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Impact of community-based educational intervention on antibiotic use and resistance awareness among the people living in Ras Al Khaimah, United Arab Emirates

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Abstract

Objectives Antibiotic resistance is a major global public health concern today. We explored the usefulness of an educational intervention in increasing antibiotic-related awareness of the public.

Methods This community-based interventional study was conducted among 100 people living in Ras Al Khaimah, UAE. Preintervention awareness regarding antibiotics and antibiotic resistance was assessed using the World Health Organization antibiotic resistance: multicountry public awareness survey. After the baseline assessment of the knowledge, educational intervention was given to the study participants. The same questionnaire was used to assess the impact of this intervention after 4 weeks.

Key findings The study participants had low baseline knowledge of antibiotics and the phenomenon of antibiotic resistance. A high proportion of study participants (54%) took antibiotics in the past 6 months. Our intervention significantly improved antibiotic-related knowledge and behaviours. Postintervention majority of study participants realized that full course of antibiotics should be taken (% change: 50.0, $P < 0.001$), leftover antibiotics from family and friends should not be used (% change: 40.0%, $P = 0.004$), antibiotics are of no use in viral infections (% change: 72.0%, $P < 0.001$), infections are becoming increasingly resistant to antibiotics (% change: 37%, $P < 0.001$), bacteria resistant to antibiotics can be spread from person to person (% change: 73%, $P < 0.001$) and infections from resistant bacteria are difficult to treat (% change: 38%, $P < 0.001$).

Conclusion Following the intervention, antibiotic-related awareness was significantly improved among study participants. Further efforts should be made to ensure that this improved awareness is converted to necessary health behaviour changes in the long term.

Keywords antibiotic resistance; antibiotics; awareness; community-based educational intervention; United Arab Emirates

Introduction

Antibiotic resistance is a major global public health concern today.[1] This threat is being accelerated by the systematic misuse and overuse of antibiotics, as well as poor infection prevention and control. Antibiotic resistance is associated with treatment failures, increased mortality and intangible healthcare costs.[2] The emergence of antibiotic resistance is currently faster than the rate of development of new antibiotics. Responding to this crisis, a global action plan was endorsed at the World Health Assembly in the year 2015.[3] One of the primary objectives of this plan was to improve public awareness and understanding of antibiotic resistance through appropriate communication, education and training.[3,4] To join the global community in addressing this crisis, the Gulf Cooperation Council (GCC) states have also adopted a strategic plan, which is being implemented by the member states.[5]

The World Health Organization (WHO) conducted a multicountry survey on antibiotic use, and awareness of antibiotics and of antibiotic resistance.[4] The results of the survey

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revealed widespread public misunderstanding regarding antibiotics and their resistance. It also pointed out the urgent need for improving awareness and understanding of antibiotic resistance.

Studies conducted in United Arab Emirates (UAE)[6,7] also highlighted significant gaps in antibiotic awareness and practices, which are in turn contributing to the growing threat of antibiotic resistance in the region. However, UAE Health Ministry's relentless efforts in cooperation with the National Committee of Antimicrobial Resistance and other relevant public and private health bodies resulted in the reduction of unnecessary antibiotic use by 43%.[8]

Educational interventions have shown to be useful in raising the awareness and modifying beliefs and attitudes of the general public towards various public health concerns[9–11] including antibiotic resistance.[12–14] Understanding the local public knowledge regarding antibiotics and their resistance development and also recognizing misconceptions related to them can play an important role in shaping government policies and campaigns to address this critical issue.

The present study was therefore undertaken to assess the awareness of people living in UAE regarding antibiotics and antibiotic resistance and to explore the usefulness of a community-based educational intervention in raising this awareness.

Methods

Study design and sample population

This study was carried out as a one-group pretest–post-test experimental design in which the same group of people was given the intervention and their scores pre- and postintervention were compared. The study was divided into three phases: the first phase was the pre-educational intervention phase, the second phase was the educational intervention phase, and the third phase was the posteducational intervention phase. Figure 1 represents the study flow diagram. People more than 18 years of age, of either gender, willing to give written informed consent and living in Ras Al Khaimah were included in the study. Participants were recruited using the convenience sampling technique. One hundred and ten people participated in the study and provided with written informed consent. Ten people were not included in the study as they did not complete their post-test. One hundred participants completed the study and were included in final data analysis with a response rate of 91%.

Study instrument

WHO antibiotic resistance: multicountry public awareness survey[4] was used for assessing the usefulness of educational intervention on antibiotic-related awareness. The Arabic version of the questionnaire, translated by a linguistic expert, was also used for the study. Prior to the conduct of the study in our population, the questionnaire was pilot-tested on 10 participants, which resulted in a Cronbach's alpha score of 0.81, signifying high reliability.

The WHO questionnaire, which has been used in 12 countries, consists of four domains with 14 questions. Domain 1 captured the use and sources of antibiotics (four items), domain 2 assessed the knowledge about antibiotics (4 items), domain 3 dealt with the knowledge about antibiotic resistance (five items), and domain 4 consisted of a question on use of antibiotics in agriculture (one item).

Educational intervention

The intervention comprised of a teaching and discussion session of 45 min, which was delivered with the help of a PowerPoint presentation. The content of the session consisted of information regarding antibiotic facts and figures, antibiotic use and misuse and antibiotic resistance. In addition to this, handouts of WHO resource material on antimicrobial resistance were used as educational tools.

Data collection procedure

The enrolment of the participants was done on the basis of study criteria. Participants gave a written informed consent before enrolment in the study. The WHO questionnaire was used to assess the baseline knowledge (pretest) regarding antibiotics and their resistance. After the baseline assessment of the knowledge, an educational intervention was given to the study participants. Impact of the intervention was evaluated after 4 weeks using the same post-test questionnaire.

Data analysis

Statistical Package for the Social Sciences (SPSS Statistics for Windows, version 22.0, IBM Corp, Armonk, NY, USA), was used for data analysis. Relationship between the categorical variables was established using the Pearson chi-square test. Mc-Nemar's test was used for testing the pre- and posteducational intervention antibiotic awareness change. $P \leq 0.05$ was considered statistically significant.

Ethical considerations

The study was initiated after taking ethical approval from RAK Medical and Health Sciences University Research and Ethics Committee (RAKMHSU-REC-100-2018-UG-P) and Ministry of Health and Prevention Research and Ethics Committee (MOHAP/REC/2019/7-2019-UG-P).

Results

Sociodemographic characteristics

The mean age of the study respondents was 28.6 ± 9.6 years, with a range from 18 to 66 years. Majority of the participants (45.0%, 95% CI: 35.0–55.0) were in the age group of 18–23 years, were female (57.0%, 95% CI: 32.0–52.0), were residing in urban areas (59.0%, 95% CI: 49.0–69.0) and had secondary-level education (33.0.0%, 95% CI: 24.0–42.0). The sociodemographic characteristics of the study participants are represented in Table 1.

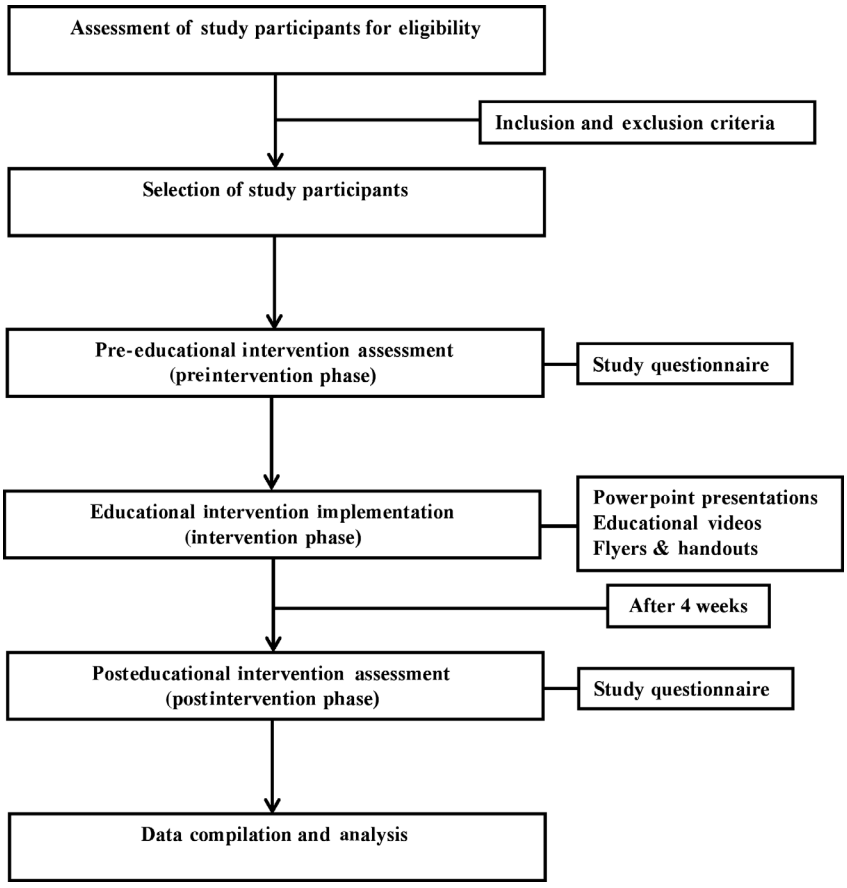

Figure 1 Study flow diagram.

Use of antibiotics among the study population

One-third of the participants (36.0%, 95% CI: 28.0–45.0) had taken antibiotics in the last 1 month preceding the survey, with more than half of the participants (57.0%, 95% CI: 47.0–67.0) obtaining the antibiotic prescriptions from a doctor or a nurse. Nearly half the study participants (55.0%, 95% CI: 46.0–65.0) took advice from a doctor, nurse or pharmacist on how to take the antibiotics. More than half of the study participants (58.0%, 95% CI: 47.0–67.0) got the antibiotics from a medical store or a pharmacy. Table 2 represents the use of antibiotics among the study participants.

Impact of educational intervention

Knowledge about antibiotics and their appropriate use

Significant improvement in antibiotic-related knowledge was observed after the educational intervention. The comparison of pre- and postintervention knowledge regarding antibiotics is represented in Table 3 and Figure 2.

Pre-educational intervention, only 49.0% of the participants believed that they should stop taking antibiotics only when all the prescribed doses are taken (question no. 4). Postintervention, this percentage significantly increased to 99.0% with a percentage change of 50.0% ($P < 0.001$).

Before taking the educational intervention, more than half of the study participants (54.0%) were of the opinion that it is okay to use antibiotics prescribed to a friend or family member to treat the same illness (question no. 5). This behaviour significantly changed (% change: 40.0, $P = 0.004$) postintervention.

Regarding question no. 6, which asked whether it is okay to buy or request to the doctor the same antibiotic that resolved the symptoms on a previous instance, most of the study participants (77.0%) after the educational intervention answered correctly that it is false compared with 43.0% preintervention.

Maximum percentage change in awareness (72.0%) between pre- and postintervention was reported for question no. 7, which listed out medical conditions asking whether they can be treated with antibiotics. Before the educational intervention, 89.0% of the participants believed that cold and flu can be treated with antibiotics, but postintervention, this belief significantly ($P < 0.001$) changed and the participants realized that cold and flu are of viral origin and antibiotics have no value in such conditions.

Knowledge and understanding about antibiotic resistance

Significant improvement was seen in the awareness of study participants regarding antibiotic resistance after the educational intervention. Postintervention majority of the participants identified correctly all the statements related to

Table 1 Sociodemographic characteristics of the study participants

	Frequency $n = 100$	Percentage (%)	95% CI
Age			
18–23	45	45.0	35.0–55.0
24–34	26	26.0	18.0–35.0
35–44	14	14.0	8.0–21.0
45–54	8	8.0	3.0–14.0
55–64	4	4.0	1.0–9.0
65+	3	3.0	0.0–6.0
Gender			
Male	43	43.0	48.0–68.0
Female	57	57.0	32.0–52.0
Residence			
Urban	59	59.0	49.0–69.0
Suburban	29	29.0	19.0–39.0
Rural	12	12.0	8.0–16.0
Education level			
No education	19	19.0	12.0–27.0
Primary	16	16.0	9.0–23.0
Secondary	33	33.0	24.0–42.0
Graduation	11	11.0	5.0–18.0
Postgraduation	8	8.0	3.0–14.0
Doctorate	5	5.0	1.0–10.0
Vocational	8	8.0	3.0–13.0
Ethnicity			
Arab	49	49.0	39.0–59.0
African	28	28.0	19.0–37.0
Asian	23	23.0	15.0–31.0
Household composition			
Single adult only	36	36.0	28.0–45.0
Single adult and at least one child under 16	2	2.0	0.0–5.0
Married adults only	17	17.0	11.0–25.0
Married and at least one child under 16	6	6.0	2.0–11.0
Multiple adults aged 16+ only	18	18.0	11.0–26.0
Multiple adults aged 16+ and at least one child under 16	21	21.0	13.0–29.0

CI, confidence interval.

Table 2 Use of antibiotics among the study population

	Frequency $n = 100$	Percentage (%)	95% CI
When did you last take antibiotics?			
In the last month	36	36.0	28.0–45.0
In the last 6 months	18	18.0	10.0–26.0
In the last year	17	17.0	10.0–25.0
More than a year ago	6	6.0	2.0–11.0
Never	8	8.0	3.0–13.0
Can't remember	15	15.0	8.0–22.0
Did you get the antibiotics (or a prescription for them) from a doctor or nurse?			
Yes	57	57.0	47.0–67.0
No	22	22.0	14.0–30.0
Can't remember	21	21.0	14.0–29.0
Did you get advice from a doctor, nurse or pharmacist on how to take them?			
Yes	55	55.0	46.0–65.0
No	27	27.0	18.0–36.0
Can't remember	18	18.0	10.0–25.0
Where did you get the antibiotics from?			
Medical store or pharmacy	58	58.0	47.0–67.0
Stall or hawker	2	2.0	0.0–5.0
The internet	1	1.0	0.0–3.0
Friend or family member	11	11.0	5.0–17.0
I had them saved up from a previous time	7	7.0	2.0–13.0
Somewhere/someone else	5	5.0	1.0–10.0
Can't remember	16	16.0	9.0–24.0

CI, confidence interval.

antibiotic resistance (Table 4). Prior to the intervention, only 37.0% of the participants answered correctly when asked about the statement 'antibiotic resistance occurs when your body becomes resistant to antibiotics and they no longer work as well'. Percentage of correct answer rose significantly to 77.0% after the intervention (% change: 40.0%, $P < 0.001$). Majority of the participants (65%) acknowledged the fact that many infections are becoming increasingly resistant to treatment by antibiotics and as a result represent major risks for medical procedures such as surgery, organ transplants and cancer treatment (90%, % change: 78%, $P < 0.001$).

Most of the participants (88%) recognized that bacteria resistant to antibiotics can be spread from person to person (% change: 73.0%, $P < 0.001$). A large proportion of the total of participants (74.0%) thought that antibiotic resistance is an issue that could affect them and their family (% change: 54.0%, $P < 0.001$) specifically for people who take antibiotics regularly (83%). 77% of the study participants acknowledged that antibiotics are widely used in agriculture (% change: 40.0%, $P < 0.001$).

Addressing the problem of antibiotic resistance

The last section of the WHO questionnaire consisted of eight statements highlighting different actions, which would help address the problem of antibiotic resistance. The study participants were required to express their agreement or disagreement on a scale of 1–5. Posteducational intervention, a large majority of the participants agreed that appropriate and timely actions could help tackle the issue of antibiotic resistance (Figure 3). Majority of the people agreed that antibiotics should be used only when prescribed by a doctor (95.0%), doctors should prescribe antibiotics only when needed (90.0%), leftover antibiotics should not be used later for other illnesses (90.0%), farmers should use fewer antibiotics in animal farms (89.0%), and washing hands regularly (99.0%) would help in tackling the problem of antibiotic resistance.

Discussion

The present study was conducted to evaluate the influence of an educational intervention on raising the antibiotics and

Table 3 Comparison of pre- and postintervention knowledge regarding antibiotics

Knowledge item	Answers (%)		Percentage of change	Mc-Nemar test
	Pretest $n = 100$	Post-test $n = 100$		P value
Knowledge about antibiotics				
When do you think you should stop taking antibiotics once you've begun treatment?				
When you feel better	51.0	1.0	50.0	**<0.001**
When you've taken all of the antibiotics as directed	49.0	99.0	50.0	
It's okay to use antibiotics that were given to a friend or family member, as long as they were used to treat the same illness				
True	54.0	14.0	40.0	**0.004**
False	46.0	86.0	40.0	
It's okay to buy the same antibiotics, or request these from a doctor, if you're sick and they helped you get better when you had the same symptoms before				
True	57.0	23.0	34.0	**<0.001**
False	43.0	77.0	34.0	
Do you think these conditions can be treated with antibiotics?				
HIV/AIDS				
Yes	10.0	8.0	2.0	0.562
Gonorrhoea				
Yes	10.0	70.0	60.0	**0.002**
Bladder infection or urinary tract infection				
Yes	18.0	75.0	57.0	**<0.001**
Diarrhoea				
Yes	91.0	48.0	43.0	**<0.001**
Cold and flu				
Yes	89.0	17.0	72.0	**<0.001**
Fever				
Yes	67.0	40.0	37.0	**0.004**
Malaria				
Yes	54.0	60.0	6.0	**0.049**
Measles				
Yes	70.0	46.0	24.0	**<0.001**
Sore throat				
Yes	92.0	40.0	52.0	**<0.001**
Body aches				
Yes	12.0	5.0	7.0	0.614
Headaches				
Yes	14.0	6.0	8.0	0.418

Statistically significant values are in bold.

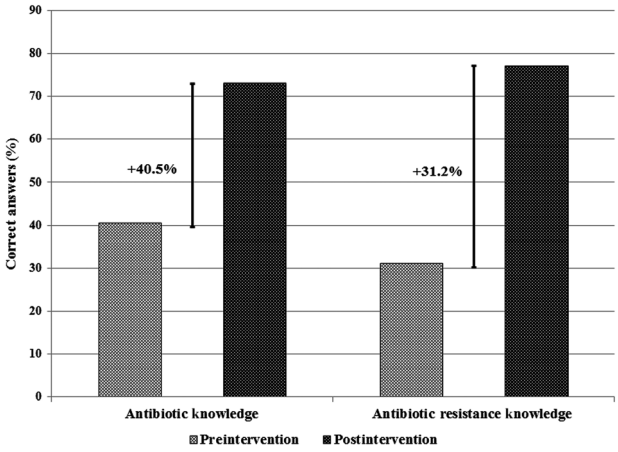

Figure 2 Pre- and postintervention knowledge of study participants regarding antibiotics and antibiotic resistance.

antibiotic resistance awareness among the people living in UAE. Our study employed the WHO questionnaire on antibiotic resistance, which was used in a multicountry survey among 10 000 people belonging to 12 different countries to assess their use of antibiotics, and knowledge of antibiotics and of antibiotic resistance. The survey findings suggested that there is a gap in knowledge regarding antibiotics. Our study also reported similar knowledge pattern pre-educational intervention among the study population.

Further, our findings suggested that subsequent to a targeted educational intervention, the people became more aware of appropriate antibiotic use and the phenomenon of antibiotic resistance and demonstrated a positive change in the behaviour for addressing the issue of resistance. Educational interventions are a cornerstone of measures to control antibiotic resistance. Moreover, focused community-based interventions can be significant add-ons to the government efforts to combat antibiotic resistance.[15]

The baseline awareness of our study participants regarding antibiotics and their resistance was low. This finding is in agreement with the other studies conducted in UAE,[6,7] other Gulf Cooperation Council (GCC) countries[16,17] and other parts of the world,[4,18,19] which reported lack of awareness regarding antibiotic use and the phenomenon of antibiotic resistance. Studies conducted in Germany[20] and United States[21] reported contrasting results, where the participants showed high level of awareness regarding antibiotics and resistance. This difference can be attributed to the fact that a high proportion of participants in both the studies received graduation level or above education.

Our intervention led to significant improvement in the knowledge of antibiotics and resistance. These findings are in agreement with the results of different international studies conducted in United States,[14,22] Malta,[23] Egypt,[12] and Jordan[13] where diverse educational interventions proved beneficial improving antibiotic-related awareness.

Regarding the use of antibiotics, a high proportion of the study participants (54%) took antibiotics in the past 6 months. This usage pattern is similar to the one seen in the WHO multicountry survey[4] where 65% of the survey participants self-reported antibiotic use in the past 6 months.

In our study, only 57% of the participants reported that they got their antibiotics from a doctor or a nurse. These findings are in line with the data from the Russian Federation in the WHO multicountry survey.[4] Contrasting results were reported by an Italian antibiotic awareness survey[24] where more than 85% of the participants got their antibiotics from a doctor. This drug-seeking behaviour of our

Table 4 Comparison of pre- and postintervention knowledge regarding antibiotic resistance

Knowledge item	Answers (%)		Percentage of change	Mc-Nemar test
	Pretest $n = 100$	Post-test $n = 100$		P value
Knowledge about antibiotic resistance				
Antibiotic resistance occurs when your body becomes resistant to antibiotics and they no longer work as well				
True	37	77	40	**<0.001**
False	63	23	40	
Many infections are becoming increasingly resistant to treatment by antibiotics				
True	28	65	37	**<0.001**
False	72	35	37	
If bacteria are resistant to antibiotics, it can be very difficult or impossible to treat the infections they cause				
True	24	62	38	**<0.001**
False	76	38	38	
Antibiotic resistance is an issue that could affect me or my family				
True	20	74	54	**<0.001**
False	80	26	54	
Antibiotic resistance is only a problem for people who take antibiotics regularly				
True	82	83	01	0.521
False	18	17	01	
Bacteria which are resistant to antibiotics can be spread from person to person				
True	15	88	73	**<0.001**
False	85	12	73	
Antibiotic-resistant infections could make medical procedures like surgery, organ transplants and cancer treatment much more dangerous				
True	12	90	78	**<0.001**
False	88	10	78	

Statistically significant values are in bold.

study participants needs to be changed as irrational use (taking antibiotics without proper prescription) of these drugs over the period of time has contributed to the emergence of resistance.

The educational intervention significantly improved the behaviour of the participants towards the appropriate duration of the antibiotic treatment and using leftover antibiotics from family and friends with 99% of them acknowledging the fact that treatment should be stopped only when all the antibiotics have been taken as directed and 86% agreeing that they should not use leftover antibiotics. Similar positive behaviour change was observed in a study conducted in Jordan[13] where a pharmacist-driven active educational intervention improved public perception regarding antibiotics and resistance.

In our study, the most common (89%) misconception before the educational intervention was that cold and flu can be treated with antibiotics. This misconception among the people was also reported by the WHO survey,[4] by a study conducted among general population in Germany[25] and by an urban setting study in Senegal.[18] The intervention significantly corrected this misconception with study participants, acknowledging the fact that antibiotics have no utility in conditions of viral origin such as cold and flu.

Studies have reported emergence and spread of antimicrobial resistance in UAE[26] and the GCC states,[5] keeping this in view a common strategic plan has been adopted for combating this issue. One of the key elements of plan is to educate the prescribers and the patients on antimicrobial resistance. In our study, awareness regarding antibiotic resistance was significantly improved after the educational intervention. This improvement is in agreement with the results of studies in Jordan,[13] Egypt[12] and USA.[27] Before the intervention, the phenomenon of antibiotic resistance was highly misunderstood. The intervention played an important role in making the study participants understand that many infections are becoming increasingly resistant to antibiotics, the rapid spread of antibiotic resistance and the risk antibiotic resistance poses to medical procedures such as surgery, organ transplants and cancer treatments. It also brought about positive behavioural change regarding the measures, which can be taken up to tackle the phenomenon of antibiotic resistance.

Our study has some strengths, which include community-based study nature, planned delivery of the intervention

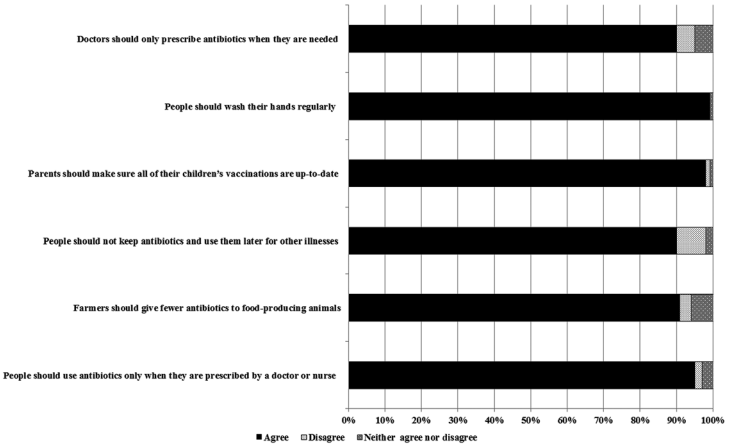

Figure 3 Postintervention behaviours of study participants towards problem of antibiotic resistance.

and assortment of information. Community-based approach has been proved successful in propagating information on public health concerns.[28] Our preintervention results regarding antibiotic awareness levels are in line with the findings of other UAE studies. Our study is subjected to some limitations also including restriction to a single emirate of UAE; therefore, the study results may not be generalizable, pre–post study design (for evaluation of interventions, RCTs are ideal), selection bias due to inability to select random sample, and paucity of data on long-term impact of this intervention.

Improving awareness and understanding of antibiotics and their use can play an important role in tackling rapid emergence of antibiotic resistance. Our findings add to the existing evidence that focused community-based educational programmes can improve the knowledge and behaviours regarding antibiotic use and resistance.

Conclusion

The awareness of antibiotics and antibiotic resistance was low among the study participants. A community-based intervention, directed at improving the awareness of the study participants towards antibiotics, was implemented. Following the intervention, antibiotic-related awareness was significantly improved. Further efforts should be made to ensure that this improved awareness is converted to necessary health behaviour changes in the long term.

Declarations

Conflict of interest

The Author(s) declare(s) that they have no conflicts of interest to disclose.

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Authors' contributions

SAR was involved in conceptualization of the study, study design, literature search, data analysis and manuscript preparation, editing and review. SBS was conceptualization of the study, study design, manuscript editing and review. DA, HAS and HAU were involved in study design, literature search, conduct of the study and data acquisition for the study. AM was involved in the study design, data analysis, manuscript preparation, editing and review. FE was involved in data analysis, manuscript preparation, editing and review.

References

1. WHO. *Antimicrobial Resistance [Internet]*. World Health Organization, 2018. https://www.who.int/en/news-room/fact-sheets/detail/antimicrobial-resistance (accessed 14 September 2019).
2. *World Health Leaders Agree on Action to Combat Antimicrobial Resistance, Warning of Nearly 10 million Deaths Annually if Left Unchecked | Meetings Coverage and Press Releases [Internet]*. General Assembly of the United Nations, 2016. https://www.un.org/press/en/2016/ga11825.doc.htm (accessed 14 September 2019).
3. WHO. *Global Action Plan on Antimicrobial Resistance [Internet]*. World Health Organization, 2015. https://www.who.int/antimicrobial-resistance/publications/global-action-plan/en/ (accessed 14 September 2019).
4. World Health Organization. *Antibiotic Resistance: Multi-Country Public Awareness Survey [Internet]*. 2015. p. 1–51. http://apps.who.int/iris/bitstream/10665/194460/1/9789241509817_eng.pdf?ua=1 (accessed 29 August 2019).
5. Balkhy HH *et al*. The strategic plan for combating antimicrobial resistance in Gulf Cooperation Council States. *J Infect Public Health* 2016; 9: 375–385.
6. Jairoun A *et al*. Knowledge, attitude and practice of antibiotic use among university students: a cross sectional study in UAE. *BMC Public Health* 2019; 19: 1–8.
7. Salama RAA *et al*. Parents knowledge, attitudes and practice of use of antibiotics for upper respiratory tract infections in children: a cross-sectional study in ras al khaimah, United Arab Emirates. *Epidemiol Biostat Public Health* 2018; 15: 1–9.
8. Ministry of Health and Prevention. *Ministry of Health and Prevention (MoHAP) Organizes 2nd UAE's International Conference on Antimicrobial Resistance (ICAMR) 2019 - Ministry of Health and Prevention - UAE [Internet]*. 2019. https://www.mohap.gov.ae/en/MediaCenter/News/Pages/2070.aspx (accessed 14 September 2019).
9. Ozoemena EL *et al*. Effects of a health education intervention on hypertension-related knowledge, prevention and self-care practices in Nigerian retirees: a quasi-experimental study. *Arch Public Health* 2019; 77: 1–16.
10. Salahshouri A *et al*. Effectiveness of educational intervention based on psychological factors on achieving health outcomes in patients with type 2 diabetes. *Diabetol Metab Syndr* 2018; 10: 1–12.
11. Rabbani SA *et al*. Impact of community-based educational intervention on breast cancer and its screening awareness among Arab women in the United Arab Emirates. *Clin Epidemiol Glob Health* 2019; 7: 600–605.
12. Kandeel A *et al*. An educational intervention to promote appropriate antibiotic use for acute respiratory infections in a district in Egypt- pilot study. *BMC Public Health* 2019; 19: 1–10.
13. Shehadeh MB *et al*. Active educational intervention as a tool to improve safe and appropriate use of antibiotics. *Saudi Pharm J* 2016; 24: 611–615.
14. Alder S *et al*. Community intervention model to reduce inappropriate antibiotic use. *Am J Health Educ* 2010; 41: 20–28.
15. Finch RG *et al*. Erratum: educational interventions to improve antibiotic use in the community: report from the International Forum on Antibiotic Resistance (IFAR) colloquium, 2002. *Lancet Infect Dis* 2004; 4: 44–53.
16. Almohammed RA, Bird EL. Public knowledge and behaviours relating to antibiotic use in Gulf Cooperation Council countries: a systematic review. *J Infect Public Health.* 2019; 12: 159–166.
17. Aziz SA, Kamel FO. Knowledge, attitude and practice toward the use of antibiotics without prescription in Jeddah, Saudi Arabia: a cross-sectional study. *J Med Sci* 2019; 19: 45–50.
18. Bassoum O *et al*. Assessment of general public's knowledge and opinions towards antibiotic use and bacterial resistance: a cross-sectional study in an urban setting, Rufisque, Senegal. *Pharmacy* 2018; 6: 103.
19. Deo SK *et al*. Knowledge of use of antibiotic, its resistance and consequences among students in private schools. *J Nepal Med Assoc* 2018; 56: 740–744.
20. Raupach-Rosin H *et al*. Knowledge on antibiotic use, self-reported adherence to antibiotic intake, and knowledge on multi-drug resistant pathogens -results of a population-based survey in lower Saxony, Germany. *Front Microbiol* 2019; 10: 1–8.
21. Carter RR *et al*. A survey and analysis of the American public's perceptions and knowledge about antibiotic resistance. *Open Forum Infect Dis* 2016; 3: 1–7.
22. Belongia EA *et al*. A community intervention trial to promote judicious antibiotic use and reduce penicillin-resistant *Streptococcus pneumoniae* carriage in children. *Pediatrics* 2001; 108: 575–583.

23. West LM, Cordina M. Educational intervention to enhance adherence to short-term use of antibiotics. *Res Soc Adm Pharm* 2019; 15: 193–201.
24. Prigitano A *et al*. Antibiotic resistance: Italian awareness survey 2016. *J Infect Public Health* 2018; 11: 30–34.
25. Salm F *et al*. Antibiotic use, knowledge and health literacy among the general population in Berlin, Germany and its surrounding rural areas. *PLoS One* 2018; 13: 1–11.
26. Al Kaabi MR *et al*. Rising bacterial resistance to common antibiotics in Al Ain, United Arab Emirates. *East Mediterr Health J*. 2011; 17: 479–484.
27. Trepka MJ *et al*. The effect of a community intervention trial on parental knowledge and awareness of antibiotic resistance and appropriate antibiotic use in children. *Pediatrics* 2001; 107: e6.
28. Pronk NP *et al*. An integrated framework for assessing the value of community-based prevention: a report of the Institute of Medicine. *Prev Chronic Dis* 2013; 10: 1–6.