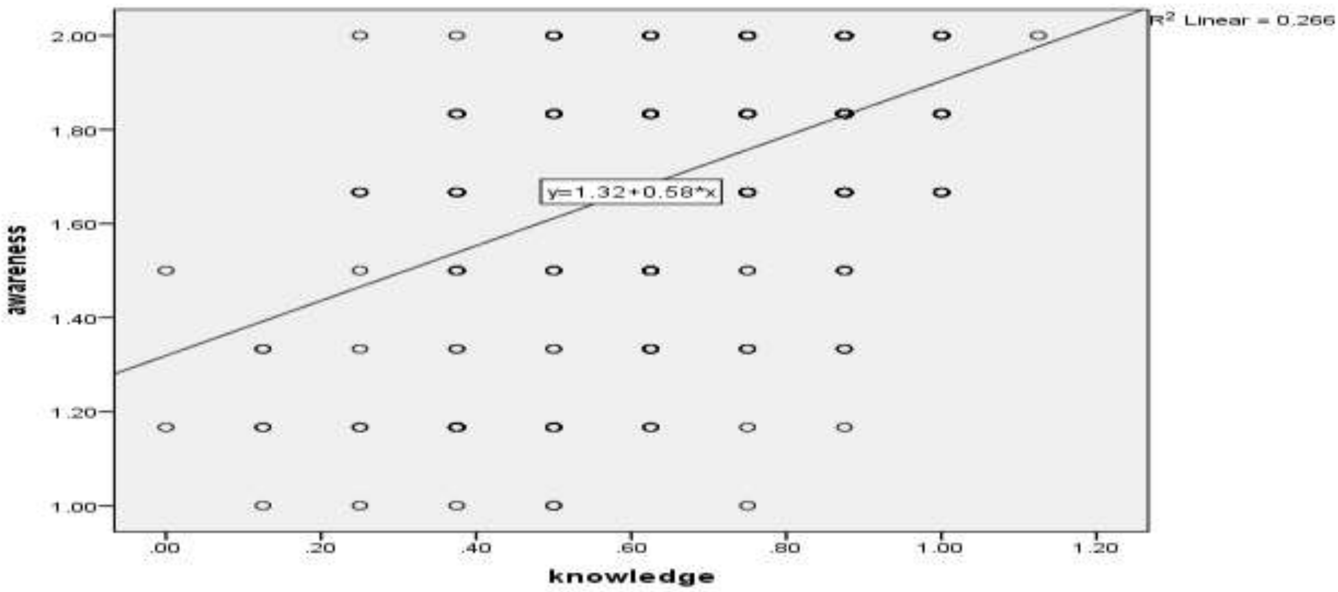
Correlation of dependent variables (knowledge, awareness, and attitude):

A) knowledge with awareness

By using simple linear regression, a relationship between knowledge and awareness has been appeared. Also, we found a correlation and effect between the degree of knowledge and awareness toward antibiotics. A positive effect is shown on figure (18) with a significant correlation table (28), these results revealed that as the knowledge is increasing, the awareness level becomes high.

Table (28): Results of simple linear regression for the effect and association of knowledge on awareness.

R	R Square	F	p-value	B0(Constant)	t	P-VALUE	B1(knowledge)	t	P-VALUE
0.516	0.266	151.166	0	1.32	36.72	0	0.58	12.29	0.12



Figurer :(18): Simple linear regression for the effect and association of knowledge with awareness.

According to table (28) and figure (18), the knowledge and awareness about antibiotics are positively correlated (R = -0.516) and statistically significant (α = 0.05). As seen in the table, the limiting factor (26.6% = R2) is antibiotic awareness, which is explained by the independent variable's effect on the dependent variable's antibiotic knowledge. The regression test of the analysis of the single variance (F = 151.66) is statistically significant at α = 0.05. Thus, the regression between knowledge and awareness toward antibiotic is statistically significant. Through the table, the regression constant B0 and regression factor B1 are statistically significant at α = 0.05. T-test values were significant at α = 0.05. Regression coefficients yield the linear regression equation.

1.32 + 0.58X knowledge

B0 = 1.32: Zero awareness is 1.32.

As knowledge increases, awareness increases 0.58 degrees.

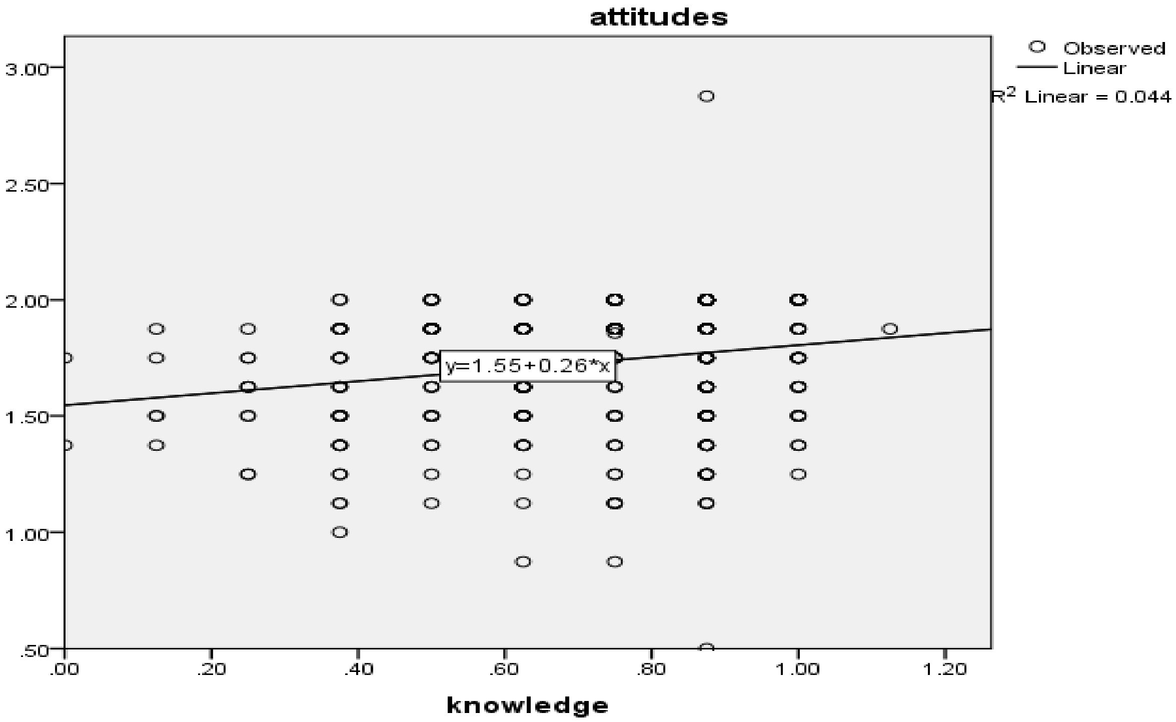
B) knowledge with attitude

Knowledge and attitude regarding antibiotics has been correlated, we found this correlation by using simple linear regression. Figure (19) shows a favorable effect and substantial connection (29). These findings showed that knowledge boosts attitude.

Table (29): Results of simple linear regression for the effect and association of knowledge on attitude

R	R Square	F	p-value	B0(Constant)	t	P-VALUE	B1(knowledge)	t	P-VALU
0.21	0.044	18.97	0	1.55	34.33	0	0.26	4.35	0

.



Figure(19):Simple linear regression for the effect and association of knowledge with attitude.

From the table (29) and the previous figure (19), there is a positive correlation between knowledge and attitude (R = -0.21), which is statistically significant at (0.05 = α). As indicated in the table, the limiting factor (4.4% = R2) explains the effect of the independent variable (antibiotic knowledge) on the dependent variable (antibiotic attitude). The regression test's statistical test value (F = 18.97) is statistically significant at the statistical significance level (α = 0.05) in the table. The regression between antibiotic knowledge and attitude is statistically significant.

The regression constant, regression coefficient B1, and T-test values are all statistically significant at α = 0.05. Regression coefficients yield the linear regression equation.

B0 (Constant) = 1.32: The degree of direction is 1.55 when the degree of direction is zero.

B1 (knowledge) = 0.58: The degree of direction increases by 0.26 degrees as the degree of knowledge increases one degree.

According to the statistical analysis in the study awareness and attitude were not correlated.

5. DISCUSSION

By continuous education through correct use of antibiotics and dangerousness of resistance germs the emergence of AMR will be reduced. Knowledge, awareness, and attitude must start at the bottom. Thus, testing education, awareness, and attitude is crucial to rational antibiotic use and antibiotic resistance reduction. This study compares medical students' knowledge, awareness, and attitudes on antibiotics and antibiotic resistance at two Universities to assess students' science understanding. Undergraduate medical education is the first step. Medical students will prescribe antibiotics in the future; thus, we need to know their antibiotic and antibiotic resistance teaching.

At these stages, medical students' baseline knowledge, awareness, and attitude must be assessed. Medical education should emphasize practical experience to rationalize antimicrobial usage and minimize antibiotic resistance. Healthcare professionals must educate Saudis among the community to bridge the government-public gap. Thus, healthcare professionals must be well-informed about antibiotics and antibiotic resistance. Students' knowledge, awareness, and attitude can affect Saudi medicine overuse.

Antibiotic resistance is largely caused by humans and animals overusing antibiotics. Overcrowding, poor cleanliness, and lack of infection control can spread resistant germs in hospitals and communities. Students should understand these key risk factors and AMR's onset [56]. From this perspective, medical students who are knowledgeable and aware of antibiotic use can help prevent unnecessary antibiotic use.

This study includes 419 people from two colleges, (53.2%) percent male (223) and (46.8%) female (196). This study compared two medical Universities with similar academic levels. In both Universities, participants had above-average antibiotic resistance knowledge.

Knowledge

University A antibiotic knowledge

University A knows antibiotics from our perspective, antibiotic knowledge was high (71.81%) and the highest rate of responders was in question 3 (Antibiotics used for treatment of bacterial infections) with 97% correct answers, while the lowest rate was in item 8 (New antibiotics are usually better than old ones) with 22% correct answers.

University B antibiotic knowledge

We observed (74.3%) of University B students were knowledgeable about antibiotics. Question 1 (penicillin or amoxicillin are antibiotics) had the highest percentage of accurate responses (89%). The lowest degree of knowledge was in question 8 (New antibiotics are usually better than old ones) with an estimated 28%. Question 8 revealed the two Universities' students insufficient antibiotic knowledge. The considerable growth in knowledge shows that students in both Universities are keeping up with the modern scientific approach to antibiotics, which bodes well for their future understanding.

In this regard, a survey of 202 students at Northern Border University in Saudi Arabia found a high rate of antibiotic self-medication and inappropriate antibiotic knowledge [57]. A Riyadh survey found that dentistry students may prescribe antibiotics inappropriately to treat various diseases, indicating a gap in their antibiotic teaching and practice [58]. A Jordanian study found that (55.6%) of antibiotics used as prevention against infections, (49.0%) utilized left-over drugs without physician consultation, and (51.8%) took antibiotics based on relative counsel [59]. In Southern India, doctor of pharmacy students were better educated about antibiotic usage and resistance than compared to B Pharm students. Future treatments should be targeting students towards educating the B Pharm students so that they can implement the acquired knowledge in their practice knowledge [60].In a Chinese university study, undergraduate students had poor antibiotic knowledge, moderately accurate beliefs, inappropriate actions, and high rates of self-medication [61]. A Kosovo pharmacy student study found good and intermediate antibiotics knowledge. Half of them self-prescribe antibiotics, although most would not serve them without a prescription [68].

Awareness

Antibiotic resistance awareness at University A

Our study found that University A students are aware of antibiotics (87.16%), which is a good sign that the University is communicating the global threat of antibiotic resistance. In our antibiotic awareness study, we asked students six questions. This part covered the definition and exclusion of resistant bacteria and how humans and animals propagate antibiotic-resistant bacteria.

Question 1 (Have you heard of antimicrobial resistance) had the highest awareness (94%). All students are aware of antibiotic resistance, although issue 6 (Antibiotics used in animals can contribute to antibiotic resistance) has the lowest awareness (66%).

Antibiotic resistance awareness at University B

As in University A, where the University B study shows high student awareness, this indicates a positive response to resistant bacteria. Our poll indicated 87% of pupils were aware of antibiotic resistance. Question 2 (In particular, have you discussed the problem of antibiotics resistance during study courses) had the greatest estimated awareness (95%). Question 6 (Antibiotics used in animals can cause antibiotic resistance) had the lowest awareness (64%). We observed that both colleges had the lowest degree of awareness in the same question, indicating that further research is needed to raise awareness of the relationship between humans and animals and resistant microorganisms.

Compared to a local study at Northern Border University Saudi Arabia among students, 60% of respondents heard about resistance bacteria and how random antibiotic usage harms the body, indicating high awareness. 40% don't understand antibiotic resistance [57]. In a study of medical students in a southern Indian teaching hospital, more than

85% were aware of antibiotic resistance's effects. In research, 79% of respondents were aware of inadequate therapy, extension of sickness, bacterial resistance, and increased medical costs [63]. A UK study found that almost all participants felt that overusing antibiotics makes them less effective and renders bacteria resistant [64].

Attitude

Attitude toward antibiotics at University A

From this poll, University A students had a positive attitude regarding antibiotic use, which is a good sign. Eight attitude questions assessed pupils' levels. These questions allow us to examine how students utilize antibiotics, whether they consult a doctor or stop eating when they feel better. Its necessary knowledge reflects constant unjustifiable usage, and the correct scientific technique continues to using optimally. Antibiotic attitudes were 86.35% in our sample. Question 8 (Do you think hand hygiene will minimize virus transmission) had the greatest attitude (96.5%). Question 7 (Have you ever begun an antibiotic therapy following a simple doctor call, without proper medical assessment) had the lowest level of attitude (77.5%), but overall, it was good towards antibiotic use.

Attitude toward antibiotics at University B

As in the case of University A, the level of attitude in medical students towards antibiotics found high with an estimated rate (86.23%). Question 8 (Do you think hand hygiene will reduce the chance of infection transmission) had the highest attitude (94.5%), while question 3 (Do you usually stop taking antibiotics when you start feeling better) had the lowest (82.5%). From the present survey, we found the highest level of attitude in question 8 (Do you think hand hygiene will reduce the chance of infection transmission) with an estimated rate of 96.5% at University A and 94.5% at University B, indicating students' awareness of the importance of hand hygiene in healthcare settings.

Compared with a national study managed in Riyadh among dental students which showed that's only 13.1% of dental students would administer antibiotics for two to three days, whereas 86.8% would prescribe antibiotics for more than three days [64].In another study, Aljouf research of non-medical students, 62.6% stopped antibiotics after improvement, while 28.1% finished the course. The survey also found that 53.5% of students rely on previous prescriptions, 14.5% on experience, and 3.5% on pharmacist guidance [65].

Medical students' knowledge, attitude, and behavior should start at the ground level in the first year and continue through the last year to apply antibiotics resistance awareness in practice.

Knowledge and attitude from higher education promote reasonable antibiotic usage and give positive impact to create healthy environment.

Finally, lawmakers, pharmaceutical companies, and medical professionals must encourage rational drug prescribing in medical colleges and hospitals. Antimicrobial agents should be dealing with an integrated approach involving all specialties.

The poll showed that education increases knowledge, awareness, and attitude. We also observed that information affects awareness and attitude. This correlation shows how knowledge improves students' drug perception and attitude.

6. CONCLUSION

Antimicrobial agents have saved millions of lives and revolutionized medicine, but restricted resources are making them less effective. Misuse and overuse of antibiotics lead to increase the global health burden which is antibiotic resistance. A healthy society relies on good science. Effective education helps provide the community with a complete health strategy and instills information, awareness, and attitudes that influence behavior and habits. In the Gulf and Saudi Arabia, resistant germs pose a global issue. International organizations and centers fight resistance bacteria, as do local governments representing the health, educational, industrial, and agricultural sectors.

Antibiotic use and distribution can only improve if everyone does their part. Resistance germs are fought at various levels, internationally represented in organizations and centers, in addition to the local representative of governments represented by the health sector, educational, industrial, and agricultural sector.

Thus, antibiotic use and resistance education is needed for positive impact among public and health society. Knowledge is the first step to rational use and antibiotic resistance prevention. Several concepts must be understood, attitude and awareness and their correlation with knowledge. We found this relationship, suggesting that taking antibiotics without a doctor's prescription and stopping them after feeling better may increase AMR prevalence.

Our exploratory study found that the medical students' in both Universities at different healthcare courses have a good knowledge and are aware of antibiotic resistance, but they need to focus more on practical application of experience to rationally use antimicrobial agents and reduce antibiotic resistance.

We advocate continuing antibiotic-related activities that foster an enthusiastic academic generation pursuing high education. Moreover, adding a course highlighting the optimal use of antibiotics and the risk of antimicrobial agents. Through the program, we will help to maintain a level of knowledge and attitude on our health community.

7. CONFLICT OF INTEREST

We declare that there is no conflict of interest.

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APPENDIX

Questionnaire:

<u>First part: demographic data</u>

1. Gender ⓜ Ⓕ
2. Year of birth 18-21 22-25 Over
3. Place of birth (country) …………….
4. Year of study **First year Third year Fifth year**
5. At least one member of your family (parents, children, husband/wife) works in a health-related field?
   - Yes
   - No

<u>Second part: knowledge about antibiotics</u>

1. Penicillin or Amoxicillin are antibiotics.
   - Agree
   - Disagree
   - I don't know

2. Aspirin is an antibiotic
   - Agree
   - Disagree
   - I don't know

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3. Antibiotics are used for treatment bacterial infections
   - Agree
   - Disagree
   - I don't know

4. Antibiotics are used for treatment viral infections
   - Agree
   - Disagree
   - I don't know

5. Antibiotics can kill good bacteria which present in our body
   - Agree
   - Disagree
   - I don't know

6. Antibiotics may cause secondary infections after killing good bacteria present in our organism.
   - Agree
   - Disagree
   - I don't know

7. Antibiotics can cause side effects like allergic reactions.
   - Agree
   - Disagree
   - I don't know

8. New antibiotics are usually better than old ones
   - Agree
   - Disagree
   - I don't know

<u>Third part: awareness about antibiotic resistance</u>

1. Have you ever heard about antibiotic resistance?
   - Yes
   - No

2. In particular, have you discussed the problem of antibiotic resistance during study courses?
   - Yes
   - No
   -

3. Antibiotic resistance is a phenomenon for which a bacterium loses its sensitivity to an antibiotic.
   - Agree
   - Disagree
   - I don't know

4. Wrong use of antibiotics can lead to a loss of sensitivity of an antibiotic to a specific pathogen.
   - Agree
   - Disagree
   - I don't know

5. If symptoms improve before it is completed the full course of antibiotic, you can stop taking it.
   - Agree
   - Disagree
   - I don't know

6. Antibiotics used in animals can lead to antibiotics resistance
   - Agree
   - Disagree
   - I don’t know

Fourth part: attitudes regarding consumption of antibiotics

1. Do you usually self-prescribe antibiotic if you have cold or sore throat?
   - Yes
   - No
2. Do you usually self-prescribe antibiotic for high body temperature (fever)?
   - Yes
   - No
3. Do you usually stop taking antibiotic when you start feeling better?
   - Yes
   - No
4. Do you take antibiotic only when prescribed by the doctor?
   - Yes
   - No
5. Do you use leftovers antibiotics when you have cold, sore throat or flu without consulting your doctor?
   - Yes
   - No
6. Do you buy antibiotics from pharmacy without prescription?
   - Yes
   - No
7. Have you ever started an antibiotic therapy after a simple doctor call, without a proper medical examination?
   - Yes
   - No
8. Do you think hand hygiene will reduce the chance of infection transmission?
   - Yes
   - No**r**

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