

# Knowledge, Attitude and Practice Regarding Antibiotic Use and resistance Among Khartoum State Residents 2021.

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## Research Article

**Keywords:** antibiotics use, antibiotic resistance, knowledge about antibiotic

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# Abstract

**Introduction:** antibiotic resistance is one of the of the world must lethal health crisis affecting low- and middle-income countries, the economic burden of the issue is high.

Multi- dug resistant strains are emerging, and actions are needed to counter it.

**Objectives:** To study knowledge, attitude and practice regarding antibiotic use and resistance among Khartoum state residents.

**Methodology:** community based cross-sectional study was conducted in Khartoum state, Sudan, residents were involved in the study were randomly selected, and the questionnaire was delivered and data about Khartoum residents' knowledge, attitude and practice regarding antibiotic use and resistance were collected.

**Results:** A total of 351 samples were collected, the sample included more females (58.7% vs 41.3), most of the respondents were in the 18- 25 age group, majority were students, most of the respondents had achieved university and post graduate education, most of the respondents were from Khartoum, Omdurman and then Bahri. The mean monthly income was 141759 SDGs. Majority had good knowledge regarding antibiotic use and resistance, more than 15% of respondents didn't know that antibiotic use can result in secondary infections after killing the good bacteria. Majority of respondents had positive attitude regarding antibiotic use and resistance, except in question 15 majority of patients think antibiotics are not safe drugs. Majority of respondents had good practice regarding antibiotic use, except in question 20 where the majority Doesn't consult in a regular basis every time before starting antibiotic.

**Conclusions:** the study concluded that the majority of Khartoum state residents had good knowledge regarding antibiotic use and resistance and good attitude and practice regarding antibiotic use.

This research is an important step in the understanding of knowledge, attitude and practice regarding antibiotic use and resistance among residents of Khartoum, its results can be used in formulation of future educational programs.

**Recommendations:** Ongoing research studies should focus on finding the reasons behind misbehaviours and research about sensitivity patterns should be done in Sudan to formulate guidelines that help doctors to choose antibiotics for prescription in a way that minimizing the emergence of new strains of resistance bacteria.

## Introduction

**1.1 Introduction:** Antibiotics are a group of chemical compounds that either kill bacteria or inhibit their growth, they are used frequently in medicine to cure infections. They are the most frequent prescribed drugs; they are often used for treatment of illnesses that mostly caused by viral infections (1).

Antibiotic resistance is the emergence of new strains of bacteria that resist the action of antibiotics, such as methicillin resistant staph aureus and multi drug resistant actinomycete, it is considered a global health problem affecting mostly low and middle income countries (2).

Antibiotic resistance is absolutely one of the major lethal health crises not only in Sudan but all over the world. The WHO estimated that by the year 2050 10 million people will die due to infection with antibiotic resistant bacteria all over the globe, and by 2030, antimicrobial resistance could force up to 24 million people into extreme poverty (3). The economic burden of the issue is high, according to a September 2013 report from the U.S. Center for Disease Control and Prevention (CDC), treatment of antibiotic-resistant infections adds \$35 billion to health care costs and 8 million hospital days per year in the United States (4).

Widespread inappropriate use of antibiotics is a major contributing factor to the emergence of antibiotic resistant bacterial strains (5). Health professionals' lack of knowledge about the antibiotic course, dose and side effects can lead to inappropriate use (6), so can limited community knowledge (including self-medication) and availability of health care services (7). It is estimated that approximately two thirds of oral antibiotics used worldwide are obtained without prescription and are inappropriately used(8).

**1.2 Problem Statement:** Antibiotic resistance is one of the biggest public health challenges of our time.

Infection with drug resistant bacteria is harder to treat than those of non-resistant bacteria.

Antibiotic resistance leads to higher medical costs, prolonged hospital stays, and increased mortality.

Each year in the U.S., at least 2.8 million people get an antibiotic-resistant infection, and more than 35,000 people die.

**1.3 Justification:** Antibiotic resistance is an important health problem that leads to death from untreated infections.

Since irrational use of antibiotics participated largely in the emergence of new multidrug resistant bacteria this research was conducted to provide baseline data to help in increasing awareness.

Community members needs knowledge to improve health practices related to antibiotic use, this research was conducted to provide information necessary to create educational programs.

**1.4 General objective:** To study knowledge, attitude and practice among Khartoum state residents.

**Specific objectives:**

- To assess knowledge of Khartoum residents toward antibiotic use and resistance.
- To assess attitude of Khartoum residents toward antibiotic use.
- To assess general practices on antibiotic use among Khartoum residents.

# Literature Review

Antibiotics are a group of chemical compounds that either kill bacteria or inhibit their growth, they are used frequently in medicine to cure infections. They are the most frequent prescribed drugs (1). They are ineffective against viral infections and most other infections. Antibiotics either kill microorganisms or stop them from reproducing, allowing the body's natural defences to eliminate them.

There are four major sites in the bacterial cell that are sufficiently different from the human cell that they serve as the basis for the action of clinically effective drugs: cell wall, ribosomes, nucleic acids, and cell membrane(9).

Classes of antibiotics are:

- Aminoglycosides
- Carbapenems
- Cephalosporins
- Fluoroquinolones
- Glycopeptides and lipoglycopeptides (such as vancomycin)
- Macrolides (such as erythromycin and azithromycin)
- Monobactams (aztreonam)
- Oxazolidinones (such as linezolid and tedizolid)
- Penicillins
- Polypeptides
- Rifamycin
- Sulfonamides
- Streptogramins (such as quinupristin and dalfopristin)
- Tetracyclines(10).

**Table 1. Mechanisms of action of important antibiotics:**

Mechanism	Antibiotic class
Inhibition of cell wall synthesis	Penicillins, cephalosporins, imipenem, vancomycin, aztreonam
Inhibition of protein synthesis	Chloramphenicol, erythromycin, clindamycin, tetracycline, aminoglycosides
Inhibition of nucleic acid synthesis	Sulfonamides, trimethoprim, quinolones
Alteration of cell membrane synthesis	Polymyxin, daptomycin

this table summarizes the action of the most common antibiotics(9).

Antibiotics are classified according to its' spectrum into:

- Narrow-spectrum antibiotics: are active against one or very few types (e.g., vancomycin is primarily used against certain gram-positive cocci, namely, staphylococci and enterococci).
- Broad-spectrum antibiotics: are active against several types of microorganisms (e.g., tetracyclines are active against many gram-negative rods, chlamydiae, mycoplasmas, and rickettsiae).
- Extended-spectrum antibiotics : are chemically modified to include additional types of bacteria (usually gram-negative bacteria) (11).

They are available in different preparations:

- Injectable intravenous.
- Injectable intramuscular.
- Injectable subcutaneous.
- Oral.
- Eye drops.
- Ointment.
- Creams.

### **Bactericidal and bacteriostatic activity:**

Bactericidal antibiotics kills bacteria, whereas bacteriostatic antibiotics inhibit their growth, in some clinical situations (immediate life-threatening infections) it is essential to use bactericidal rather than bacteriostatic drugs.

Dis-advantages of bacteriostatic antibiotics:

- Bacteria can grow again when antibiotic is withdrawn.
- Host immune responses are needed in the elimination of bacteria(9).

Antibiotic resistance happens when bacteria develop the ability to resist the effects of antibiotics which means it continues to grow and multiply(12).

Infections caused by multi-drug resistant bacteria are hard, and sometimes impossible, to treat. In most cases it requires extended hospital stays, extensive monitoring and toxic alternatives with a wide range of unpleasant side effects(12).

<b>Antibiotic</b>	<b>Resistant strains</b>
Penicillin	Penicillin-resistant <i>Staphylococcus aureus</i> Penicillin-resistant <i>Streptococcus pneumoniae</i> Penicillinase-producing <i>Neisseria gonorrhoeae</i>
Vancomycin	Plasmid-mediated vancomycin-resistant <i>Enterococcus faecium</i> Vancomycin-resistant <i>Staphylococcus aureus</i>
Amphotericin B	Amphotericin B-resistant <i>Candida Auris</i>
Methicillin	Methicillin-resistant <i>Staphylococcus aureus</i>
Extended-spectrum cephalosporins	Extended-spectrum- beta lactamase producing <i>Escherichia coli</i>
Azithromycin	Azithromycin-resistant <i>Neisseria gonorrhoeae</i>

Table2: example of commonly used antibiotics and strains resistant to it(12).

### Mechanisms of antibiotic resistance:

- Modifications of the antibiotic molecule (produce enzymes that inactivate the drug by adding specific chemical moieties to the compound or that destroy the molecule itself).

- Decreased Antibiotic Penetration and Efflux, decreasing permeability of the cell membrane to the drug or production of complex pumps to efflux the antibiotic compound out of the cell, both ways prevent the antibiotic molecule from reaching its target inside the cell membrane.
- Changes in the target sites, either by target protection (e.g. proteins that dislodge the bacteria from its binding site) or modifications to the target site.

Modifications occur by mutation of the target site thus blocking antibiotic effect, enzymatic cleavage of the target site or complete replacement or bypass of the target site which means synthesizing new targets accomplishing the first ones' functions but are not inhibited by the antibiotic molecule or simply getting rid of the target and compensate to live without its functions.

- Resistance due to global cell adaptations.

Resistance to one antibiotic class can be achieved by different mechanisms and one bacterial cell can be able to use multiple mechanisms of resistance to survive the effects of antibiotics. As an example, fluoroquinolone resistance can occur by three biochemical routes, all of which may coexist in the same bacteria at a given time (producing an additive effect and, often, increasing the levels of resistance):

1. mutations in genes encoding the target site of fluoroquinolones (DNA gyrase and topoisomerase IV).
2. overexpression of efflux pumps that extrude the drug from the cell.
3. protection of the fluoroquinolone target site by a protein(13).

### **Genetic basis of resistance:**

- Chromosomal mediated resistance, due to a mutation in the gene that either the target of the drug or the transport system.
- Plasmid mediated resistance, extrachromosomal DNA that carries genes that encode enzymes able to degrade antibiotic molecules, plasmids frequently mediate resistance to multiple drugs and have high rate of transference.
- Transposon mediated resistance, genes that transport either within or between large pieces of DNA such as chromosomes and plasmids. Composed of three gene flanks:1. Transposase, which transport of the transposon,2. Repressor which regulate synthesis of transposase,3. The drug resistance gene(9).

Transfer of DNA between bacteria contribute largely to the spreading of antibiotic resistance.

### **Mechanisms of DNA transfer between bacteria:**

- Transformation, direct absorption, incorporation and expression of exogenous DNA between closely related bacteria, and it is mediated chromosomally by encoded proteins(14).
- Transduction, DNA transfer is mediated by independently replicating bacteriophages, bacterial viruses that can package segments of host DNA in their capsid, and inject it into a new host when an

environmental stimulus triggers cell lysis. When this happens, the new injected genetic material in the cell infected by the virus can be recombined with the chromosomal DNA, generating either a lytic or lysogenic cycle(15).

- Conjugation, transfer of genetic materials between two bacteria using plasmids(16).

Overuse and misuse of antibiotics can lead to selection of resistance strains and emergence of new multi drug resistance bacteria(9).

### **Antibiotic sensitivity testing:**

Measure the sensitivity of the bacteria to each antibiotic. Its results are the most important factor to determine the choice of antibiotic or combination of antibiotics to treat the patient. It has two types of tests:

- The tube dilution test, which is used to determine the minimal inhibitory concentration.
- The disk diffusion (Kirby Bauer) test which defines the diameter of the zone of inhibition(9).

Antibiotic sensitivity tests are done frequently to define resistance pattern in different areas and to formulate guidelines of antibiotic prescription.

### **Previous studies:**

- Knowledge, attitudes and practices relating to antibiotic use among community members of the Rupandehi District in Nepal, Anant Nepal<sup>1</sup>, Delia Hendrie, Suzanne Robinson and Linda A. Selvey.

A quantitative survey was conducted with 220 community members of the Rupandehi district of Nepal, with cluster sampling techniques applied to select households. Interviews were carried out face-to-face using a structured questionnaire. Responses were presented using descriptive analysis, with chi-squared tests and regression analysis applied to identify factors associated with KAP about antibiotic use and the Spearman's rank order correlation coefficient calculated to examine the relationship between responses to the KAP questions.

The sample comprised more females (54%) than males, the average age of respondents was 38.5 years and almost 60% of respondents lived in rural areas. Respondents had relatively good knowledge about aspects of antibiotic use other than identifying antibiotics. The concept of antibiotic resistance was well known but imperfectly understood. Half of respondents (50.9%) were unsure whether skipping doses would contribute to the development of antibiotic resistance, 88.2% indicated they would go to another doctor if not prescribed an antibiotic when they thought one was needed and nearly half (47.7%) believed antibiotics helped them get better more quickly if they had a fever. Most respondents reported correct practices accessing and using antibiotics, however, 84.6% at least sometimes preferred an antibiotic when they have a cough and sore throat. Logistic regression showed respondents with higher levels of education tended to have better knowledge, more appropriate attitudes and better practices about

antibiotic use. Rural respondents were less likely to have better knowledge about antibiotic use, while females were more likely to report better practices.

- Knowledge, Attitude and Practice towards Antibiotic Use among the Public in Kuwait Abdelmoneim Ismail Awad, Esraa Abdulwahid Aboud.

A cross-sectional survey was performed using a pretested self-administered questionnaire on a sample of 770 randomly selected Kuwaiti individuals. Descriptive and multivariate logistic regression analysis were used in data analysis.

The response rate was 88.3%. Nearly three-quarters (72.8%) of respondents had been prescribed antibiotics within 12 months prior to the study period, and 36% of them had not finished the course of treatment. Over one-quarter (27.5%) were self-medicated with antibiotics to treat mainly common cold, sore throat and cough. Self-medication was more prevalent among those who were prescribed antibiotics and those who had attitudes towards using and accessing antibiotic inappropriately. Almost 47% of participants had low knowledge regarding action, use, safety and resistance of antibiotics. Forty one percent of respondents had attitudes towards using and accessing antibiotic inappropriately. Better knowledge was found to be a predictor for positive attitude. Respondents level of agreement that doctors often prescribe antibiotics to meet the patient's expectation, and that doctors often take time to consider carefully the need for an antibiotic were 52.7% and 35.3%, respectively.

- Community knowledge and practices regarding antibiotic use in rural Mozambique: where is the starting point for prevention of antibiotic resistance? Olga Cambaco, Yara Alonso Menendez, John Kinsman.

The study was conducted in Manhiça, a semi-rural district of Southern Mozambique. Sixteen in-depth interviews and four focus group discussions (FGDs) were conducted with community members to explore lay knowledge and practices regarding antibiotics and awareness of antibiotic resistance. The qualitative data was analyzed using a combination of content and thematic analysis. The SRQR guidelines for reporting qualitative studies was performed.

Although participants did not hold any consistent knowledge of antibiotics, their visual recognition of amoxicillin (distinct red yellow capsule) was acceptable, but less so for different types and brands of antibiotics. The majority of participants were aware of the term 'antibiotic', yet the definition they gave was rarely backed by biomedical knowledge. Participants associated antibiotics with certain colors, shapes and health conditions.

Participants reported common habits that may contribute to resistance: not buying the full course, self-medication, sharing medicines and interruption of treatment. Most had never heard of the term 'antibiotic resistance' but were familiar with the phenomenon. They often understood the term 'resistance' as treatment failure and likened 'resistance' to non-compliance, ineffective medication, disease resistance or to an inability of the physical body to respond to it.

There is a broad understanding of the importance of medication compliance but not specifically of antibiotic resistance. In addition, there is a recognized gap between knowledge of responsible drug compliance and actual behavior.

## **Research Methodology**

### **3.1 Study design:**

Descriptive study, community based cross-sectional study design.

### **3.2 Study setting:**

The study was conducted at Khartoum state, one of the eighteen states of Sudan, located at middle of Sudan, comprises 3 cities Omdurman, Bahri and Khartoum city which is the capital of Sudan.

### **3.3 Study population:**

Residents of Khartoum state.

## **Inclusion criteria:**

- Sudanese nationality.
- Above 18.
- Males and females.

## **Exclusion criteria:**

- Being under 18<sup>th</sup> year of age.
- People with a mental handicap.
- Non- Sudanese people.

### **3.5 Data collection methods:**

- List of variables:

**Dependent variables:**

- Educational level.
- Job.

### **Independent variables:**

- Age.
- Gender.
- Residency.
- income

### **-Data collection instrument:**

Structural open ended and close ended questionnaire. The questionnaire was delivered using google form via social media (online survey) and the collected data was analysed using google form and SPSS version 22.

### **3.6 Sample size and Sampling technique:**

The population size is unknown, the sample size was calculated to be 384 using the formula of unknown population.

95% confidence interval, 5% margin of error, the minimal number of required samples calculated to be 384.

Using the formula of unknown population:  $n = z^2 (p)(1-p) / c^2$

Where:

z = standard normal deviation set at 95% confidence level

p = percentage picking a choice or response

c = confidence interval

### **3.7 Ethical Considerations:**

- Ethical approval was obtained from Al- Neelain university faculty of medicine.
- Informed consent was taken from participants and were assured of their confidentiality.

### **3.8 Data analysis:**

Knowledge and attitude were analysed using 5-point likert scale whose responses are strongly agree, agree, neither agree nor disagree, disagree and strongly disagree.

Strongly agree and agree were regarded as agree, and strongly disagree and disagree were regarded as disagree.

A scoring system was used, with 1 point for the correct answer and 0 for the other answers. The total is 9 points for knowledge and 5 point for attitude.

Practice was analysed using 3-point scale whose responses are always, sometimes and never.

For the right practice 2 point for always, 1 point for sometimes and 0 for never.

For the wrong practice 2 points for never, 1 point for sometimes and 0 for always.

The total is 16 points.

The collected data was coded and entered in SPSS version 22. Frequency, means and percentages was calculated to find out knowledge, attitude and practice toward antibiotic use and their resistance.

## Results

### Characteristics of respondents:

A total of 351 samples were collected, the sample included more females (58.7% vs 41.3), most of the respondents were in the 18- 25 age group, majority were students, most of the respondents had achieved university and post graduate education, most of the respondents were from Khartoum, Omdurman and then Bahri. The mean monthly income was 141759 SDGs.

### Table 3: socio-demographic characteristics of respondents:

variable	number	percentage
Gender		
Male	145	41.3%
female	206	58.7%
Age group		
18-25	299	85.2%
26-40	42	12%
Over 40	10	2.8%
Residency		
Omdurman	108	40.4%
Bahri	47	17.6%
Khartoum	112	41%
Level of education		
Primary school	1	0.3%
Secondary school	7	2%
University	323	92%
Post graduate education	20	5.7%

### **Knowledge, attitude and practice regarding antibiotic use and resistance:**

Majority had good knowledge regarding antibiotic use and resistance, more than 15% of respondents didn't know that antibiotic use can result in secondary infections after killing the good bacteria.

Majority of respondents had positive attitude regarding antibiotic use and resistance, except in question 15 majority of patients think antibiotics are not safe drugs, more than 25% of respondents didn't know that skipping one or two doses can participate in development of antibiotic resistance.

Majority of respondents had good practice regarding antibiotic use, except in question 20 where the majority

Doesn't consult in a regular basis every time before starting antibiotic. Majority of respondents sometimes take antibiotic when they have sore throat or cough.

## Discussion

There is no published study regarding knowledge, attitude and practice regarding antibiotic use and resistance in Sudan.

Overall, the respondents had good knowledge regarding antibiotic use, majority of respondents responds correctly in the question antibiotics are useful for bacterial infection(93%) which is comparable to a similar study that was done in Nepal(17) and significantly larger than 56% in a study done in Kuwait(18), 75% of respondents know that antibiotics can lead to secondary infections by killing good bacteria which is comparable to 70% and 68% in studies done in Saudi Arabia and Kuwait respectively(19)(18).

About 61.5% of respondents respond no to the question antibiotic can speed up recovery from flu which is significantly higher than 47.3% correct response in the Kuwait research(18) and significantly lower from a similar study( more than 85%)(17), 74.4% thinks antibiotics can kill good bacteria which is comparable to the results of the study conducted in Nepal(17). 90% of respondents think that antibiotic resistance is a global health problem which is significantly higher than 9.9% of Kuwait study(18).

Regarding attitude 18.3% responded yes in the question skipping one or two doses may can contribute to the development of resistance which is significantly lower when compared to the results of the same study mentioned above(40%)(17), 45% thinks that antibiotics are safe drugs which is significantly higher when compared to the results of the same study(<15%)(17).

Regarding practice 64% prefer to take antibiotics when they have sore throat or cough which is slightly lower compared to the same study (70%), 84% checks expiry date before taking the antibiotic which is comparable to the results of the same study of Nepal.

## Conclusions And Recommendations

### 6.1. conclusion:

The study concluded that the majority of Khartoum state residents have good knowledge regarding antibiotic use and resistance and generally good attitude and practice regarding antibiotic use.

This research is an important step in the understanding of knowledge, attitude and practice regarding antibiotic use and resistance among residents of Khartoum, its results can be used in formulation of future educational programs and can be used to correct mis concepts and false believes about antibiotic use and resistance and to correct misbehaviours that can result in antibiotic resistance.

### 6.2. recommendations:

Ongoing research studies should focus on finding the reasons behind misbehaviours and research about sensitivity patterns should be done in Sudan to formulate guidelines that help doctors to choose

antibiotics for prescription in a way that minimizing the emergence of new strains of resistance bacteria.

## Abbreviations

**KAP** Knowledge attitude and practice

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**DNA** Deoxy ribonucleic acid

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**SPSS** Statistical package for the social sciences

## Declarations

**Conflict of interest:** No conflict of interest.

I hereby declare that this thesis is the result of my own investigations, except where otherwise stated. I also declare the fact that the research is purely an academic requirement, and the information gathered will be addressed accurately and credibly.

## References

1. Earnshaw S, Monnet DL, Duncan B, O'Toole J, Ekdahl K, Goossens H. European Antibiotic Awareness Day, 2008 - the first Europe-wide public information campaign on prudent antibiotic use: methods and survey of activities in participating countries. *Euro Surveill.* 2009;14(30):19280.
2. Sabry NA, Farid SF, Dawoud DM. Antibiotic dispensing in Egyptian community pharmacies: An observational study. *Res Soc Adm Pharm.* 2014 Jan 1;10(1):168–84.
3. New report calls for urgent action to avert antimicrobial resistance crisis [Internet]. [cited 2021 Aug 10]. Available from: <https://www.who.int/news/item/29-04-2019-new-report-calls-for-urgent-action-to-avert-antimicrobial-resistance-crisis>
4. Dantas G, Sommer MOA. How to fight back against antibiotic resistance. *Am Sci.* 2014 Jan;102(1):42–51.
5. Radyowijati A, Haak H. Improving antibiotic use in low-income countries: an overview of evidence on determinants. *Soc Sci Med.* 2003 Aug 1;57(4):733–44.
6. Michael CA, Dominey-Howes D, Labbate M. The antimicrobial resistance crisis: Causes, consequences, and management. *Front Public Heal.* 2014;2(SEP):1–8.
7. Simba D, Kakoko D, Semali I, Kessy A, Embrey M. Household knowledge of antimicrobials and antimicrobial resistance in the wake of an Accredited Drug Dispensing Outlet (ADDO) program rollout in Tanzania. *PLoS One.* 2016;11(9):1–13.

8. [REDACTED], [REDACTED] [REDACTED]. Gannon J (2000) The global infectious disease threat and its implications for the United States. Washington: National Intelligence Council 52 p.
9. warren levinson. Review of Medical Microbiology and Immunology 13th edition.
10. Overview of Antibiotics - Infections - Merck Manuals Consumer Version [Internet]. [cited 2021 Aug 10]. Available from: <https://www.merckmanuals.com/home/infections/antibiotics/overview-of-antibiotics>
11. antibiotic | Description, Uses, Classification, & Antibiotic Resistance | Britannica [Internet]. [cited 2021 Aug 10]. Available from: <https://www.britannica.com/science/antibiotic>
12. About Antibiotic Resistance | Antibiotic/Antimicrobial Resistance | CDC [Internet]. [cited 2021 Sep 2]. Available from: <https://www.cdc.gov/drugresistance/about.html>
13. Munita JM, Arias CA. Mechanisms of antibiotic resistance. *Virulence Mech Bact Pathog*. 2016; (6):481–511.
14. MG L, W W. Bacterial gene transfer by natural genetic transformation in the environment. *Microbiol Rev* [Internet]. 1994 Sep [cited 2021 Sep 2];58(3):563–602. Available from: <https://pubmed.ncbi.nlm.nih.gov/7968924/>
15. Bello-López JM, Cabrero-Martínez OA, Ibáñez-Cervantes G, Hernández-Cortez C, Pelcastre-Rodríguez LI, Gonzalez-Avila LU, et al. Horizontal gene transfer and its association with antibiotic resistance in the genus aeromonas spp. *Microorganisms*. 2019;7(9):1–11.
16. Shintani M. The behavior of mobile genetic elements (MGEs) in different environments. *OUP* [Internet]. 2017 [cited 2021 Sep 2];81(5):854–62. Available from: <https://www.tandfonline.com/doi/abs/10.1080/09168451.2016.1270743>
17. Nepal A, Hendrie D, Robinson S, Selvey LA. Knowledge, attitudes and practices relating to antibiotic use among community members of the Rupandehi District in Nepal. *BMC Public Health*. 2019;19(1):1–12.
18. Awad AI, About EA. Knowledge, attitude and practice towards antibiotic use among the public in Kuwait. *PLoS One*. 2015;10(2):1–15.
19. Alnasser AHA, Al-Tawfiq JA, Ahmed HAA, Alqithami SMH, Alhaddad ZMA, Rabiah ASM, et al. Public knowledge, attitude and practice towards antibiotics use and antimicrobial resistance in Saudi Arabia: A web-based cross-sectional survey. *J Public health Res*. 2021;

## Figures

figure 1: responses to questions about knowledge

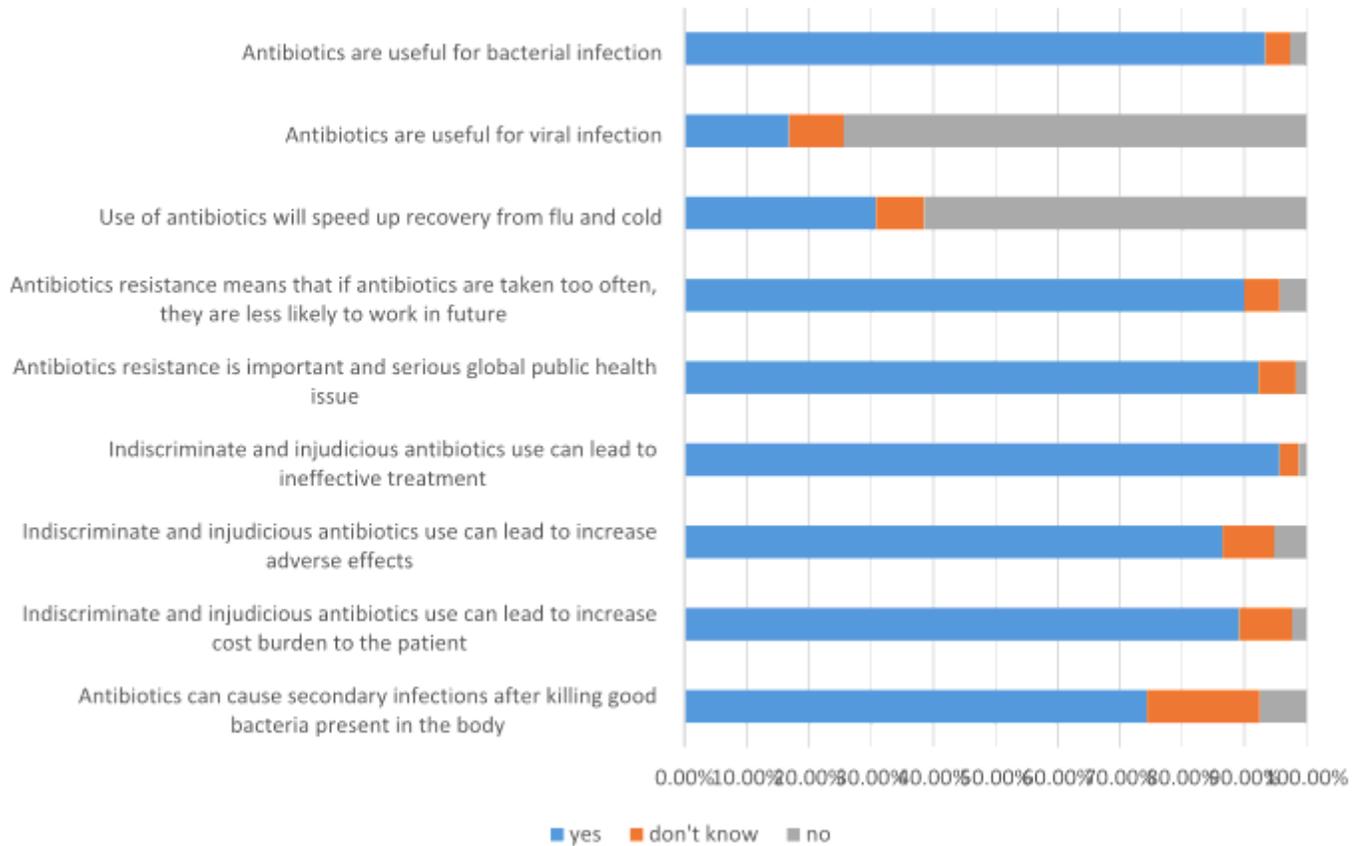


Figure 1

The level of knowledge about antibiotic use and resistance was better for responders who were females ( $\chi^2= 14.4$ , p value = 0.026), 18-25 years ( $\chi^2= 25.691$ , p value = 0.042), university education ( $\chi^2= 26.858$ , p value = 0.217) and living in Khartoum ( $\chi^2= 20.799$ , p value = 0.049).

figure2: responses to questions about attitude

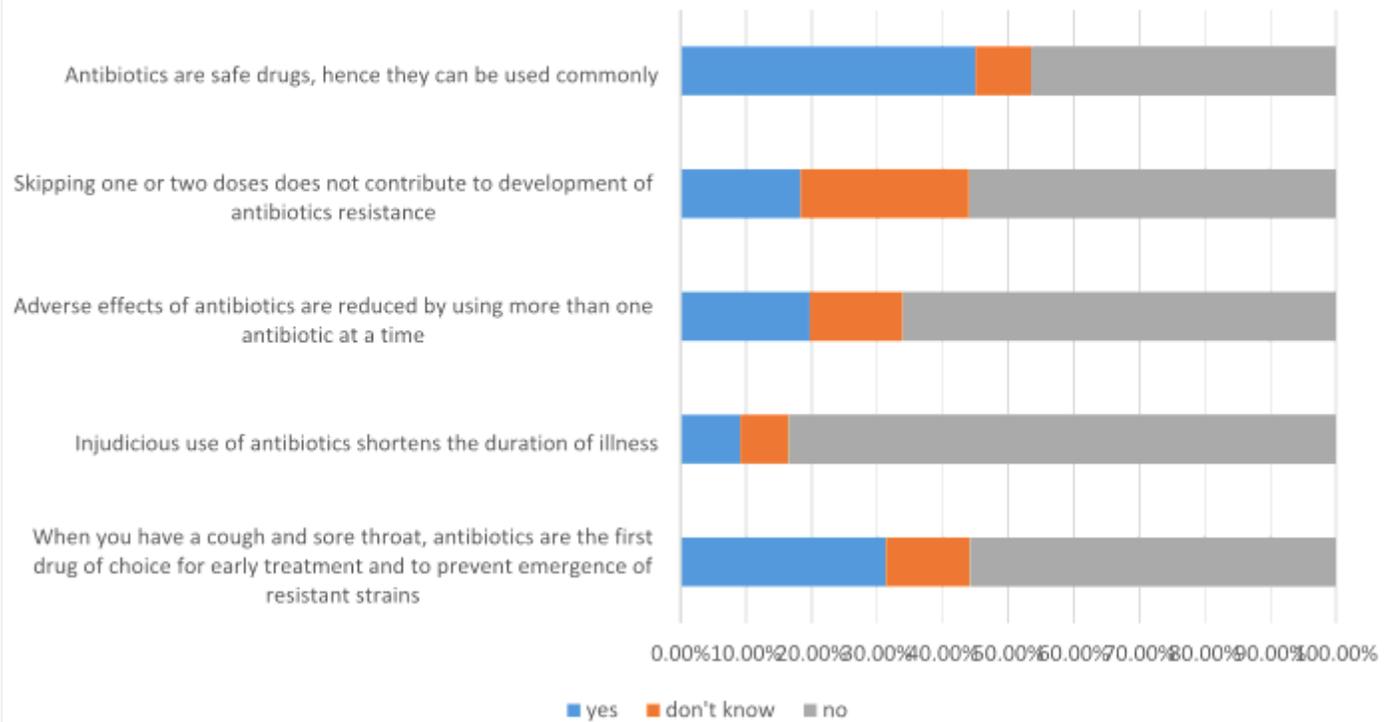


Figure 2

The level of attitude regarding antibiotic use and resistance was better for respondents who were females ( $\chi^2= 6.243$ ,  $p$  value = 0.328), over 40 ( $\chi^2= 10.326$ ,  $p$  value = 0.248), post graduates ( $\chi^2= 13.154$ ,  $p$  value = 0.165), and people living in Bahri ( $\chi^2= 20.097$ ,  $p$  value = 0.120).

figure3: responses to questions about practice

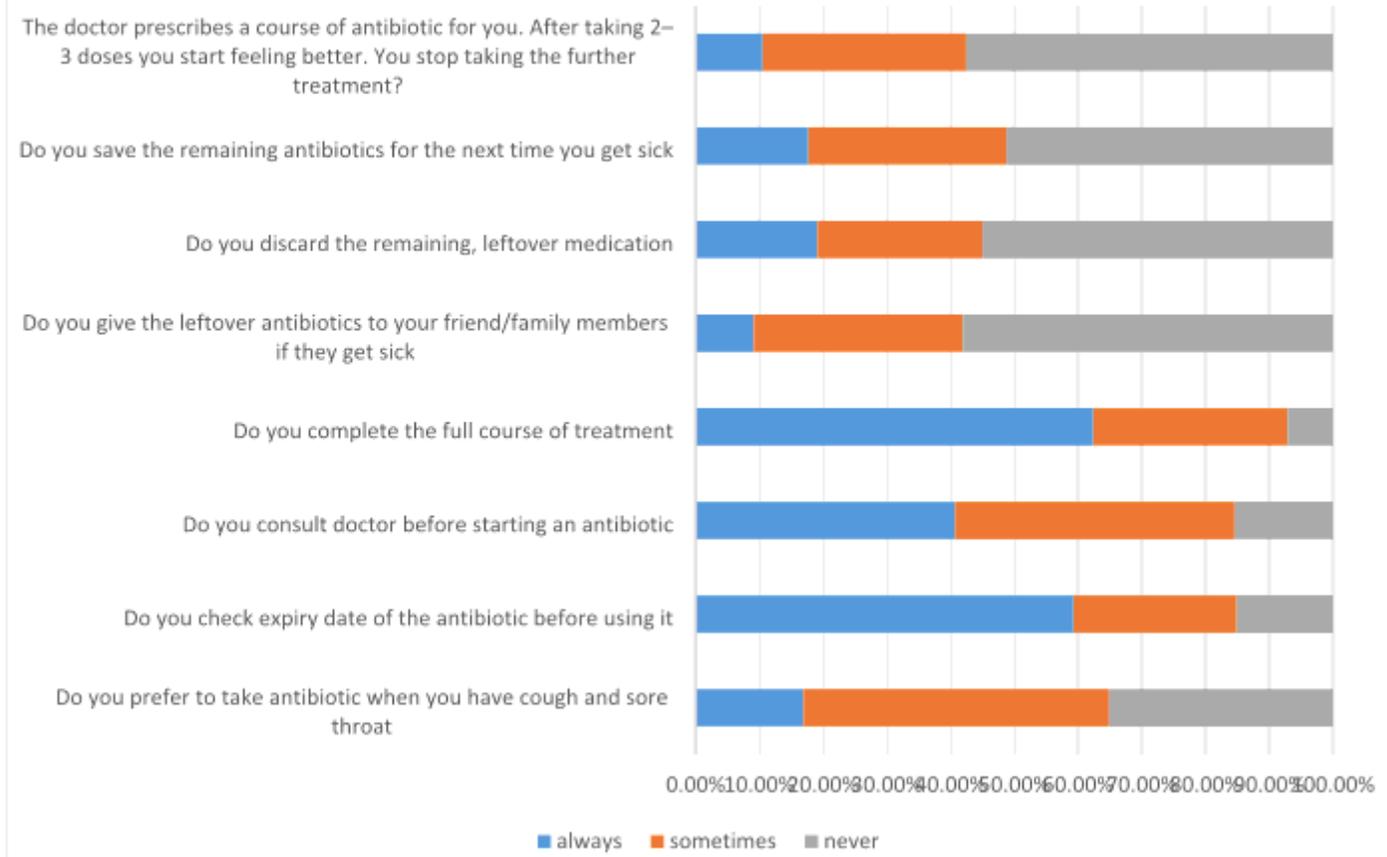
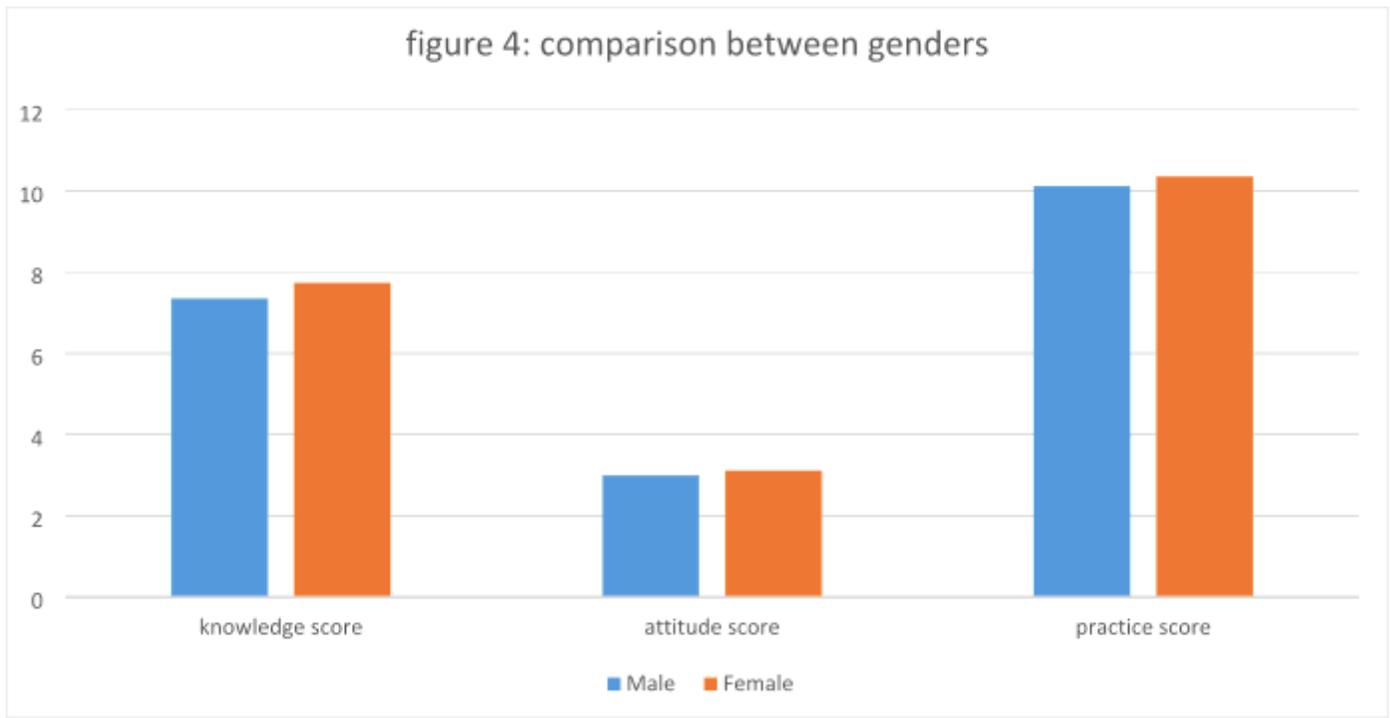


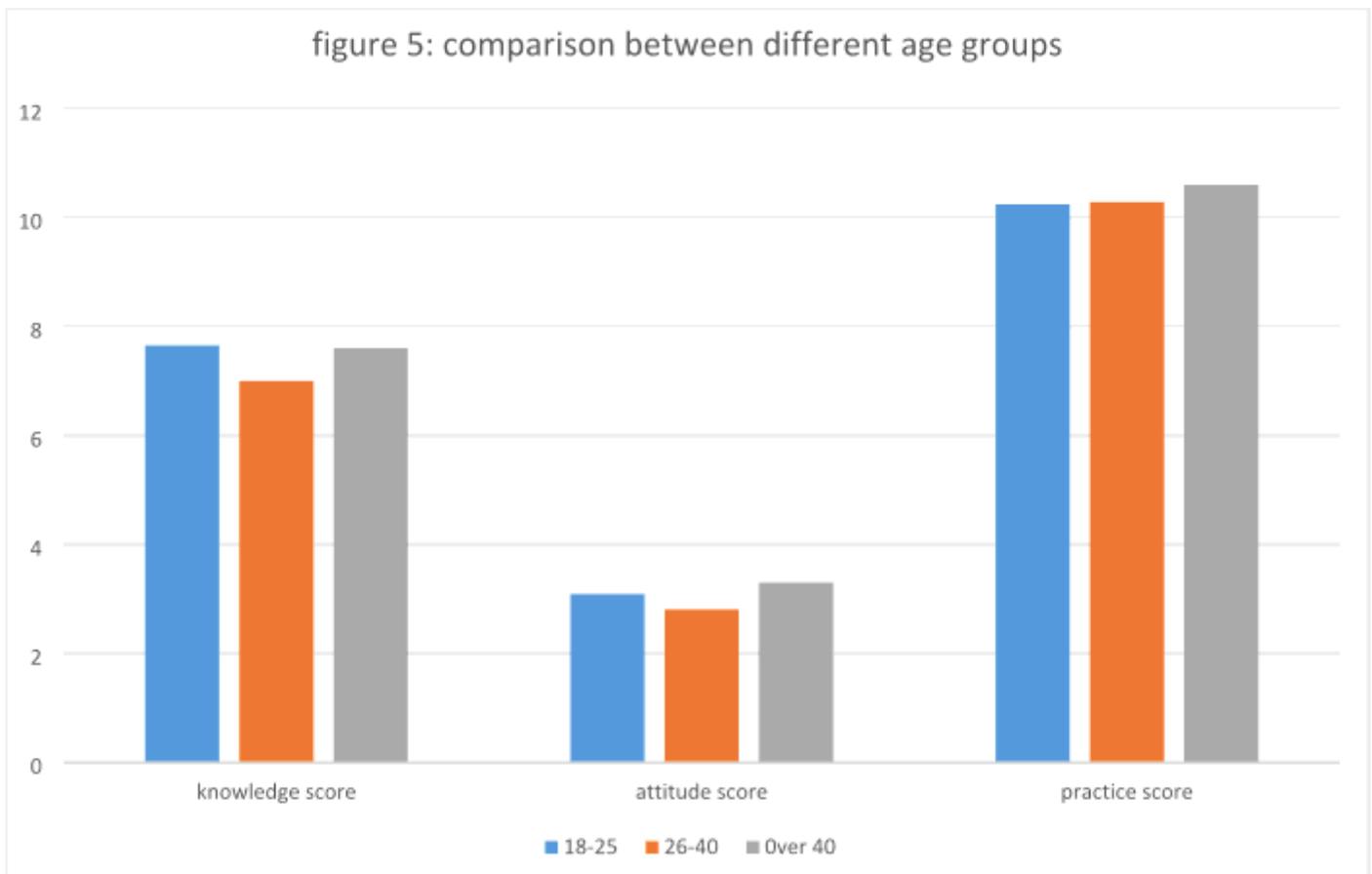
Figure 3

Practice regarding antibiotic use was better in females ( $\chi^2= 17.805$ ,  $p$  value = 0.410), over 40 ( $\chi^2= 45.476$ ,  $p$  value = 0.918), post graduate ( $\chi^2= 50.054$ ,  $p$  value = .0.982) and people living in Bahri ( $\chi^2= 35.625$ ,  $p$  value = 0.558).



**Figure 4**

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**Figure 5**

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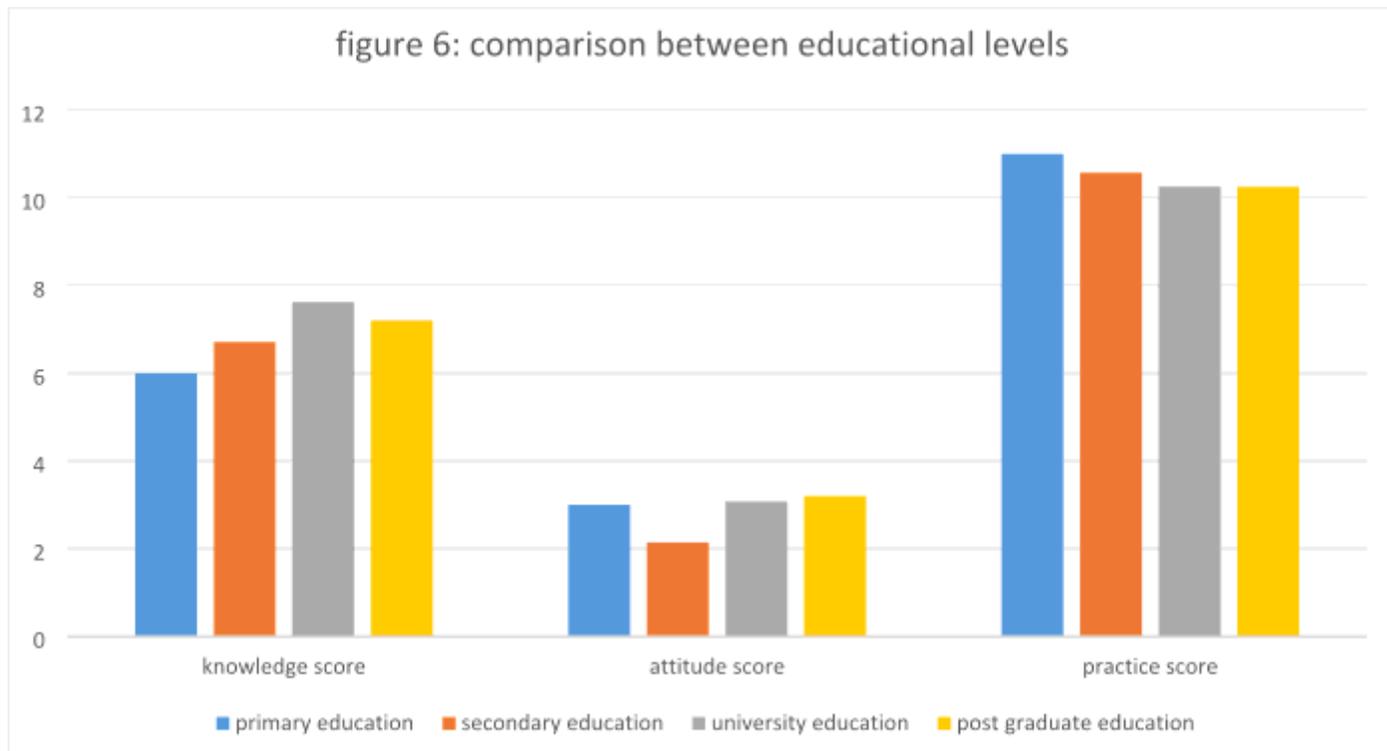
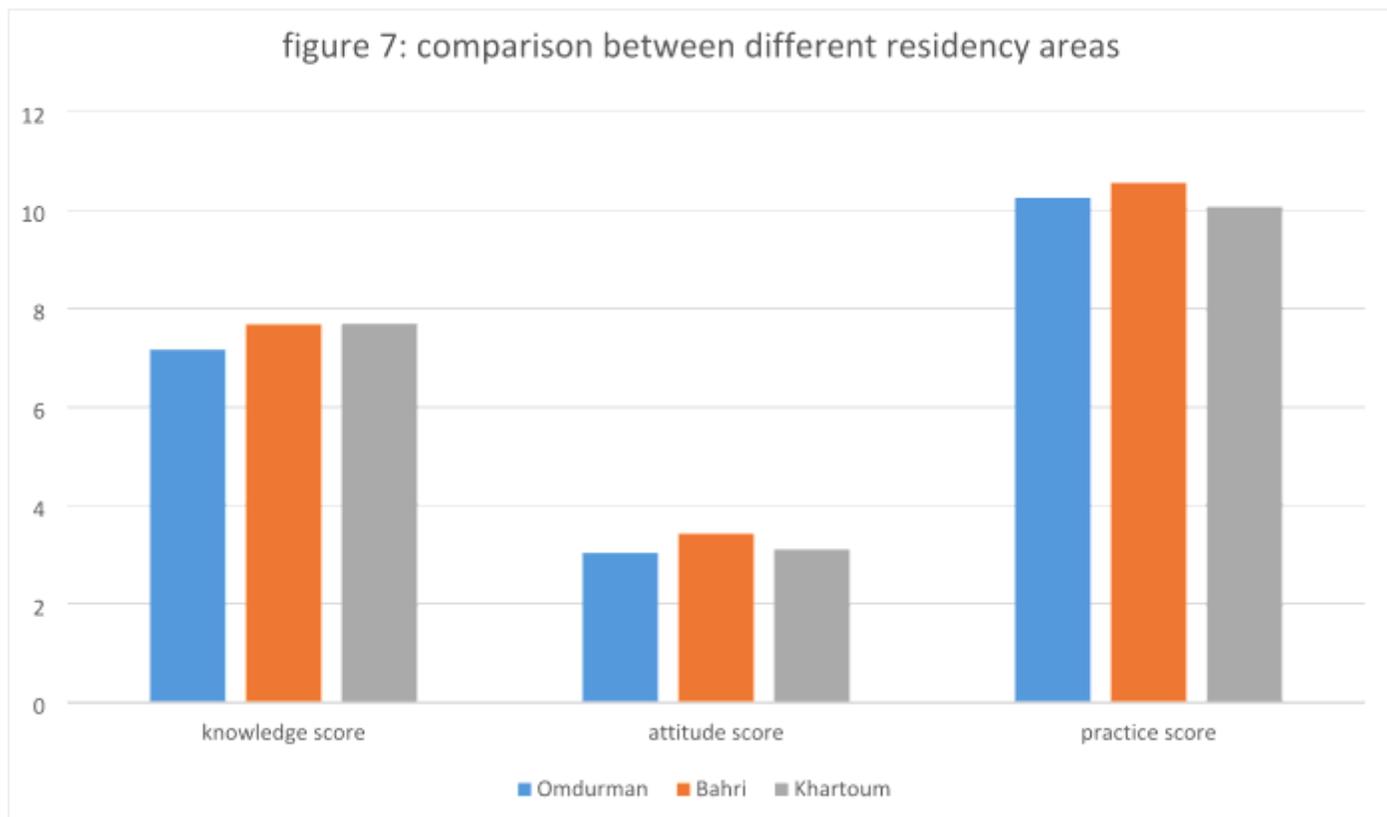


Figure 6

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## Figure 7

See image above for figure legend.

## Supplementary Files

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