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## RESEARCH ARTICLE

### Association between Awareness on Antibiotic Resistance and Antibiotic Misuse Among Saudi University Students

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#### Abstract:

##### Background:

Saudi Arabia has the highest prevalence of resistant pathogens in the Gulf Region, with a rapid increase in antibiotic resistance seen in recent years. Misuse is common despite laws prohibiting dispensing antibiotics without prescription. This study was conducted to determine the association between awareness of antibiotic resistance and antibiotic misuse among Saudi university students. Specifically, it aimed to determine the proportion of university students who were aware of antibiotic resistance, the proportion of university students who were aware that antibiotic resistance is a public health problem, the prevalence of antibiotic misuse among university students, and the association between awareness and antibiotic misuse.

##### Methods:

The study utilized an analytic cross-sectional design. By using a self-administrated survey, responses on awareness of antibiotic resistance as well as antibiotic use among bachelor students were obtained. Two-stage stratified cluster sampling was conducted to select the required 825 participants. Epi Info<sup>®</sup> version 7 was used to estimate the proportion of students who were aware of antibiotic resistance as well as the proportion of students who misused antibiotics. Logistic regression was used to determine the association between awareness of antibiotic resistance and antibiotic use.

##### Results:

Over 75% of university students were aware of antibiotic resistance (95% CI: 72.09% - 77.98%), while 54.67% (95% CI: 51.26% - 58.03%) were aware that antibiotic resistance is a public health problem. Nearly 67% misused antibiotics (95% CI: 63.63% - 70.04%) with failure to follow the prescribed number of days of antibiotic therapy and using leftover antibiotics as the most common forms of misuse. Students who were aware of antibiotic resistance were 27.96% less likely to misuse antibiotics (OR = 0.7204,  $p = 0.0642$ ). Those who were aware that antibiotic resistance is a public health problem were 51.32% less likely to misuse antibiotics (OR = 0.4868,  $p < 0.0001$ ).

##### Conclusion:

Awareness of antibiotic resistance is associated with lower antibiotic misuse. Education campaigns on the consequences of inappropriate antibiotic use and the development of antibiotic resistance should be intensified.

**Keywords:** Antibiotics, Antibiotic resistance, Antibiotic misuse, University students, Resistant bacteria, Population.

#### Article History

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## 1. INTRODUCTION

Antibiotic resistance is one of the most serious global threats to public health. It is now considered as among the ten global health issues that need to be monitored in 2021, according to the WHO [1].

The development of drug-resistant bacteria can happen without human intervention, but the process is boosted by some of the antibiotic practices of humans [2]. Epidemiological studies have shown a direct relationship between the misuse and overuse of antibiotics as well as irrational prescription and dispensing of antibiotics and the growth and spread of resistant bacterial strains [3].

Poor knowledge and misconceptions about antibiotic use

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and conflicting views on infectious diseases are known to exacerbate the development of antibiotic-resistant bacterial strains [4]. Similarly, excessive and inappropriate prescriptions based on patient demand are extremely important causes of antibiotic resistance [5, 6].

The global consumption of antibiotics has rapidly increased, especially in low and middle-income countries where self-medication with antibiotics and their use outside hospitals is common [7].

Self-medication is indeed very common worldwide except in Northern Europe and North America [5]. Advertisements on television, radio, and social media, in addition to advice from friends and family, are the most popular and primary reasons for people to begin taking drugs without prescription. The expensive healthcare system is another primary reason for people to indulge in self-medication.

Antibiotic resistance could lead to prolonged infections, more returns to physicians, longer hospital stays, more intensive care, a need for more expensive drugs, and even death [8 - 11]. Resistance to antibiotics has also been identified as one of the most important public health problems in the world [4, 12 - 14]. The presence of antibiotic-resistant bacteria in communities is one of the serious public health challenges in the 21<sup>st</sup> century [15, 16]. Greater morbidity and higher mortality rates are reported due to the rise in antibiotic-resistant bacteria all over the world [11].

Antibiotic resistance crisis is not only a problem for the healthcare industry, but if not regulated, the emerging crisis may potentially harm the economic growth of a country as well [5, 15, 17]. Drug-resistant bacteria are expected to cause 25,000 deaths in the European Union alone and cost more than 1.5 billion US dollars annually in healthcare along with a loss of productivity [5]. According to a 2017 study, it is predicted that there will be 10 million deaths caused by antibiotic resistance by 2050, and if there are no interventions done to find solutions, \$100 million might be lost due to antimicrobial resistance [16]. A study has estimated that there will be a Gross Domestic Product (GDP) loss of 100.2 trillion dollars by 2050 if there are no proper interventions actively applied [6]. The Organization for Economic Cooperation and Development has predicted that antibiotic resistance will be responsible for 2.4 million deaths and an approximate 3.5 billion US dollars in Australia, North America and Europe in the next 30 years [17].

In recent years, the Kingdom of Saudi Arabia has seen a rapid increase in antibiotic resistance [4, 18]. The Kingdom has also shown the highest prevalence of resistant pathogens in clinical isolates throughout all countries of the Gulf Corporation Council (GCC) [18, 19]. The use of antibiotics without a physician's prescription is prevalent, with close to 38% of Saudis able to purchase antibiotics directly from pharmacists without prescription [14, 16, 18]. Seventy percent of people who self-medicate with antibiotics discontinued antibiotics before finishing the course because they felt better, according to a 2018 study [19]. The Saudi Ministry of Health has begun to take steps out of concern to resolve this issue by announcing a law prohibiting pharmacists from dispensing any antibiotic drug without a doctor's prescription, and violators

would face legal proceedings, including a fine of up to 100,000 Saudi Riyals SAR [16, 20].

There is a lack of information regarding the level of awareness on antibiotic resistance among residents of Saudi Arabia [21]. The factors that influence antibiotic misuse among the general Saudi population and especially among university students have not been validated [18, 21]. This study was conducted to determine the proportion of university students who were aware of antibiotic resistance as well as those who were aware that antibiotic resistance is a public health problem. In addition, this research sought to assess the antibiotic use of university students and determine whether awareness of antibiotic resistance influenced their antibiotic use.

## 2. METHODOLOGY

The study utilized an analytic cross-sectional design. The study population consisted of King Faisal University (KFU) bachelor students.

The sample size was calculated using EpiInfo<sup>®</sup> version 7 using the KFU student population for the academic year 2018 – 2019 of 37,607 bachelor students and the expected frequency of 43.4% based on the reported prevalence of antibiotic misuse from the study conducted by Alghadeer *et al.* (2018) and a confidence limit of 5% [22]. Two-stage stratified cluster sampling was used to select the colleges and study participants to obtain the required sample size of 748 participants. All university students enrolled as full-time students in any of the bachelor programs of King Faisal University were considered eligible to participate. Students of the preparatory year, diploma programs, and postgraduate programs as well those enrolled in online programs, were deemed ineligible. A total of 825 students were surveyed from health colleges (Medicine, Applied Medical Sciences, and Pharmacy) and non-health colleges (Education, School of Business, and Computer Science and Information Technology).

Awareness of antibiotic resistance among university students was based on an affirmative response to the question "Are you aware of antibiotic resistance?" while awareness on antibiotic resistance as a public health problem "Are you aware that antibiotic resistance is a public health problem?" Students were considered to be misusing antibiotics if they respond "yes" to antibiotic use within the past six months and if they respond "yes" to questions pertaining to the use of antibiotics without a doctor's prescription, premature discontinuation of prescribed antibiotics, failure to comply to the prescribed dose, using leftover medications, or sharing antibiotics with family members.

The survey tool was developed by the researchers. Content validation was done independently by a physician. It was then pretested among university students who were not included in the final participants of the study before administering it to the study participants. The study questionnaire contained three sections: 1) demographic variables such as college, age, and gender; 2) awareness section including questions on awareness on antibiotic resistance and antibiotic resistance as a public health problem; and 3) antibiotic use, consisting of questions about whether participants self-medicate antibiotic, following the number of prescribed days, following the amount of

prescribed dose, using leftover antibiotic, sharing antibiotic with others and using an expired antibiotic.

Students participated in the study on a voluntary basis and were assured of their anonymity and the confidentiality of their responses. Following the approval of the research proposal by the Department of Public Health, ethical clearance was obtained from the Research Ethics Committee of the Deanship of Research, King Faisal University, Al-Ahsa, KSA (KFU – REC/2019 – 11 – 03).

Data were collected using self-administered questionnaires. Collated data were encoded in MS Excel and cleaned for missing data before statistical treatment using EpiInfo® version 7. Descriptive analysis was applied to the demographic data. In addition, estimation of the proportion of students who were aware and unaware of antibiotic resistance as a public health problem was computed. The proportion of students who misuse antibiotics was also determined using the estimation of proportion. Finally, logistic regression was used to determine the association between awareness of antibiotic resistance and antibiotic misuse and to determine the association between awareness of antibiotic resistance as a public health problem and antibiotic misuse.

Data collection took place in the King Faisal University main campus located in Hofuf, Al Ahsa, Kingdom of Saudi Arabia, from November 4, 2019 until November 21, 2019.

**3. RESULTS**

**3.1. Demographic Profile of Study Participants**

As seen in Table 1, participants from health colleges comprised 50.42% (Medicine, Applied Medical Sciences, and Pharmacy), while students from the non-health colleges (Education, School of Business, and Computer Science and Information Technology) represented 49.58% of the total respondents. There was an almost equal distribution of male (403, 48.85%) and female (422, 51.15%) respondents. The age of study participants ranged from 18 to 26 years old. The majority of the participants were 21 to 22 years old, and students who were from 18 to 22 years old comprised 89.09% of the total respondents.

**3.2. Awareness of Antibiotic Resistance**

The majority of university students (75.15%) were aware of antibiotic resistance (Table 2).

**Table 1. Sociodemographic profile of university students.**

| Variable                                    | Frequency | Percentage |
|---|-----------|------------|
| <b>Gender</b>                               |           |            |
| Male  | 403       | 48.85      |
| Female                                      | 422       | 51.15      |
| <b>Age Group</b>                            |           |            |
| Below 20                                    | 362       | 43.88      |
| 21-22                                       | 373       | 45.21      |
| 23-24                                       | 86        | 10.42      |
| 25 and above                                | 4         | 0.48       |
| <b>College</b>                              |           |            |
| Medicine                                    | 168       | 20.36      |
| Education                                   | 170       | 20.61      |
| School of Business                          | 130       | 15.76      |
| Applied Medical Science                     | 169       | 20.48      |
| Computer Science and Information Technology | 109       | 13.21      |
| Pharmacy                                    | 79        | 9.58       |

**Table 2. Awareness antibiotic resistance among university students.**

| Sociodemographic Variable | Aware |       |               | Unaware |       |              |
|---------------------------|-------|-------|---------------|---------|-------|--------------|
|                           | Count | %     | 95% CI        | Count   | %     | 95% CI       |
| <b>Gender</b>             | -     | -     | -             | -       | -     | -            |
| Male                      | 301   | 74.69 | 70.23- 78.69  | 102     | 25.31 | 21.31- 29.77 |
| Female                    | 319   | 75.59 | 71.28- 79.45  | 103     | 24.41 | 20.55- 28.72 |
| <b>Age Group</b>          | -     | -     | -             | -       | -     | -            |
| Below 20                  | 97    | 63.82 | 55.64 - 71.44 | 55      | 36.18 | 28.56- 44.36 |
| 20-21                     | 311   | 74.76 | 78.66- 78.69  | 105     | 25.24 | 21.31- 29.63 |
| 22 – 23                   | 199   | 83.97 | 78.66- 88.40  | 38      | 16.03 | 11.60- 21.34 |
| 24 and above              | 13    | 65.00 | 40.78- 84.61  | 7       | 35.00 | 15.39- 59.22 |
| <b>College</b>            | -     | -     | -             | -       | -     | -            |
| Medicine                  | 159   | 94.64 | 90.07- 97.52  | 9       | 5.36  | 2.48- 9.93   |

(Table 2) contd.....

|   |     |        |               |    |       |              |
|---|-----|--------|---------------|----|-------|--------------|
| Education                                   | 100 | 58.82  | 51.03- 66.30  | 70 | 41.18 | 33.70- 48.97 |
| School of Business                          | 82  | 63.08  | 54.17- 71.37  | 48 | 36.92 | 28.63- 45.83 |
| Applied Medical Science                     | 124 | 73.37  | 66.04- 79.87  | 45 | 26.63 | 20.13- 33.96 |
| Computer Science and Information Technology | 76  | 69.72  | 60.19 - 78.16 | 33 | 30.28 | 21.84 -39.81 |
| Pharmacy                                    | 79  | 100.00 | 95.44- 100.00 | 0  | 0.00  | 0.00 - 4.56  |

There was an almost equal proportion of male and female students who were aware of antibiotic resistance. When grouped by age, there was a higher proportion of students who were aware of antibiotic resistance in the 22 – 23-year-old group.

Among the 620 participants who were aware of antibiotic resistance, 58.39% were students from health colleges, while 41.61% were students from non-health colleges. There were 205 students who were not aware of antibiotic resistance, of which 73.66% were from non-health colleges.

A high proportion of students (40.73%, 95% CI: 37.43 – 44.12%) obtained their information on antibiotic resistance from health professionals (doctors, pharmacists and nurses). On the other hand, 39.76% of the students obtained their information on antibiotic resistance from Internet and social media (95% CI: 36.37 – 43.14%).

**3.3. Awareness of Antibiotic Resistance as a Public Health Problem**

Among the 825 study participants, 451 (54.67%) were aware that antibiotic resistance is a public health problem.

There was a higher proportion of female students who were aware that antibiotic resistance is a public health problem. Among the age groups, there was a higher proportion of students who were aware that antibiotic resistance is a public health problem in the 22 – 23-year-old group. Among the 451 participants who were aware that antibiotic resistance is a

public health problem, 67.85% were students from the health colleges, while 32.15% were students from non-health colleges. There were 374 students who were not aware that antibiotic resistance is a public health problem, of which 70.59% were from non-health colleges (Table 3).

Nearly 40% (39.76%, 95% CI: 36.47 – 43.14%) of the students obtained their information on antibiotic resistance from the Internet and social media. A higher proportion (40.73%, 95% CI: 37.43 – 44.12%) obtained their information from health professionals (doctors, pharmacists, and nurses). Nineteen percent (95% CI: 16.50 – 21.85%) obtained their information from family and friends.

**3.4. Antibiotic use among University Students**

Majority of university students (66.91%, 95% CI: 63.63 – 70.04%) misused antibiotics (Table 4).

When comparing students who misused antibiotic medications (552 participants) by type of college, a greater proportion (56.16%) were from non-health colleges, while 43.84% were students from health colleges. On the other hand, there were 273 students who were not misusing antibiotics, of which 36.26% were from the non-health colleges, and 63.74% were students from health colleges.

A higher proportion of male students misused antibiotics compared to female students. Among the age groups, antibiotic misuse was more common among those who were below 20 years old.

**Table 3. Awareness on antibiotic resistant is a public health problem among university students.**

| Sociodemographic Variables | Aware |            |               | Unaware |            |               |
|----------------------------|-------|------------|---------------|---------|------------|---------------|
|                            | Count | Proportion | 95% CI        | Count   | Proportion | 95% CI        |
| <b>Gender</b>              |       |            |               |         |            |               |
| Male                       | 204   | 41.47      | 44.53- 54.24  | 204     | 50.62      | 45.76- 55.47  |
| Female                     | 247   | 66.09      | 36.87- 46.23  | 175     | 49.38      | 36.87- 46.23  |
| <b>Age Group</b>           |       |            |               |         |            |               |
| Below 20                   | 53    | 34.87      | 27.33 – 43.01 | 99      | 65.130     | 56.99 – 72.67 |
| 20 – 21                    | 225   | 54.09      | 94.28 – 58.82 | 191     | 45.91      | 41.18 - 50.72 |
| 22 – 23                    | 167   | 70.46      | 64.21 – 76.19 | 70      | 29.54      | 23.81 – 35.79 |
| 24 and above               | 6     | 30.00      | 11.89 – 54.28 | 14      | 70.00      | 45.72 – 88.11 |
| <b>College</b>             |       |            |               |         |            |               |
| Medicine                   | 147   | 87.50      | 81.53 – 92.09 | 21      | 12.50      | 7.91 – 18.47  |
| Education                  | 63    | 37.06      | 29.97 – 44.79 | 107     | 62.94      | 55.21 – 70.21 |
| School of Business         | 42    | 32.31      | 24.37 – 41.01 | 88      | 67.69      | 58.93 – 75.63 |
| Applied Medical Science    | 84    | 49.70      | 41.93 – 57.48 | 85      | 50.30      | 42.52 – 58.07 |
| Computer Science           | 40    | 36.70      | 27.67 – 46.47 | 69      | 63.30      | 53.53 – 72.33 |
| Pharmacy                   | 75    | 94.94      | 87.54 – 98.60 | 4       | 5.06       | 1.40 – 12.46  |

**Table 4. Antibiotic use of university students among university students by sociodemographic variables.**

| Sociodemographic Variable | Not Misuse |            |               | Misuse |            |               |
|---------------------------|------------|------------|---------------|--------|------------|---------------|
|                           | Count      | Proportion | 95% CI        | Count  | Proportion | 95% CI        |
| <b>Gender</b>             |            |            |               |        |            |               |
| Male                      | 109        | 27.05      | 22.94 - 31.59 | 294    | 72.95      | 68.41 - 77.06 |
| Female                    | 164        | 38.86      | 34.33 - 43.59 | 258    | 61.14      | 56.41 - 65.67 |
| <b>Age Group</b>          |            |            |               |        |            |               |
| Below 20                  | 42         | 27.63%     | 20.70 - 35.46 | 110    | 72.37%     | 64.54 - 79.30 |
| 20 – 21                   | 138        | 33.17%     | 28.82 - 37.83 | 278    | 66.83%     | 62.17 - 71.18 |
| 22 – 23                   | 87         | 36.71%     | 30.56 - 43.19 | 150    | 63.29%     | 56.81 - 69.44 |
| 24 and above              | 6          | 30.00%     | 11.89 - 54.28 | 14     | 70.00%     | 45.72 - 88.11 |
| <b>College</b>            |            |            |               |        |            |               |
| Medicine                  | 74         | 44.05      | 36.41- 51.90  | 94     | 55.95      | 48.10 - 63.59 |
| Education                 | 43         | 25.29      | 18.95 - 32.52 | 127    | 74.71      | 67.48 - 81.05 |
| School of Business        | 35         | 26.92      | 19.52 - 35.40 | 95     | 73.08      | 64.60 - 80.48 |
| Applied Medical Science   | 59         | 34.91      | 27.75 - 42.61 | 110    | 65.09      | 57.39 - 72.25 |
| Computer Science          | 21         | 19.27%     | 12.34 - 27.93 | 88     | 80.73%     | 72.07 - 87.66 |
| Pharmacy                  | 41         | 51.90%     | 40.36 - 63.29 | 38     | 48.10%     | 36.71 - 59.64 |

The study investigated various types of antibiotic misuse among university students. As seen in Table 5, the most common form of antibiotic misuse was the failure to follow the prescribed number of days of antibiotic therapy. This was followed by using leftover antibiotics, sharing antibiotics with others, failure to follow the prescribed dose, self-medication, and finally, the use of expired antibiotics.

**3.5. Crude Association between the Study Variables and Antibiotic Misuse**

As seen in Table 6, female students were 41.67% less likely to misuse antibiotics compared to male students (OR = 0.5933,  $p = 0.0003$ ).

**Table 5. Forms of antibiotic misuse of university students.**

| Type of Antibiotic Misuse           | Count | Proportion (%) | 95% CI |       |
|-------------------------------------|-------|----------------|--------|-------|
| <b>Incomplete Antibiotic Dose</b>   |       |                |        |       |
| Yes                                 | 233   | 28.24          | 25.28  | 31.41 |
| No                                  | 592   | 71.76          | 68.59  | 74.72 |
| <b>Expired Antibiotics</b>          |       |                |        |       |
| Yes                                 | 22    | 2.67           | 1.77   | 4.00  |
| No                                  | 803   | 97.33          | 96.00  | 98.23 |
| <b>Use of Leftover Antibiotics</b>  |       |                |        |       |
| Yes                                 | 312   | 37.82          | 34.57  | 41.18 |
| No                                  | 513   | 62.18          | 58.82  | 65.43 |
| <b>Sharing of Antibiotics</b>       |       |                |        |       |
| Yes                                 | 274   | 33.21          | 30.08  | 36.50 |
| No                                  | 551   | 66.79          | 63.50  | 69.92 |
| <b>Incomplete Antibiotic Course</b> |       |                |        |       |
| Yes                                 | 346   | 41.94          | 38.62  | 45.34 |
| No                                  | 479   | 58.06          | 54.66  | 61.38 |
| <b>Self-Medication</b>              |       |                |        |       |
| Yes                                 | 145   | 17.58          | 15.13  | 20.32 |
| No                                  | 680   | 82.42          | 79.68  | 84.87 |

**Table 6. Crude association between awareness on antibiotic resistance and antibiotic misuse of university students.**

| Variables     | OR     | 95% C.I. |        | p-value |
|---------------|--------|----------|--------|---------|
| <b>Gender</b> |        |          |        |         |
| Female        | 0.5833 | 0.4346   | 0.7829 | 0.0003  |

(Table 6) contd....

|  |        |        |        |         |
|--|--------|--------|--------|---------|
| Male   | 1.0000 |        |        |         |
| <b>Type of College</b>   |        |        |        |         |
| Health   | 0.4443 | 0.3296 | 0.5989 | 0.0000  |
| Non-health   | 1.0000 |        |        |         |
| <b>Age</b>   |        |        |        |         |
| Older  | 0.6398 | 0.4752 | 0.8616 | 0.0033  |
| Younger  | 1.0000 |        |        |         |
| <b>Awareness on Antibiotic Resistance</b>                            |        |        |        |         |
| Aware  | 0.7204 | 0.5090 | 1.0195 | 0.0642  |
| Unaware  | 1.0000 |        |        |         |
| <b>Awareness on Antibiotic Resistance as a Public Health Problem</b> |        |        |        |         |
| Aware  | 0.4868 | 0.3601 | 0.6580 | <0.0001 |
| Unaware  | 1.0000 |        |        |         |

\*significant at  $\alpha=0.25$ .

Students from the health colleges were 55.57% less likely to misuse antibiotics compared to students of the non-health colleges (OR = 0.4443,  $p < 0.0001$ ).

The older students were 36.02% less likely to misuse antibiotics when compared to the younger students (OR = 0.6398,  $p = 0.0033$ ).

Students who were aware of antibiotic resistance were 27.96% less likely to misuse antibiotics compared to students who were unaware of antibiotic resistance (OR = 0.7204,  $p = 0.0642$ ).

Students who were aware that antibiotic resistance is a public health problem were 51.32% less likely to misuse antibiotics compared to students who were not aware of antibiotic resistance as a public health problem (OR = 0.4868,  $p < 0.0001$ ).

### 3.6. Adjusted Association between the Study Variables and Antibiotic Misuse

When the sociodemographic variables were held constant, students who were aware of antibiotic resistance were 3% less likely to misuse antibiotics compared to students who were unaware of antibiotic resistance (OR = 0.9700,  $p = 0.8724$ ). This represents a 34.64% change in the association between awareness of antibiotic resistance and antibiotic misuse (Table 7).

Students who were aware that antibiotic resistance is a public health problem were 33.74% less likely to misuse antibiotics when gender, age, and type of college were held constant (OR = 0.6626,  $p = 0.0151$ ). This represents a 36.25% change in the association between awareness that antibiotic resistance is a public health problem and antibiotic misuse among students (Table 8).

**Table 7. Adjusted association between awareness on antibiotic resistance and antibiotic misuse among university students.**

| Variables                                 | OR     | 95% C.I. |        | p-value |
|---|--------|----------|--------|---------|
| <b>Awareness on Antibiotic Resistance</b> |        |          |        |         |
| Aware                                     | 0.9700 | 0.6687   | 1.4070 | 0.8724  |
| Unaware                                   | 1.0000 |          |        |         |
| <b>Gender</b>                             |        |          |        |         |
| Female                                    | 0.5429 | 0.3961   | 0.7442 | 0.0001  |
| Male                                      | 1.0000 |          |        |         |
| <b>Age</b>                                |        |          |        |         |
| Older                                     | 0.6633 | 0.4739   | 0.9284 | 0.0167  |
| Younger                                   | 1.0000 |          |        |         |
| <b>Type of college</b>                    |        |          |        |         |
| Health                                    | 0.5241 | 0.3774   | 0.7280 | 0.0018  |
| Non-health                                | 1.0000 |          |        |         |

**Table 8. Adjusted association between awareness on antibiotic resistance as a public health problem and antibiotic misuse among university students**

| Variable   | OR     | 95% C.I. |        | p-value |
|--|--------|----------|--------|---------|
| <b>Awareness on Antibiotic Resistance as Public Health Problem</b> |        |          |        |         |
| Aware  | 0.6626 | 0.4754   | 0.9235 | 0.0151  |
| Unaware  | 1.0000 |          |        |         |
| <b>Gender</b>  |        |          |        |         |

(Table 8) contd.....

|                        |        |        |        |        |
|------------------------|--------|--------|--------|--------|
| Female                 | 0.5607 | 0.4082 | 0.7702 | 0.0004 |
| Male                   | 1.0000 |        |        |        |
| <b>Age</b>             |        |        |        |        |
| Older                  | 0.7061 | 0.5022 | 0.9929 | 0.0454 |
| Younger                | 1.0000 |        |        |        |
| <b>Type of College</b> |        |        |        |        |
| Health                 | 0.5931 | 0.4234 | 0.8309 | 0.0024 |
| Non-health             | 1.0000 |        |        |        |

#### 4. DISCUSSION

This study was conducted to determine the proportion of university students who were aware of antibiotic resistance and that antibiotic resistance is a public health problem. It also sought to determine the proportion of university students who misused antibiotics and whether awareness about antibiotic resistance was associated with antibiotic misuse. The study revealed that the majority of the university students were aware of antibiotic resistance, but only over half of them were aware that antibiotic resistance is a public health problem. Antibiotic misuse was highly prevalent among university students, with early discontinuation of antibiotics as the most common form of misuse. Students who were aware that antibiotic resistance is a public health problem were found to be less likely to misuse antibiotics compared to students who were not.

This study showed that 75.15% of university students were aware of antibiotic resistance. A 2019 study conducted in Jeddah showed that 63% of students had knowledge about proper antibiotic use. Moreover, less than 40% of health science students were aware of the relationship of antibiotic resistance to antibiotic overuse [21]. A study conducted among dental students in Riyadh showed awareness levels similar to the current study [23, 24]. Inappropriate antibiotic use of antibiotics in dental practice is believed to contribute to the development of antibiotic resistance in the Albaha region of Saudi Arabia [20].

Studies on awareness of antibiotic resistance among adult Saudis yielded varied results. A cross-sectional study among residents of Saudi Arabia has revealed that only 32% were not aware of antibiotic resistance [16]. Low awareness about antibiotic resistance was also found in a multi-center study done in the northwestern city of Tabuk, Saudi Arabia. Awareness of antibiotic resistance was only slightly higher in a study conducted among adults in the capital city of Riyadh. In yet another study in Riyadh, it was found that while the majority of prospective health professionals were aware of the concept of antibiotic resistance, a tendency for inappropriate prescription was still present [4, 23].

A World Health Organization (WHO) survey was conducted on 9772 adults with different educational degrees from 12 countries with lower income (Egypt, India, Indonesia, Nigeria, Sudan, Vietnam) or higher incomes (Barbados, China, Mexico, Russian Federation, Serbia, South Africa). It reported that awareness of antimicrobial resistance was 70% [25].

An almost similar proportion of male and female university students was found to be aware of antibiotic resistance in the current study, implying that there were no barriers in accessing information about antibiotic resistance between gender groups.

In contrast, a 2020 study in Italy showed that being female and having a higher-level education were predictors of knowledge about antibiotics and antibiotic resistance [17].

The proportion of students who were aware of antibiotic resistance varied between the six colleges included in the study. Awareness about antibiotic resistance and awareness that antibiotic resistance is a public health problem was highest in the College of Clinical Pharmacy and College of Medicine. On the other hand, awareness of antibiotic resistance was the lowest among students from the College of Education. Awareness that antibiotic resistance is a public health problem was lowest among students from the School of Business. Only half of the university students in the current study were aware that antibiotic resistance is a public health problem. This was observed among the students of the six colleges included in the study. The results of this study were consistent with a similar study conducted in Lebanon, where health major students had a higher level of knowledge on antibiotic resistance compared to non-health majors. However, the results were higher than the result obtained in a study in Colombia [3, 26].

The sources of information of the respondents in the current study were similar to a WHO survey where the most common source of information was a doctor or nurse (50%), followed by the media (41%), and lastly, a family member or friend (23%) [25]. Research has reported that 47% use the Internet and social media for antibiotic-related information [27].

The consumption of antibiotics worldwide is associated with the development of antibiotic resistance [28, 29]. Antibiotic use was found to be fairly common among the students. The current study showed that 33.15% of the respondents actually used antibiotics in the past six months. The results were slightly lower than the percentage of individuals who claim to have taken antibiotics within the past six months in a recent WHO survey [25].

Misconception about antibiotics was prevalent among university students in the current study, with many self-medicating with antibiotics for the common cold, fever, and headache. Misconceptions and beliefs about antibiotics were found to substantially increase the odds of their misuse [4, 5]. Inappropriate use of antibiotics for the treatment of symptoms of common respiratory ailments was also found to be prevalent in several studies conducted in Europe [17, 30]. The use of antibiotics for common viral infections was also reported in separate studies in Pakistan and China [2, 31, 32]. Inappropriate use of antibiotics was reported to be fairly common in India, Kenya, and China [33].

This study investigated the common forms of misuse,

namely failure to follow the prescribed number of days of antibiotic therapy, using leftover antibiotics, sharing antibiotics with others, the failure to follow the prescribed dose, self-medication, and finally, the use of expired antibiotics. While purchasing antibiotics without a doctor's prescription is illegal in Saudi Arabia, self-medication was found to be quite common among university students. Self-medication was found to be more common among non-health college students compared to students of health colleges. However, self-medication among the students in the current study was significantly lower than the findings in separate studies conducted in India and Pakistan [32, 34].

A recent study conducted in the Eastern Province of Saudi Arabia reported that difficulty accessing healthcare services, participants' cultural beliefs and practices, lack of knowledge about antibiotics and antibiotic resistance, and weak regulatory enforcement contributed to self-medication [18]. Even after the implementation of the law prohibiting the dispensing of antibiotics without a prescription, a 2020 study in a Saudi population reported that antibiotics were still commonly purchased without prescriptions [16]. An earlier study in Riyadh has reported that close to 40% of respondents were able to purchase antibiotics without a prescription [23].

Other forms of misuse, like failure to follow the prescribed number of days of antibiotic therapy, were prevalent among university students. Incomplete courses of antibiotic therapy among the respondents were higher than what was reported in a study in Jordan [35]. Using leftover antibiotics could facilitate the self-medication of antibiotics. The use of leftover antibiotics among university students was higher compared to a study in South Korea but was lower than a study in the United Arab Emirates [36, 37]. Sharing of antibiotics was also common among university students and was actually higher than what has been reported in the study by Nafisah *et al.* (2017), which showed that the prevalence of sharing antibiotics was nearly 20% [38]. Moreover, the latter study has also revealed inappropriate antibiotic use for viral infections and even as an analgesic. All these are despite the existence of laws regarding the dispensing of antibiotics without prescription.

The results supported the study hypothesis that students who are aware of antibiotic resistance are less likely to misuse antibiotics compared to students who are unaware of antibiotic resistance. It further supported the fact that university students who are aware that antibiotic resistance is a public health problem are less likely to misuse antibiotics compared to students who are not aware of antibiotic resistance as a public health problem. This study revealed that university students who were aware of antibiotic resistance were less likely to misuse antibiotics compared to students who were unaware of antibiotic resistance. In addition, students who were aware that antibiotic resistance is a public health problem were even less likely to misuse antibiotics compared to students who were not aware that antibiotic resistance is a public health problem.

## CONCLUSION

In conclusion, this study showed that eight out of ten university students were aware of antibiotic resistance and that five of every ten students were aware that antibiotic resistance

is a public health problem. The study further showed that students who were aware of antibiotic resistance were less likely to misuse antibiotics compared to students who were unaware of antibiotic resistance. Furthermore, students who were aware that antibiotic resistance is a public health problem were less likely to misuse antibiotics compared to students who were not aware that antibiotic resistance is a public health problem.

University students who were aware of antibiotic resistance and those who were aware that antibiotic resistance is a public health problem were less likely to misuse antibiotics.

## LIMITATIONS

The study has some limitations. The study participants were limited to undergraduate students restricting the generalizability of the study findings to other members of the university community. The findings do not reflect the perceptions of Al-Ahsa residents or even of Saudis of other age groups and outside the university setting. No validation was conducted for responses rendering them prone to misclassification. The study did not consider all demographic variables that could affect antibiotic use. Based on the study findings, university students must be educated about antibiotics, their side effects, and the need to avoid their improper use. Awareness campaigns on antibiotic resistance must be conducted in the university with special emphasis on the non-health colleges where a lower proportion of awareness on antibiotic resistance and a higher proportion of antibiotic misuse students were found. Specifically, the failure to follow the prescribed number of days of antibiotic therapy must be addressed. The implementation of policies regarding dispensing antibiotics by pharmacies must be closely monitored. The use of social media for disseminating antibiotics-related information must be explored to further raise information on antibiotic resistance.

## ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical clearance to conduct the study was obtained from the Research Ethics Committee of the Deanship of Research, King Faisal University, Al-Ahsa, KSA (KFU – REC/2019 – 11 – 03).

## HUMAN AND ANIMAL RIGHTS

Not applicable.

## CONSENT FOR PUBLICATION

All respondents freely gave consent to participate in the research.

## STANDARDS OF REPORTING

STROBE guidelines and methodologies were followed in this study.

## AVAILABILITY OF DATA AND MATERIALS

Fabella, Eduardo (2021), "Awareness on Antibiotic



Resistance, Saudi Students”, Mendeley Data, V1, doi: 10.17632/yg4kfjc66f.1

<https://dx.doi.org/10.17632/yg4kfjc66f.1><https://data.mendeley.com/datasets/yg4kfjc66f/draft?a=a9598fd1-12d5-4e66-bb37-0dc06d1cd768>

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None.

## CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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